April 12, 2021

Ms. Shannon Ames, Executive Director
Low Impact Hydropower Institute
329 Massachusetts Avenue, Suite 2
Lexington, MA 02420

Transmitted via e-mail to comments@lowimpacthydro.org

Subject: **Medway, Orono, Stillwater Projects**

Dear Ms. Ames:

On behalf of its six chapters and their over 2,000 members, Maine Council of Trout Unlimited submits these comments regarding the Black Bear Hydro, a Brookfield Renewable Partners company (Brookfield) applications for Low Impact Hydro Institute (LIHI) certification dated March 18, 2021. We object to the recertification of the Stillwater and Orono and the Medway Projects.

None of the projects have been relicensed by FERC within the last 15 years. The respective relicensing dates are:

- Medway 3/29/1999
- Orono 12/8/2005
- Stillwater 4/20/1998

They all exceed the limits established by the courts for the usefulness of environmental study information.[1] New study data obtained while the LIHI recertification process was in progress shows significant downstream mortality at all the dams. We have attached the reports: Attachment A - Stillwater Project (FERC No. 2712); Orono Project (FERC No. 2710); Milford Project (FERC No. 2534); 2020 Diadromous Fish Passage Report; and Attachment B - Medway Project (FERC No. 2666), Article 405; 2020 Evaluation of Downstream Passage Effectiveness for Adult American Eel.

The Stillwater and Orono projects both are located on the Stillwater Branch of the Penobscot River, and are located in federally designated critical Atlantic salmon habitat. There are a total of three dams located on this five-mile stretch of river and that many dams in such a short stretch of river will drastically affect these waters. None of these dams can reasonably be considered to be low impact. Downstream mortality of radio-tagged alosines recently reported was significant.[2]

[1] American Rivers and Alabama Rivers Alliance v. FERC and United States Secretary of the Interior, No. 16-1195 (D.C. Cir. 2018)

[2] Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization Lower Penobscot River Projects Milford Hydroelectric Project (FERC No. 2534) Stillwater Hydroelectric Project (FERC No. 2712) Orono Hydroelectric Project (FERC No. 2710) dated February 2021, page 50.

The Medway Project in also located in federally designated critical Atlantic salmon habitat. The project includes the first dam upstream on the West Branch of the Penobscot. This is an effective upstream barrier to the of stream passage of all diadromous species with the exception of American eels. Besides Atlantic salmon, American shad are also affected. It should be noted that Shad Pond located upstream on the West Branch of the Penobscot is a pool so named because of its former shad runs.[3] Shad are also adversely affected by the dams included in the application. Like Atlantic salmon, shad were once an important food source in Maine. In addition to the lack of upstream fish passage, a new study shows significant downstream mortality to American eels.[4]

Besides the Endangered Species Act, there is another important factor to weigh when considering these projects. The Penobscot Indian Nation was promised a sustenance fishery on the Penobscot that has yet to be provided. These projects continue to impede delivery on that promise.

While the Penobscot River Project gave Atlantic salmon restoration renewed hope, the outcome is far from certain. The methodology used to designate critical habitat requires that all critical habitat be restored for restoration goals to be achieved. These projects degrade significant stretches of that habitat, both for Atlantic salmon and for the coevolved indigenous species so vital to their recovery.

Maine Department of Marine resources recommended that recertification of these projects be delayed and we have attached their letter as Attachment C. Maine TU Council heartily agrees.

It should also be noted that LIHI has become aware of the questionable status that it certification bestows, and reflected this in its proposal to modify the process.[5] Maine TU Council Comments[6] cited a number of other LIHI certified projects in the state that have obvious impacts, the worst being another Brookfield project: the **Rumford Falls Project in Rumford, Maine that dewaters the largest waterfall east of Niagara for months at a time during the summer.**

Maine TU Council implores LIHI to reconsider the renewal of LIHI certification of these projects. **Is it truly in the best interests of LIHI or the hydro industry for these projects to join Rumford Falls as recertified as *low impact*: *Medway that represents the first complete barrier to upstream fish passage on the Penobscot, Maine's most iconic Atlantic salmon river; and the Stillwater River projects that degrade critical Atlantic salmon habitat? Recertification of these projects is effectively an endorsement of the extirpation of native Atlantic salmon from the United States, and an affront to the Penobscot Indian Nation.* Please deny the application or at the very least, hold certification in abeyance for these projects until they are relicensed or until LIHI has resolved its recertification criteria.**

[3] The Founding Fish by John McPhee Published September 10th 2003 by Farrar, Straus and Giroux (first published 2002), ISBN13: 9780374528836.
[4] Brookfield report RE: Medway Project (FERC No. 2666), Article 405; 2020 Evaluation of Downstream Passage Effectiveness for Adult American Eel dated February 15, 2021, page 2.
[5] LIHI Recertification Proposal Dated October 27, 2020
[6] Maine Council of Trout Unlimited letter dated January 27, 2021, Subject: Recertification Proposal Comments

Too often, LIHI certification results in no value added for the environment beyond that provided by the FERC relicensing process. The only value is to the applicant who can then market its electricity as low impact renewable energy. Should LIHI certify these projects under the conditions that we have described, it would serve to further underline just how misrepresentative those criteria are and how misleading that your organization can be in its use of the term "*low impact.*"

Maine TU Council appreciates the opportunity to comment on the recertification.

Respectfully,

Stephen G. Heinz
Maine TU Council FERC Coordinator

Reply to: heinz@maine.rr.com

Attachments:

A - Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization Lower Penobscot River Projects Milford Hydroelectric Project (FERC No. 2534) Stillwater Hydroelectric Project (FERC No. 2712) Orono Hydroelectric Project (FERC No. 2710) dated February 2021

B - Brookfield report RE: Medway Project (FERC No. 2666), Article 405; 2020 Evaluation of Downstream Passage Effectiveness for Adult American Eel dated February 15, 2021

C - Maine Department of Marine Resources comments on Stillwater, Orono and Medway recertification

Attachment A

February 15, 2021

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Stillwater Project (FERC No. 2712); Orono Project (FERC No. 2710); Milford Project (FERC No. 2534); 2020 Diadromous Fish Passage Report

Dear Secretary Bose:

On behalf of the licensees for the Projects listed below, Brookfield Renewable (Brookfield) is filing this 2020 Diadromous Fish Passage Report for the Milford, Stillwater, and Orono hydroelectric projects, which are located on the Penobscot River in Maine:

- **Milford Project (FERC No. 2534),** licensed to Black Bear Hydro Partners, LLC
- **Orono Project (FERC No. 2710),** licensed to Black Bear Hydro Partners, LLC; Black Bear SO, LLC; and Black Bear Development Holdings, LLC
- **Stillwater Project (FERC No. 2712),** licensed to Black Bear Hydro Partners, LLC; Black Bear SO, LLC; and Black Bear Development Holdings, LLC (collectively "Black Bear")

Pursuant to Commission Orders "*Amending License and Revising Annual Charges*" for the Orono and Stillwater Projects (both dated September 14, 2012) and "*Approving Fish Passage Design Drawings Under Articles 407 and 408"* for the Milford Project (dated October 9, 2012), and consistent with the June 25, 2004 Lower Penobscot River Multiparty Settlement Agreement (Settlement Agreement), aspects of which were incorporated into the Orono Project license on December 8, 2005 and the Stillwater and Milford Project licenses on April 18, 2005, the licensees constructed and installed upstream and downstream fish passage systems at the Milford, Stillwater (downstream only), and Orono Projects in 2013 and 2014 to facilitate the passage of diadromous fish species on the Penobscot River. Articles 408, 409, and 411 of the Stillwater, Milford, and Orono Project licenses, respectively, also require evaluations of the constructed fishways to determine their effectiveness at passing alosines (collectively American shad, blueback herring, and sea run alewives) and American eels.

Background

To evaluate the performance of the new fish passage facilities at passing alosines and American eels, the licensees have performed monitoring studies at these Projects since 2014. A listing of these studies is as follows:

- **2014**: Conducted qualitative investigations of (1) American eel upstream passage at the Stillwater and Orono Projects (site location surveys), (2) adult eel presence via electrofishing and netting surveys, and (3) fish passage through the downstream surface fishways using underwater video.

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- **2015**: Conducted (1) a radio-telemetry study to evaluate the upstream and downstream passage of adult river herring at the Milford and Orono Projects, (2) a pilot tagging study of juvenile alosines, (3) underwater video camera monitoring of the Stillwater downstream low-level American eel fishway, and (4) underwater video camera monitoring of the upstream fish lift entrances at the Milford and Orono Projects.

- **2016**: Conducted a downstream eel passage radio telemetry study at the Milford, Stillwater, and Orono Projects.

- **2017**: Conducted a radio telemetry study of adult American shad downstream passage at the Milford, Stillwater, and Orono Projects

- **2018:** Conducted (1) a radio telemetry study of adult river herring downstream passage at the Orono, Stillwater and Milford Projects, and (2) a second year radio telemetry study of adult American shad downstream passage at the Milford Project following structural modifications to the Project's outer intake rack.

- **2019:** Conducted an evaluation of adult river herring upstream passage at the Milford Project.

Additional diadromous fish passage studies conducted by the licensees at these Projects since 2014, which have been reported separately to the Commission, have included downstream Atlantic salmon smolt studies and upstream eel passage studies at all three Projects, plus two years of upstream adult Atlantic salmon passage studies at the Milford Project. In addition, the licensees continued collaboration with the Maine Department of Marine Resources (MDMR) to collect upstream fish lift tallies of fish at the Milford and Orono Projects in 2020 (see Table 1), including the trucking of river herring upriver from Orono.

Table 1. Annual quantitative counts of American shad and river herring at the Milford and Orono Project fish lifts in the lower Penobscot River, Maine.

	Milford		Orono	
	American shad	River Herring	American shad	River Herring
2014	812	187,429	0	2,075
2015	1,806	589,503	1	19,016
2016	7,862	1,259,384	6	78,700
2017	3,868	1,256,061	0	90,483
2018	3,958	2,174,745	6	93,939
2019	2,522	1,987,681	9	163,126
2020	11,276	1,952,537	2	111,518
TOTAL	32,104	9,407,340	24	558,857

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2020 Evaluations

For 2020, two study plans were submitted to the Commission (on April 15, 2020) for studying diadromous fish passage at these Projects, including the "*Study Plan for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization*" and the "*Study Plan for the Desktop Assessment of Juvenile Alosine Project Passage Survival"*. Together, and as requested by the resource agencies[1] and Penobscot Indian Nation (PIN), these two studies allowed whole station survival estimates of juvenile alosines to be generated for each Project.

Please find attached two reports covering these 2020 studies of juvenile alosine passage at the Milford, Stillwater, and Orono Projects. The first report, entitled "*Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization*", details an assessment of downstream passage route utilized by out-migrating juvenile alosines at the Projects. The second report, entitled "*Study Report for the Desktop Assessment of Juvenile Alosine Project Passage Survival*", utilizes a Turbine Blade Strike Analysis desktop tool developed by the United States Fish and Wildlife Service to probabilistically model turbine survival. The two studies were conducted in tandem to produce whole station survival estimates for juvenile river herring for each of the three Projects, as traditional methods of using radio telemetry alone to generate survival estimates won't work for the juvenile river herring due to their small size and fragile nature.

Drafts of these reports were distributed for resource agency and tribal review on December 10, 2020. Following a request by the resource agencies and PIN for additional time to review these reports, along with an associated December 28, 2020 extension of time request filed by the licensees, the Commission issued an order on January 11, 2021 to extend the deadline for filing these reports to February 15, 2021. A consultation meeting was then remotely held on January 27, 2021 with the resource agencies and PIN to present and review the study results and to answer questions. Responses to questions and comments received during the January 27th meeting are respectively provided in Appendices A and B of the attached desktop survival assessment and passage route reports, while correspondence associated with the agency and tribal reviews of the reports are provided in Appendices B and C of the respective reports. Finally, a copy of the PowerPoint slides prepared and presented by Normandeau Associates at the January 27th meeting are also attached in Appendices C and D of the reports. Where appropriate, the reports have been revised based on the comments received.

The licensees intend to continue quantitative alosine evaluations at the lower Penobscot River Projects in 2021, and a study plan will be provided to the Commission by April 1, 2021 (following the Commission's January 28, 2021 approval of the licensees' one-month time extension request). The licensees also intend to continue to collaborate with MDMR in 2021 to collect upstream fish lift tallies of migratory fish at the Milford Project and will continue to report counts of migratory fish that use the Orono fish lift.

[1] Maine Department of Environmental Protection (MDEP); MDMR; Maine Department of Inland Fisheries and Wildlife (MDIFW); United States Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS); Bureau of Indian Affairs (BIA)

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Status Update on FERC's March 6, 2020 Request

On March 6, 2020, the Commission provided a response to the diadromous fish passage studies conducted by the licensees at the Milford, Stillwater, and Orono Projects in 2018 and 2019. In the letter, the Commission identified three recurring requests/concerns in resource agency and PIN comments, including (1) performance standards, (2) migratory delay, and (3) operational conditions. The Commission requested that the licensees conduct additional analysis or consultation with the stakeholders regarding these issues, and then include any consultation letters or emails regarding these issues in this 2020 Diadromous Fish Passage Report. The Commission further requested that the licensees describe actions that are being taken toward a resolution of these three issues.

Following an initial discussion regarding these issues during a March 18, 2020 conference call with the resource agencies and PIN (to review the 2020 study plans), the licensees have subsequently hosted three Teams Meetings with the stakeholders to discuss the issues identified in the Commission's March 6, 2020 letter. Notes from two of the three meetings, which were held on June 3, 2020, September 9, 2020, and February 10, 2021, are attached (finalized notes from the February 10th meeting will be provided to the Commission by April 1, 2021, together with the 2021 study plan submittal; the resource agencies and PIN provided no comments following their reviews of the attached June 3rd and September 9th meeting notes). To facilitate this effort, the licensees compiled a comprehensive summary (attached) of both qualitative and quantitative alosine and eel passage studies conducted at the Milford, Orono, Stillwater, and other hydro projects. Information provided in the summary tables included: river conditions during the studies, general and unique operational conditions, passage success estimates, and residence durations.

<u>Performance Standards</u>

The Commission's March 6, 2020 letter notes that Black Bear's 2019 Diadromous Fish Passage Report references the dam passage performance standard model for the Penobscot River developed for American shad (Stich et. al., 2018). The model estimates the effects of dam passage and migratory delay on management goals for shad (i.e., abundance, spatial distribution of spawning adults, and proportion of repeat spawners in space and time). The 2019 Report provides a comparison of the river herring passage results, where approximately 58 percent of the river herring passed upstream within 24 hours and 79 percent within 48 hours of arrival at the Milford Project, with the model finding that upstream passage efficiencies of 60 percent or greater within 48 hours are needed to meet interim recovery targets for shad.

The Commission requests that the parties discuss the potential for passage criteria using the published model and consider a re-examination of radio telemetry studies completed for adult alosines from 2017 to 2019 to potentially inform the understanding of those results in regard to management objectives and/or determining what additional information is needed. The dam performance standard model for American shad has been extensively discussed during the agency and PIN meetings, including with the participation of one of its authors. Key inferences from these model discussions to date include the importance of downstream passage survival, the model's need for updated fisheries management goals and objectives, and the fact that the lower Penobscot downstream passage study results to date appear to meet the criteria used in the model that demonstrate achievement of alosine restoration goals.

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Overall, the parties support the use of the model as a backdrop for the ongoing diadromous fish passage studies at the Stillwater, Orono, and Milford projects, and for informing the evaluation of fish passage effectiveness in light of recovery goals for shad and river herring populations on the Penobscot River.

Migratory Delay

Regarding migratory delay, the model emphasizes upstream and downstream passage in the context of 24 and 48 hour fish residence times in the vicinity of the Projects. However, the residence times for some of these species, life-stages, and migratory directions need to be considered in the context of their migration stage (e.g. pre-spawn, post-spawn), along with the environmental cues (especially for eels) that stimulate downstream migration behaviors. The model may be informative to these discussions, and any delay will continue to be investigated as part of ongoing diadromous fish passage studies, as will conversations regarding various measures that may reduce delay at the Projects.

Operational Conditions

The Commission emphasized in the March 6, 2020 letter that fish passage Articles for each Project require that the licensees consult with the resource agencies and PIN if the results of monitoring indicate that changes in project structures or operations are necessary to protect fish resources. Based on its review of the completed studies, the Commission recognized that the licensees have been making modifications to facility structures and operations based on the results of the studies to improve passage conditions for diadromous fish. Most recently, Black Bear has committed to the prioritization of Stillwater B station over Stillwater A during the downstream eel and alosine migration seasons, based on the 2020 juvenile alosine study results and as discussed during a February 5, 2021 Teams Meeting with the resource agencies and PIN. Final details of this operational change will be included in the 2021 study plan submittal, which is due to the Commission by April 1, 2021. Below are examples of other structural and operational changes made and further measures that the licensees have taken at the Stillwater, Orono, and Milford Projects to improve passage conditions for diadromous fish since the new fish passage facilities were completed in 2014 and monitoring studies began:

Stillwater

- Hired dedicated seasonal staff and a full-time fisheries biologist to supervise, inspect, monitor and operate the Stillwater downstream fish passage facilities and upstream eel passage.
- Repaired gaps in the trashracks at Stillwater A Station to prevent eel entrainment.
- Instituted annual dive inspections of the trashracks for both Stillwater powerhouses to ensure integrity prior to the eel outmigration season.
- Installed stop logs to increase the depth of the Stillwater B downstream fishway plunge pool.

- Increased the height of the Stillwater B plunge pool wall to prevent water and fish from spilling over the top and onto ledges below.

- Extended the climbing substrate at the entrance to the upstream eel passage based on the first-year study results.

- Conducted surveys of the spillway bypass area during raising and caulking of the flashboards to search for and relocate stranded fish.

- Amended the Stillwater Project FERC license to redirect minimum flows in order to enhance upstream eel passage.

Orono

- Made operational changes to substantially increase the number of river herring trucked upstream from the Orono fish trapping facility, including:
    - Utilizing dedicated seasonal fish passage staff to operate the facility and transport fish upstream.
    - Purchased additional transport trucks and trailers.
    - Refined operations, including (1) increasing the number of fish per truck load based on MDMR river herring trucking procedures, and (2) use of underwater cameras to improve overall efficiency resulting in more fish moved during peak migration days.

- Instituted annual dive inspections of the trashracks to ensure integrity prior to the eel outmigration season.

- Instituted annual external engineering inspections of fish lift hoists, cables, etc. prior to the start of operations to reduce the risk of catastrophic failure.

- Implemented a significant pre-season operational and maintenance start-up procedure, an end of season shut-down procedure, and bolstered the spare parts inventory for the fish lift.

- Increased the height of the blocking screen upstream of the fish lift hopper to ensure that fish cannot pass over the screen during times of extremely high tailwater elevations.

- Replaced a 90 degree turn in the Orono downstream fishway with a rounded curve to streamline flows and reduce water overtopping and loss of fish over the fishway wall.

- Modified (shortened by 6 feet) the steel discharge flume of the downstream passage to reduce turbulence at the entrance to the fish lift in order to improve fish attraction.

- Modified the wedge-wire screen floor in the downstream fish passage/fish lift auxiliary water flow transition box with a punch plate overlay to reduce debris load and provide supplemental protection for downstream fish migrants.

- Implemented procedures during impoundment maintenance drawdowns to prevent dewatering of the Orono Project bypass area.
- Conducted surveys of the spillway bypass area during raising and caulking of flashboards to search for and relocate stranded fish.
- Prioritized operation of Station A over Station B at the Orono Project during the smolt downstream migration window based on empirical study survival results.

Milford

- Hired dedicated seasonal staff and a full-time fisheries biologist to supervise, inspect, monitor, and operate the upstream fish lift, downstream fish passage facilities, and upstream eel passage at the Milford Project.
- Installed two backwatering bulkheads and a false ceiling system at the Milford fish lift to alleviate an entrained air issue; these improvements resulted in refined operations to meet USFWS engineering flow criteria for fish lifts and improve fish passage.
- After low use and low fish survival was noted in the Bay 7 downstream fish passage at Milford, an investigation found debris blocking the passage, which was later removed.
- Visual inspections of the Bay 2 and Bay 7 downstream fish passage entrance weirs for debris and to verify proper flow to identify any potential obstructions.
- Sealed gaps in the Milford attraction water system that were causing adult eel mortalities.
- Instituted annual dive inspections of the trashracks and fish lift auxiliary water system screen to ensure integrity prior to the eel outmigration season.
- Instituted annual external engineering inspections of fish lift hoists, cables, etc. prior to the start of fish lift operations to reduce the risk of catastrophic failure.
- Implemented a significant pre-season operational and maintenance start-up procedure, an end of season shut-down procedure, and bolstered the spare parts inventory for the fish lift.
- Installed weirs in the Milford outer trashracks to enhance downstream shad passage.
- Refined the flashboard caulking strategy on the west side of Milford Dam, thereby providing continuous egress flow into the spillway bypass area to reduce fish stranding.
- Successfully reconfigured the upstream eel passage.
- Conducted surveys of the spillway bypass area during raising and caulking of flashboards to search for and relocate stranded fish.

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- During dam safety repairs at Milford, filled several ledge crevices with concrete to prevent fish stranding, and installed a sloped transition on the Obermeyer spillway toe to smooth the flow of water (and any downstream-migrating fish) to the tailrace.

- In a collaborative effort with MDMR, resolved key structural and operational issues associated with the secondary lift/sorting facility, which have significantly reduced the occurrence of shad mortality within the fish lift flume from approximately 8% down to about 1%. Several operational and structural changes were also made at the primary Milford fish lift to reduce shad mortalities, such as addressing sharp ends and gaps in and around the primary hopper that were resulting in injuries to fish.

- Modified the Milford fish lift operations to allow fish passage at night during peak passage periods for eel and sea lamprey, and when handling temperature criteria for Atlantic salmon are exceeded.

Please feel free to contact me by e-mail at Kevin.Bernier@brookfieldrenewable.com or by phone at (207) 951-5006 if you have any questions or comments.

Sincerely,

Kevin Bernier

Kevin Bernier
Senior Compliance Specialist

Attachments

cc: S. Ledwin, M. Simpson, C. Clark, G. Wippelhauser, J. Valliere; MDMR
D. McCaw, J. Banks; PIN
H. Peterson, C. Mokhtarzadeh; BIA
B. Sojkowski, J. Rosset; USFWS
J. Murphy, D. Dow; NMFS
J. Perry, K. Dunham, K. Gallant; MDIFW
K. Howatt, C. Sferra; MDEP
S. Michaud, N. Stevens, B. Brochu, J. Cole, R. Dill, K. Maloney, L. Macomber; Brookfield
D. Trested, Normandeau

Brookfield Files: HSSE 4a/Stillwater/01; HSSE 4a/Orono/01; HSSE 4a/Milford/01

Study Report
for the
2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization

Lower Penobscot River Projects

Milford Hydroelectric Project (FERC No. 2534)
Stillwater Hydroelectric Project (FERC No. 2712)
Orono Hydroelectric Project (FERC No. 2710)

Prepared For

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ENVIRONMENTAL CONSULTANTS

February 2021

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1 Introduction

Affiliates of Brookfield Renewable (Brookfield) own and operate hydroelectric projects in the Penobscot River watershed pursuant to licenses issued by the Federal Energy Regulatory Commission (FERC). Among those projects, the Milford Project (FERC No. 2534) is licensed to Black Bear Hydro Partners, LLC, and the Stillwater (FERC No. 2712) and Orono (FERC No 2710) Projects are licensed to Black Bear Hydro Partners, LLC, Black Bear SO, LLC, and Black Bear Development Holdings, LLC (collectively, “Black Bear”).

Background:

Pursuant to the amended Project licenses and a 2004 settlement agreement between the licensees, state and federal agencies, Penobscot Indian Nation (PIN), and other stakeholders, the licensees developed a comprehensive upstream and downstream fish passage program to facilitate the passage of diadromous species on the Penobscot River. FERC license amendment orders for Orono, Stillwater, and Milford contain Articles 411, 408 and 409, respectively, requiring the licensees to develop study plans to monitor the effectiveness of the fish passage facilities. All fish passage monitoring plans are to be developed in consultation with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), PIN, Maine Department of Marine Resources (MDMR), and Maine Department of Inland Fisheries and Wildlife (MDIFW).

A Diadromous Fish Passage Study Plan (DFPSP) describing studies to evaluate the performance of the new fish passage facilities for alosines and American eels was approved by FERC on February 11, 2014. Pursuant to the DFPSP, the licensees performed qualitative monitoring studies in 2014 to evaluate the use of the new fishways and to assess the availability of alosines and adult eels for future quantitative studies at the three hydroelectric Projects. In 2015, Black Bear proposed and performed quantitative radio tagging studies of upstream migrating adult river herring at Milford and Orono and conducted a pilot downstream radio tagging study of juvenile alosines. Neither study provided meaningful results, as ninety percent of the radio tagged adult river herring fell back downriver after tagging/release and did not return, and almost all of the juvenile river herring (including tagged and control fish) died with 48 hours. Based on the 2015 study results, the licensees did not propose any quantitative studies of alosines for 2016, other than upstream passage tallies of alosine fish species at the Milford and Orono fish lifts. Black Bear instead focused on American eel passage in 2016 at the three Projects by studying both upstream juvenile eel passage (via nighttime surveys and video/direct tally evaluations of the new and modified upstream eelways) and downstream adult (silver-phase) eel passage utilizing radio-tagged eels from an out of basin supplier. The upstream juvenile eel passage surveys and video observations were repeated during 2017 at Stillwater to evaluate modifications made to the upstream eel passage entrance.

Black Bear has most recently evaluated downstream passage of adult American shad at Milford (2017 and 2018), Stillwater (2017), and Orono (2017) and of adult river herring during 2018 at Milford, Stillwater and Orono. The 2017 and 2018 adult alosine downstream passage studies evaluated residence duration upstream of each dam, downstream passage route selection, and project reach survival. During the spring of 2019, Black Bear conducted a "proof of concept" evaluation to develop a set of methodologies to be used in the evaluation of adult river herring upstream passage effectiveness. The revised approach led to a successful evaluation of the existing Milford fish lift for upstream passage of adult river herring during spring 2019. During the most recent field season (October 2020), Black Bear evaluated downstream passage route selection for radio-tagged juvenile alosines at the Milford, Stillwater, and Orono Projects.

Study Plan Development:

Prior to performing this downstream passage assessment, the licensees developed a draft study plan for review by the resource agencies[1]. A draft version of the study plan was distributed to members of the MDMR, NMFS, USFWS, MDIFW, Maine Department of Environmental Protection (MDEP) and the PIN on February 20, 2020. The licensees requested that any comments related to the draft Evaluation of Downstream Juvenile Alosine Passage Route Utilization Study Plan be submitted in writing by March 23, 2020. The draft study plan was discussed during a conference call between Black Bear, the resource agencies, and PIN on March 18, 2020. Following receipt and incorporation of agency comments, the final study plan was filed with FERC on April 15, 2020.

Study Report Development:

The 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization study was conducted following the methodologies presented in the April 15, 2020 FERC-filed study plan. A draft report summarizing results from that effort was distributed by the licensees for the Milford, Stillwater, and Orono Projects to the agencies and PIN on December 10, 2020. As part of the December 10 distribution correspondence, Black Bear indicated a virtual meeting would be held in early January to discuss the study results and requested receipt of written comments related to the draft report by January 11, 2021. At the request of the agencies and PIN, the licensees for the Milford, Stillwater, and Orono Projects submitted a time extension request to the Commission on December 28, 2020 for submittal of the annual eel and alosine study report for these lower Penobscot facilities. The Commission approved this request on January 11, 2021, thereby extending the report submittal deadline to February 15, 2021.

A consultation meeting to discuss the 2020 study results was held virtually on January 27, 2021, and Normandeau provided an overview of the study methods and results to representatives from Brookfield, NMFS, USFWS, MDMR, MDEP and the PIN. A summary of questions and comments from the January 27 meeting is provided in Appendix B. Correspondence related to the distribution of the draft study report, as well as written comments received following agency review, are provided in Appendix C. A copy of the PowerPoint slides presented by Normandeau at the January 27, 2021 meeting is also provided in Appendix D.

[1] Normandeau Associates, Inc. (Normandeau). 2020. Study Plan for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization. Plan prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, and Black Bear Development Holdings, LLC. Plan dated April 2020.

1.1 Study Objectives

As described in the FERC-filed Study Plan, the objectives of the 2020 downstream passage route evaluation for juvenile alosines in the lower Penobscot River were to:

- Evaluate the residence time from arrival until downstream passage at the Milford, Stillwater, and Orono Projects, and
- Determine the proportional downstream passage route selection at the Milford, Stillwater, and Orono Projects.

2 Project Descriptions

2.1 Milford

Following removal of the downstream Great Works and Veazie dams in 2012 and 2013, respectively, the Milford Project dam, located in the towns of Milford and Old Town, Maine, became the lowermost dam on the main stem of the Penobscot River. The Milford Project has a generating capacity of 8,230 kilowatts (kW), six generating units, a minimum hydraulic capacity of 500 cfs, and a maximum hydraulic capacity of 6,730 cfs. The downstream fish passage facilities at the Milford Project consist of two surface bypass flumes passing through the powerhouse wall at the western end and center of the powerhouse. The entrances are located at the face of the interior full-depth trashracks, which have 1-inch clear spacing. Each surface bypass is capable of passing up to 280 cfs. The licensee has also installed a low-level bypass for American eels at the bottom of the trashracks, directly below the surface bypass entrance at the west end of the powerhouse. The low-level bypass is designed to pass up to 70 cfs and has a 4-foot by 4-foot entrance that reduces to a 24-inch-diameter pipe, which in turn discharges into an unused turbine bay. The two surface bypasses are opened for the duration of the juvenile alosine outmigration period, while the low-level bypass is open from August 15 to November 15 annually to provide downstream eel passage. In addition to the downstream passage facility described above, a bypass sluice is also located at the downstream end of the exit flume of the upstream fish passage facility. This sluice can be used for incidental downstream passage of fish that end up in the exit flume. Non-generational flow can also be passed via a 25 foot-wide bottom-opening sluice gate located adjacent to the mid-channel side of the powerhouse. When fully opened under normal headpond conditions, the sluice gate is capable of passing approximately 2,000 cfs.

2.2 Stillwater

The Stillwater Project is a run-of-river project located on the Stillwater Branch of the Penobscot River in Orono, Maine, approximately 3.7 river kilometers upstream from the confluence of the Stillwater Branch with the main stem of the Penobscot River. The confluence of the Stillwater Branch with the Penobscot River is approximately 53 river kilometers upstream from the Atlantic Ocean, and 8 river kilometers downstream of the Milford Project. The Project has a generating capacity of 4,170 kW, a minimum hydraulic capacity of 100 cfs, and a maximum hydraulic capacity of 3,498 cfs. Powerhouse A has four generating units, and Powerhouse B has three units.

In 2013, the licensees replaced the downstream bypass facility at the Stillwater A powerhouse and constructed a new downstream passage facility at the Stillwater B powerhouse. The new downstream fishways include full-depth trash racks with 1-inch clear spacing at the powerhouse intakes and consist of a single surface bypass and a single low-level bypass (for American eels) at Stillwater powerhouses A and B. At Stillwater A, the bypass entrances are located at the left side of the intake (looking downstream) between the forebay wall and trashracks. The low-level and surface bypasses discharge into the tailwater through a 36-inch-diameter conduit. At Stillwater B, the entrance to the surface bypass is located at the downstream-most end of the trashracks, perpendicular to the face of the trashracks. The surface bypass is a 4-foot by 4-foot notch in the intake wall that discharges into a 5-foot-deep plunge pool. An attraction flow of 70 cfs is provided to the bypass and is controlled by removable stoplogs.

2.3 Orono

The Orono Project is a run-of-river project located on the Stillwater Branch just upstream from the confluence with the main stem of the Penobscot River in Orono, Maine. Powerhouse A is equipped with four generating units, and Powerhouse B is equipped with three units. The total generating capacity of the Project is 6,548 kW; it has minimum and maximum hydraulic capacities of 100 cfs and 3,822 cfs, respectively. A new downstream fish passage system at the Orono Project, which was commissioned in 2014, consists of full-depth angled trashracks with 1-inch clear spacing across both powerhouse intakes, a single downstream surface bypass, and a single low-level bypass for American eels. An attraction flow of up to 150 cfs is provided to the downstream surface bypass through an 8-foot-wide, adjustable entrance. Attraction flow is controlled by a 3-foot-wide adjustable weir that discharges into a plunge pool below the dam.

3 Project Methodology

Radio telemetry was used to evaluate the downstream passage route selection and upstream residence durations for juvenile alosines at Milford, Stillwater, and Orono during the 2020 outmigration period. Following the release of radio-tagged individuals upstream of each of the three Projects, their approach to and passage at the dams was evaluated using a series of stationary receivers.

3.1 Capture, Tagging, and Release Procedures

Juvenile alosines tagged as part of this evaluation were obtained from Souadabscook Stream[2]. Prior to the onset of the 2020 study period, Black Bear coordinated with researchers at the University of Maine to install the weir previously used for the collection of silver-phase American eels from Souadabscook Stream. Low outflow from that system during September and October 2020 prevented collections of juvenile alosines using that device. As a result, Brookfield fisheries staff dip-netted an adequate number of test fish from pools immediately upstream of the weir and transported those fish via truck to a series of holding tanks installed

[2] Souadabscook Stream is a tributary to the Penobscot River which enters the Penobscot in Hampden, Maine, downstream of the Milford Project.

at Milford. The holding tanks were supplied with a continuous flow of Penobscot River water as well as a supplemental feed of bubbled oxygen in the event of a pump failure.

Prior to tagging, fish were lightly anesthetized using diluted soda water (10:1 river water: soda water ratio), and each individual was quickly measured to ensure a total length of at least 100 mm[3]. Lotek NTQ-1 transmitters were attached to a dry fly hook using bonding cement and were spray-painted black to reduce visibility once attached to fish. The hook was inserted posterior to the dorsal fin with the majority of the tag and antenna trailing behind the insertion point. After tagging, fish were placed in holding cans and maintained in ambient Penobscot River water until they were transported to the release site.

For testing, five groups of juvenile alosines were externally radio-tagged and released upstream of each of the three Projects (Figure 3-1). To eliminate safety concerns with boat operations immediately upstream of the hydro facilities during early-evening and nighttime hours, releases during the 2020 were conducted from shore. Individuals were placed in the mainstem of the Penobscot River at the Elks Club boat launch, located on the western shoreline approximately 0.8 km upstream of Milford. Juvenile alosines stocked into the Stillwater Branch were released at the Bennoch Road Old Town Water District Facility, approximately 1.5 km upstream of Stillwater and at the University of Maine steam plant boat launch, approximately 2.2 km upstream of Orono. A number of untagged juvenile alosines were released in conjunction with tagged fish during each release event to provide a “schooling” feel for the tagged fish. All releases were conducted during the evening hours.

3.2 Radio Telemetry Equipment

Movements of radio-tagged juvenile alosines were recorded via a series of stationary radio-telemetry receivers. Radio-telemetry equipment included Orion receivers, manufactured by Sigma Eight, as well as SRX receivers manufactured by Lotek Wireless. All receivers were installed following consideration of the detection requirements for the specific area of coverage, as well as the attributes of the receiver model. Each receiver was paired with either an aerial or dropper antenna. Aerial antennas were utilized to detect radio-tagged fish within the larger, more open sections of river (e.g., the area immediately in front of the unit intakes), and dropper antennas were fixed at appropriate depths within passage structures (e.g., within the downstream bypass). Dropper antennas were custom built by stripping the shielded end of RG58 coaxial cable.

Juvenile alosines were tagged using Lotek NTQ-1 transmitters. The NTQ-1 transmitters measured approximately 5 x 3 x 10 mm, weighed 0.25 g, and had an estimated battery life of 12 days when set at a 2.0 second burst rate. Transmitters for this study operated on one of three

[3] Due to the current minimum sizes of available radio-transmitters, body sizes for this evaluation were limited to individuals greater than 100 mm in length. See Appendix C for a description of pilot studies which helped evaluate this threshold.

distinct frequencies (149.320, 149.340, or 149.360 MHz). Burst rates for the full set of transmitters were programmed at a setting of 2.0 seconds.

3.3 Monitoring Stations

A total of eleven monitoring stations were installed at Milford, eight stations at Stillwater and eight stations at Orono to evaluate downstream route selection for radio-tagged juvenile alosines. Each station consisted of a data-logging receiver(s), one or more antennas, a power source, and was configured to receive transmitter signals from a designated area continuously throughout the study period. During installation of each station, range testing was conducted to configure the antennas and receivers in a manner which maximized detection efficiencies at each location. The operation of the monitoring system as a whole was confirmed during installation and throughout the study period by using beacon tags. A number of beacon tags were stationed at strategic locations within the detection range of one or more antennas and emitted a signal at a programmed time interval. These signals were detected and logged by the receivers and used to record the functionality of the system throughout the study period. Although each monitoring station was installed in a manner which limited the ability to detect transmitters from unwanted areas, the possibility of such detections did still exist. As a result, behavioral data collected in this study (e.g., passage route) was determined based on the signal strength and the duration and pattern of contacts documented across the entire detection array.

The antenna array located at each Project was positioned to detect all tagged fish that approached within approximately 200 meters of the upstream face of the dam. The “approach” receiver logged radio-tagged juvenile alosines as they arrived. A series of antennas were installed at passage points to detect radio-tagged individuals and facilitate the identification of specific passage routes and times. Overviews of the monitoring locations for detection of tagged juvenile alosines are provided in Figure 3-2 for Milford, Figure 3-3 for Stillwater, and Figure 3-4 for Orono. A description of each receiver station is provided here:

3.3.1 Milford Monitoring Stations

Monitoring Station M1: This station consisted of a pair of receivers to provide cross-river aerial coverage of the upstream approach. Receivers were installed at a private residence along the eastern shoreline at a point approximately 700 m upstream of the dam and at a private residence along the western shoreline at a point approximately 400 m upstream of the dam.

Monitoring Station M2: This station consisted of a single receiver and underwater drop coverage of downstream bypass A (i.e., the unused turbine bay number 7 located towards the center of the intake rack structure) and provided detection information for radio-tagged fish having passed downstream via that route.

Monitoring Station M3: This station consisted of a single receiver and underwater drop coverage of downstream bypass B (i.e., the unused turbine bay number 2 located towards the river side of the intake rack structure) and provided detection information for radio-tagged fish having passed downstream via that route.

Monitoring Station M4: This station consisted of a single receiver and aerial coverage of the intake area immediately upstream of the Milford powerhouse and provided detection information for radio-tagged fish present upstream of the intakes and downstream bypass entrances.

Monitoring Station M5: This station consisted of a single receiver and underwater drop coverage of Units 1 and 2. The dropper antennas were positioned at equally spaced intervals across the width of Units 1 and 2 ("new" Milford units) and combined to create a single large underwater antenna for full coverage of both turbines. Detections of a transmitter passing through Units 1 and 2 were collected as a single data set and not identified to a particular turbine.

Monitoring Station M6: Station M6 consisted of a single receiver and underwater drop coverage installed through the access holes to turbine units 3, 4 and 5. The dropper antennas were positioned at equally spaced intervals across the width of Units 3, 4 and 5 ("old" Milford units) and combined to create a single large underwater antenna for full coverage of both turbines. Detections of a transmitter passing through Units 3, 4 or 5 were collected as a single data set and were not identified to a particular turbine.

Monitoring Station M7: This station consisted of a single receiver and aerial coverage of the area immediately downstream of the powerhouse, and when coupled with detection information collected at Stations M2 through M6, was used to confirm passage through the powerhouse turbine units and downstream bypasses. Since there is no access for drop antennas into Unit 6, any individuals passing via that unit were identified by process of elimination (i.e., detection at Station M4 followed by Station M7 with no intermediate detections at Stations M2, M3, M5, or M6. Individuals identified in this manner were pooled with those identified by Station M6 to be representative of passage via the "old" units at Milford.

Monitoring Station M8: Station M8 consisted of a single receiver and aerial coverage of flows passing Milford via the waste gate located adjacent to the powerhouse. Detection information from this location was used to inform on radio-tagged fish having passed downstream via that route.

Monitoring Station M9: This station consist of a pair of receivers and aerial coverage of the region downstream of the Milford Project spillway. These units were installed on the eastern (powerhouse) and western (spillway) sides of the dam and oriented perpendicular to the river channel. Detection information from these receivers were used to inform on radio-tagged fish having passed downstream via that route.

Monitoring Station M10: This station consisted of a single receiver and underwater drop coverage of the bypass sluice located at the downstream end of the exit flume of the upstream fish passage facility and provided detection information for radio-tagged fish having passed downstream via that route.

Monitoring Station M11: This station consisted of a single receiver and aerial, cross-river coverage at a point approximately 2.4 km downstream from the Milford powerhouse tailrace. This receiver was located along the eastern bank of the river and served to provide redundant downstream detection data for juvenile alosines having passed downstream at Milford.

3.3.2 Stillwater Monitoring Stations

Monitoring Station S1: This station was installed at a private residence along the western shoreline and consisted of a single receiver and aerial coverage of the upstream approach area. Station S1 provided cross-river coverage of the headpond area at a point approximately 200 m upstream of the dam.

Monitoring Station S2: This station consisted of a single receiver and underwater drop coverage of the downstream bypass located at powerhouse B and provided detection information for radio-tagged fish having passed downstream via that route.

Monitoring Station S3: Station S3 consisted of a single receiver and aerial coverage of the area immediately upstream of powerhouse B and provided detection information for radio-tagged fish present upstream of the intake racks.

Monitoring Station S4: This station consisted of a single receiver and aerial coverage of the area immediately downstream of powerhouse B, and when coupled with detection information collected at Stations S2 and S3, was used to infer turbine passage through powerhouse B.

Monitoring Station S5: Station S5 consisted of a single receiver and underwater drop coverage of the downstream bypass located at powerhouse A and provided detection information for radio-tagged fish having passed downstream via that route.

Monitoring Station S6: Station S6 consisted of a single receiver and aerial coverage of the area immediately upstream of powerhouse A and provided detection information for radio-tagged fish present upstream of the intake racks.

Monitoring Station S7: This station consisted of a single receiver and aerial coverage of the area immediately downstream of powerhouse A, and when coupled with detection information collected at Stations S5 and S6, was used to infer turbine passage through powerhouse A.

Monitoring Station S8: This station consisted of a single receiver and aerial coverage of the region downstream of the Stillwater Project spillway. It was installed along the eastern shoreline and oriented to cover the region downstream of the spillway

3.3.3 Orono Monitoring Stations

Monitoring Station O1: This station consisted of a single receiver and aerial coverage of the upstream approach area and provided cross-river coverage of the headpond area at a point approximately 200 m upstream of the dam. Station O1 was installed at a private residence along the western shoreline.

Monitoring Station O2: This station consisted of a single receiver and underwater drop coverage of the downstream bypass and provided detection information for radio-tagged fish having passed downstream via that route.

Monitoring Station O3: This station consisted of a single receiver and aerial coverage of the area immediately upstream of powerhouse A and provided detection information for radio-tagged fish present upstream of the intake racks.

Monitoring Station O4: This station consisted of a single receiver and aerial coverage of the area immediately downstream of powerhouse A, and when coupled with detection information collected at Station O3, was used to infer passage through the powerhouse A turbine units.

Monitoring Station O5: This station consisted of a single receiver and aerial coverage of the area immediately upstream of powerhouse B and provided detection information for radio-tagged fish present upstream of the intake racks.

Monitoring Station O6: This station consisted of a single receiver and aerial coverage of the area immediately downstream of powerhouse B, and when coupled with detection information collected at Station O5, was used to infer passage through the powerhouse B turbine units.

Monitoring Station O7: This station consisted of a single receiver and aerial coverage of the region downstream of the Orono Project spillway.

Monitoring Station O8: Station O8 consisted of a single receiver and aerial, cross-river coverage at a point approximately 1.4 km downstream from the Orono powerhouse A tailrace. This receiver was located along the western bank of the river and served to provide redundant downstream detection data for juvenile alosines having passed downstream at Orono.

3.4 Data Collection

3.4.1 Stationary Telemetry Data

Receiver downloads occurred at least once weekly during the period from the initial tag and release event until the date two weeks following release of the final set of radio-tagged fish. This ensured that monitoring occurred over the full warrantied battery life for all transmitters released during the study. Backup copies of all telemetry data were made prior to receiver initialization. Field tests at the time of download to ensure data integrity and receiver performance included confirmation of file integrity, confirmation that the last record was consistent with the downloaded data (beacon tags were critical to this step), and lastly, confirmation that the receiver was operational upon restart and actively collecting data post download. Within a data file, transmitter detections were stored as a single event (i.e., single data line). Each event included the date and time of detection, frequency, ID code, and signal strength.

3.4.2 Manual Telemetry Data

Manual tracking associated with this study was limited to a scan of the Project headpond and tailrace on dates when receivers were downloaded. This effort occurred on a range of dates from the initial tag and release date until two weeks after the final group of test fish was released. Information collected during these events provided confirmation of stationary records from the "approach", intake, and tailrace receivers.

3.4.3 Operational and Environmental Data

In addition to the radio telemetry detection data, river and project operations data were collected for the 2020 evaluation period. Mainstem river temperature was recorded via an Onset temperature logger deployed in the Milford headpond. Project discharge (unit and waste), unit operations, downstream bypass settings, and extent and location of spill were obtained from Black Bear at the completion of the study period.

3.5 Analytical Methodology

3.5.1 Data Processing

Tag detections in each downloaded stationary telemetry data file were validated through a series of site-specific and logical criteria, which included:

1. Signal strength threshold level of the detection,
2. Frequency of the radio tag signals per unit of time, and
3. Spatial and temporal characteristics of each individual detection with respect to the full series of detections at monitoring stations within the entire detection array.

To determine the signal strength threshold for a valid tag signal, power levels associated with background noise were recorded at each monitoring station prior to the release of radio-tagged fish. These "false" signals are typically received at relatively low power levels, and they were removed from the analysis using a series of data filters. The frequency of the signal detections for an individual radio tag was examined at each monitoring station, such that over a set period of time, there were an adequate number of detections to rule out an isolated false detection (e.g. at least 3 detections within 1 minute). Finally, the spatial and temporal distributions of detections across multiple monitoring stations were examined to verify that the pattern of detections was not occurring in a manner that was unreasonable (i.e., time for a fish to have relocated within the time between the detections).

3.5.2 Data Analysis

A complete record of all valid detections for each uniquely coded radio-tagged juvenile alosine was generated, and the pattern and timing of detections in these individual records reviewed. For all radio-tagged juveniles approaching Milford, Stillwater or Orono, the arrival and passage times, as well as the downstream route of passage (i.e., turbine, bypass, or spill) were determined. In addition to downstream passage route usage, the project residence duration was calculated as the duration of time from initial detection at the dam (i.e., detection at the "approach" receiver) until the time at which downstream passage was confirmed at a particular Project.

Figure 3–1. Relative locations of release sites for radio-tagged juvenile alosines upstream of Milford, Stillwater and Orono, October, 2020.

Figure 3–2. Locations for Monitoring Stations M1-M10 during the 2020 juvenile alosine downstream passage route evaluation study at Milford.

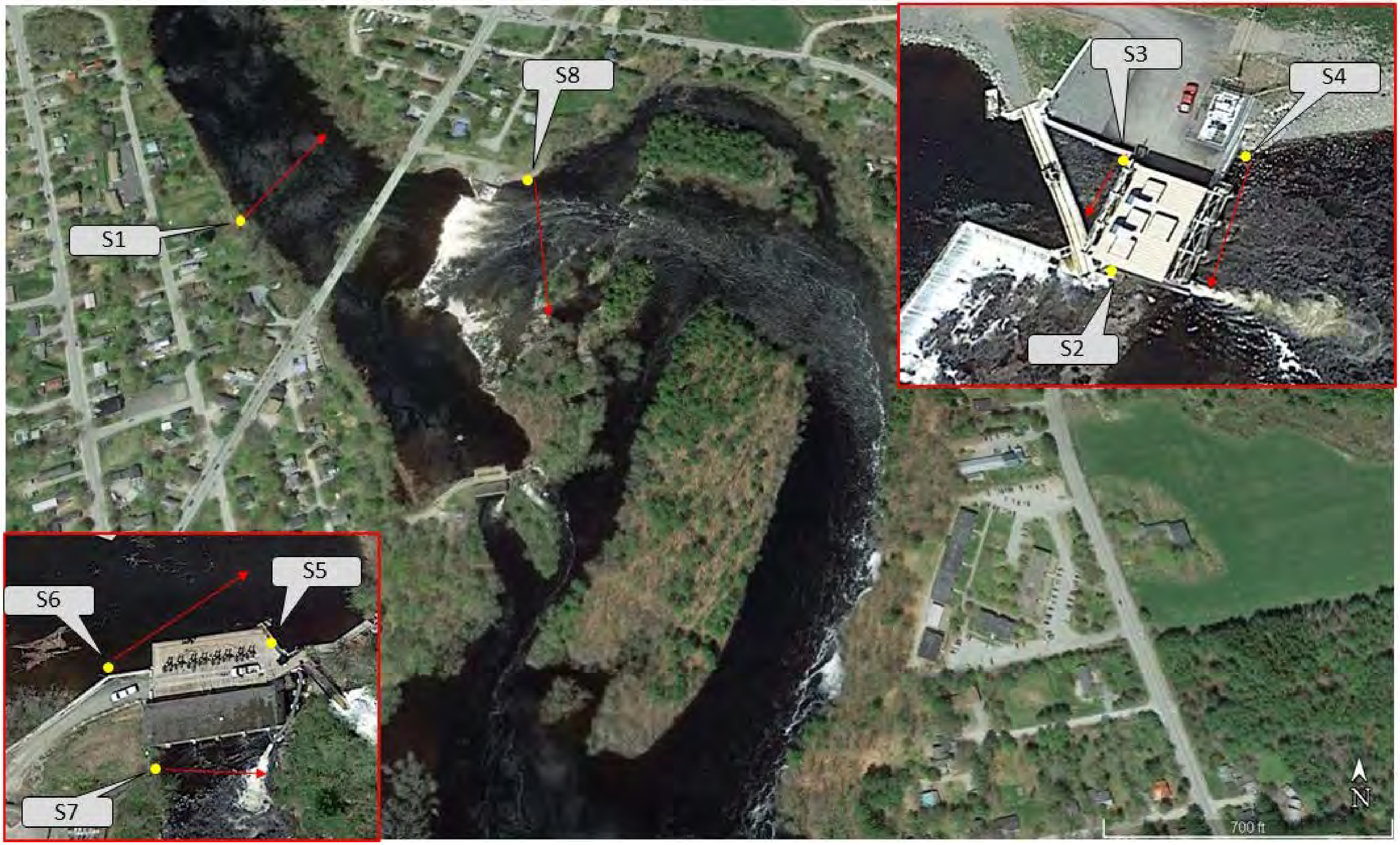

Figure 3–3. Locations for Monitoring Stations S1-S8 during the 2020 juvenile alosine downstream passage route evaluation study at Stillwater.

Figure 3–4. Locations for Monitoring Stations O1-O7 during the 2020 juvenile alosine downstream passage route evaluation study at Orono.

4 Results

4.1 Penobscot River Conditions and Project Operations

The April 2020 study plan indicated that the downstream passage of radio-tagged juvenile alosines would be evaluated under normal “baseline” river and operational conditions for October at Milford, Stillwater and Orono. These conditions were defined in that document as:

- Penobscot River flows within the 20th to 80th percentile for average daily October flows based on West Enfield USGS gage data for the 1990-2019 time period (5,040-14,850 cfs);
- At Milford, the two surface bypass and one low-level bypass entrances are open for the duration of the study period;
- At Stillwater, the surface and low-level bypass entrances are open at powerhouses A and B for the duration of the study period;
- At Orono, the single downstream surface and low-level bypass are open for the duration of the study period;
- Milford, Stillwater and Orono turbine units are operated as ISO and riverine flow conditions permit; and
- Spill conditions at Milford, Stillwater, and Orono are a result of natural inflows in excess of Project capacity.

Figure 4-1 presents the total river flow and water temperature for the Penobscot River during the period October 13 to October 30, 2020. River flow values are as reported by the USGS gage 01034500 for the Penobscot River at West Enfield, Maine. Total flow ranged from 3,060-20,500 cfs (median = 9,480 cfs) from the date of first release on October 13 until the end of the monitoring period on October 30. West Enfield gage flows were at 3,510, 5,150, 10,500, 8,570, and 9,660 cfs at the time of release on each of the five release dates for radio-tagged juvenile alosines at the Lower Penobscot Projects. Although the Penobscot River flow was just below the targeted condition window for the first study release on October 13, flow conditions for the following four releases were within the targeted conditions. Penobscot River water temperature ranged from 11.6 ^{o}C at the time of first release to 6.6 ^{o}C at the end of the monitoring period.

Milford:

Total river flow, as distributed between the downstream fishways, powerhouse and spill during the October 2020 study period at Milford is presented in Figure 4-2. Project flow rose to excess of the Milford station capacity of 6,730 cfs on October 15 and remained elevated for the majority of the remainder of the study period. Black Bear operated the full set of downstream bypasses (two surface entrances and one low-level entrance) for the duration of the study, and those facilities passed approximately 550 cfs. Spill flows were provided by the waste sluice gate and by lowering of the inflatable Obermeyer gate system. Units 1 and 2 (vertical propeller turbines) were offline at the onset of the study until just prior to the third release on October

15. At least one of those two units was in operation until October 28 when they both went offline. Units 3-6 (fixed blade propeller and three Kaplan units) were all online from just prior to the third release until the completion of the monitoring period. Units 5 and 6 were online for the duration of the study period.

Stillwater:

Total river flow, as distributed between the downstream fishways, powerhouses A and B, and spill during the October 2020 study period at Stillwater is presented in Figure 4-3. Project flow rose to excess of the Stillwater station capacity of 3,458 cfs on October 15 and remained elevated for the majority of the remainder of the study period. The downstream bypasses at powerhouse A (surface entrance and low-level entrance) and B (surface entrance and low-level entrance) were operated for the duration of the study, and those facilities passed approximately 140 cfs. Spill flows were passed over the spillway. Turbine units in powerhouse A (Francis units) were offline until just prior to the third release on October 15. At least one powerhouse B turbine (one Kaplan/two vertical propeller) was in operation for the duration of the study.

Orono:

Total river flow, as distributed between the downstream fishways, powerhouses A and B, and spill during the October 2020 study period at Orono is presented in Figure 4-4. Project flow rose to excess of the Orono station capacity of 3,822 cfs on October 15 and remained elevated for the majority of the remainder of the study period. The single surface entrance and single low-level entrance bypasses were operated for the duration of the study, and those facilities passed approximately 200 cfs. Spill flows were passed over the spillway. Turbine units in powerhouse A (Francis units) were offline until just prior to the fourth release on October 16. With the exception of two brief interruptions (0900-1000 on October 19 and 1000-1200 on October 20), at least one powerhouse B turbine (one Kaplan/two vertical propeller) was in operation for the duration of the study.

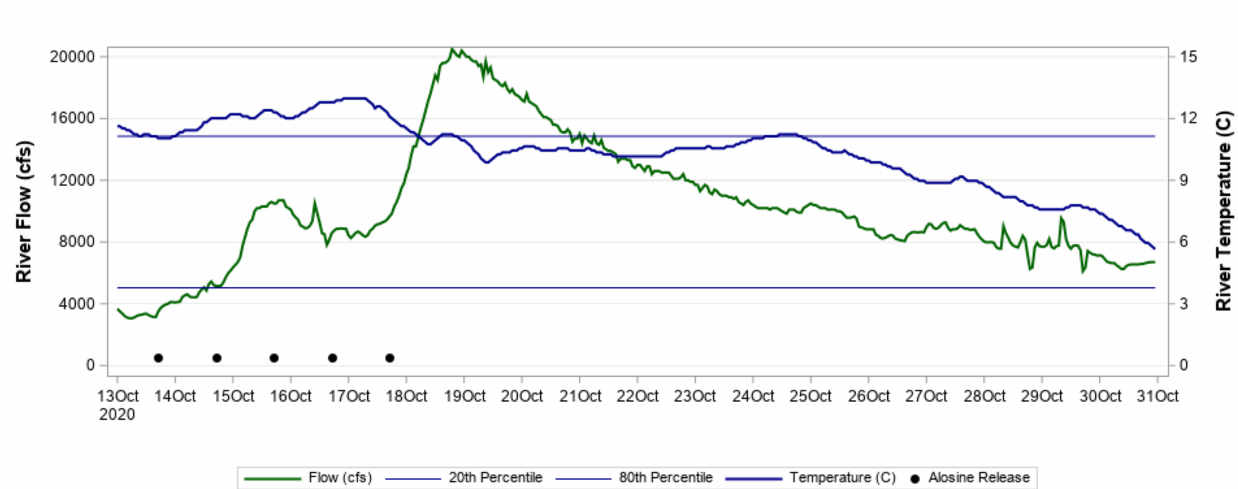

Figure 4–1. Penobscot River flow (USGS gage 01034500 at West Enfield) and river temperature (Milford headpond) for the period October 13-30, 2020.

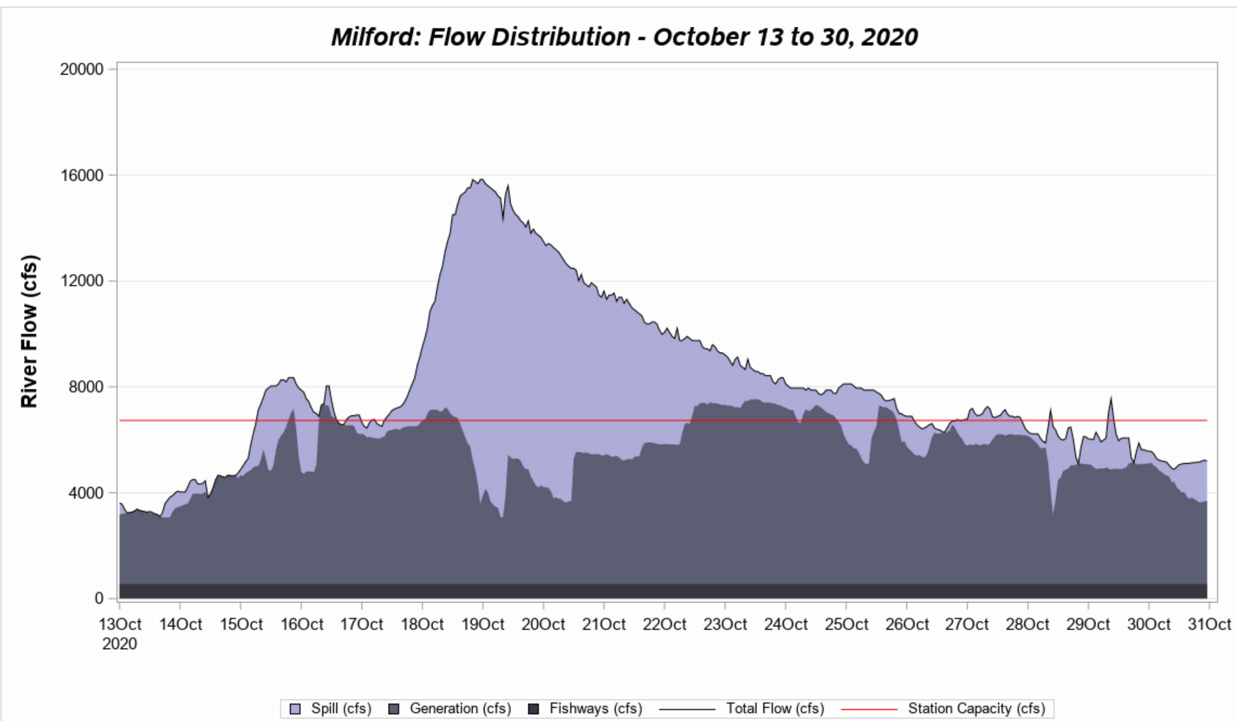

Figure 4–2. Total, powerhouse, and spill flow (cfs) at Milford relative to station capacity for the period October 13-30, 2020.

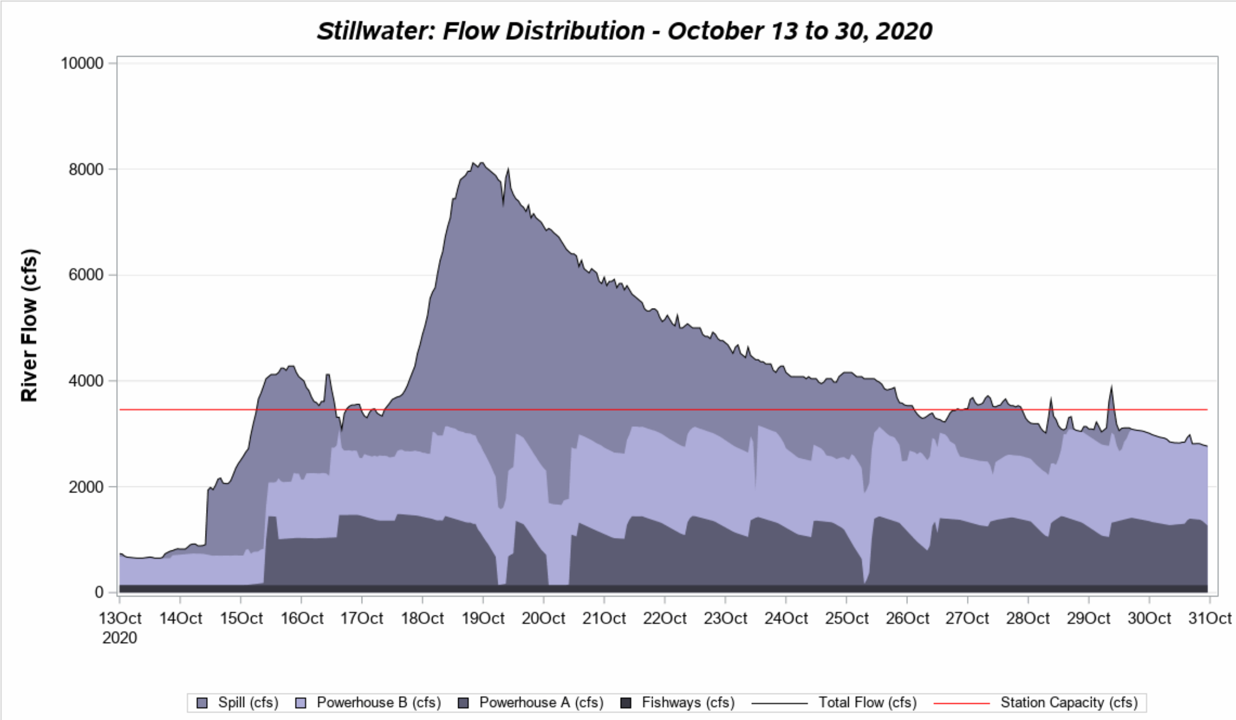

Figure 4–3. Total, powerhouse, and spill flow (cfs) at Stillwater relative to station capacity for the period October 13-30, 2020.

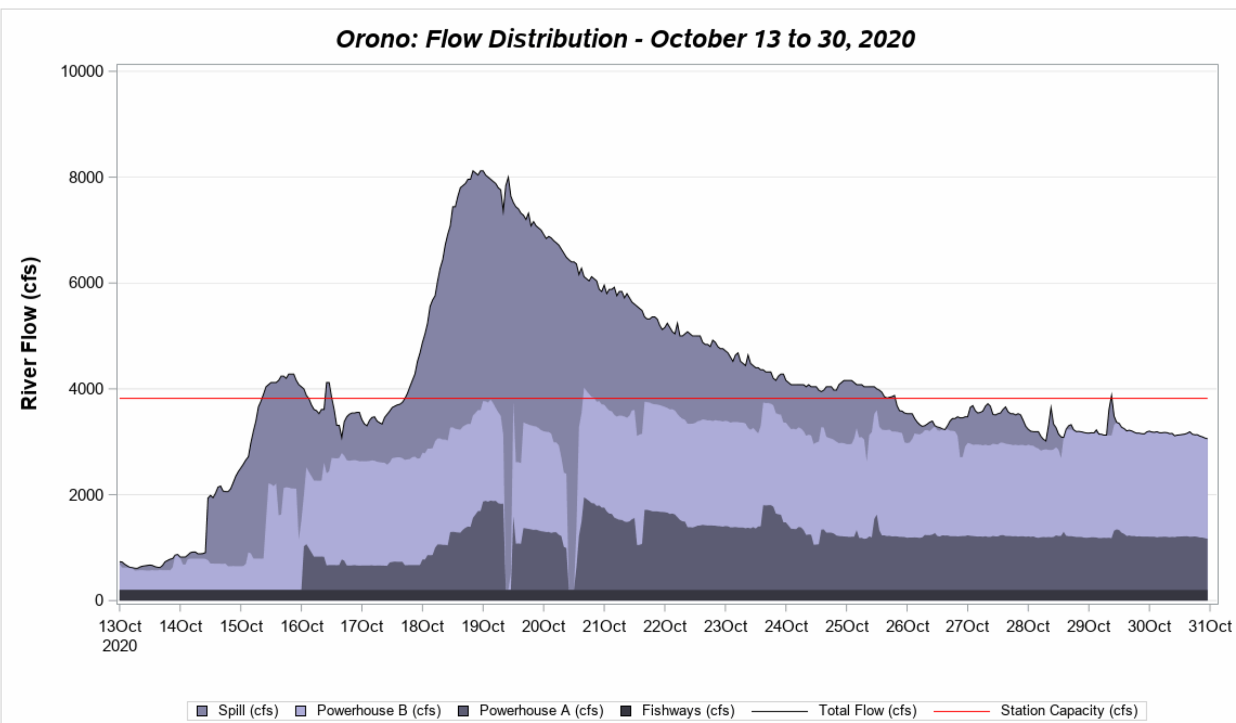

Figure 4–4. Total, powerhouse, and spill flow (cfs) at Orono relative to station capacity for the period October 13-30, 2020.

4.2 Monitoring Station Functionality

Radio-tagged juvenile alosines were released into the Penobscot River upstream of Milford, Stillwater, and Orono beginning on October 13 and continuing each evening through October 17, 2020. The study plan called for operation of all stationary receiver locations until a date approximately two weeks after the last release of tagged fish (calculated based on the warrantied life span of 12 days for the study transmitters when set at a 2.0 second burst rate). Normandeau conducted regular checks and downloads of all stationary receivers during the study period. Station coverage was determined by a combination of beacon transmitter detections and observations reported by field personnel conducting the receiver checks and data downloads. The majority of the radio-telemetry monitoring stations installed to evaluate downstream passage of juvenile alosines at each of the three Projects during October 2020 operated without issue for the full study period.

At Milford (Figure 4-5), a single outage occurred at the approach receiver located along the western shoreline during the overnight hours immediately following the first release group on October 13. The issue was discovered and corrected during the morning of October 14. The Milford approach stations both operated without issue for the remainder of the study. The upstream residence duration for juvenile alosines released on October 13 was estimated based on known passage times and the time of release just upstream from the approach receiver.

With the exception of Station S7 (tailrace A), receivers installed at Stillwater operated with no issues for the duration of the study period (Figure 4-6). An interruption to the power supply at Station S7 led to an outage period at the tail end of the monitoring period. This outage occurred well after the arrival and passage of radio-tagged fish and had no impact on study findings.

A pair of outages were documented at Orono (Figure 4-7). Station O8 was offline for an 11 hour period October 22-23. This station was added to the study to provide redundant information on the presence of tagged juvenile alosines downstream of the Project and was not critical to determination of residence time or downstream passage. The tailrace B receiver (Station O6) was offline for a short period starting on October 26 due to a power glitch. Similar to the short outage at Stillwater tailrace A, this outage occurred well after the arrival and passage of radio-tagged fish and had no impact on study findings.

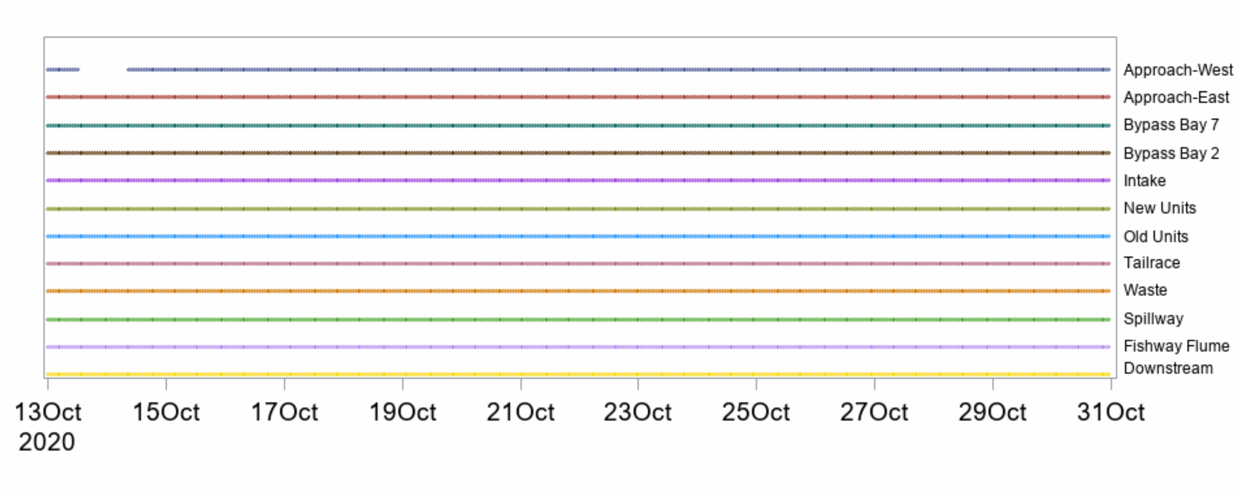

Figure 4–5. Monitoring station coverage for telemetry receivers at Milford during the downstream juvenile alosine telemetry evaluation, October 2020.

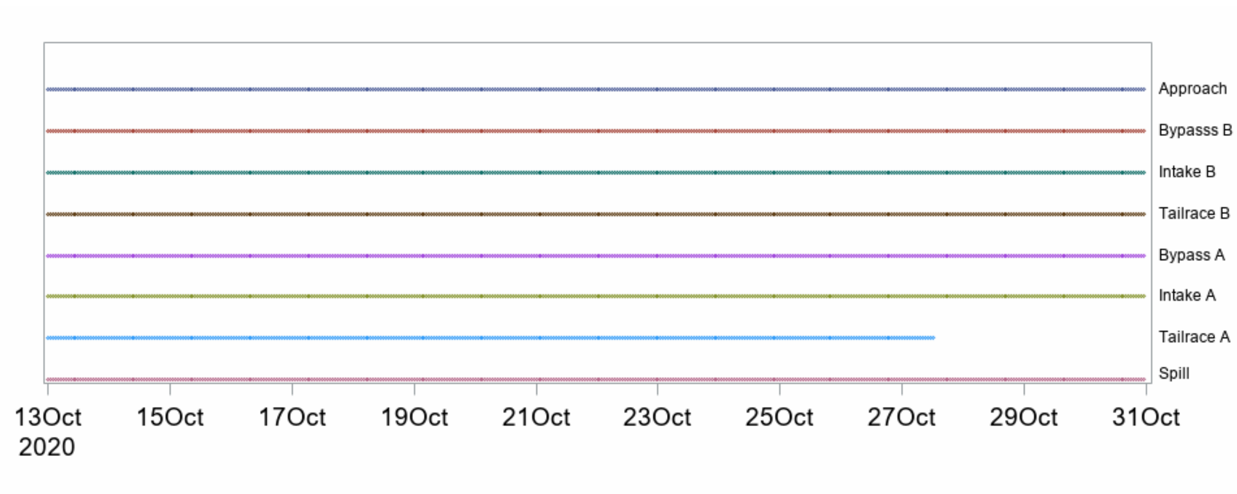

Figure 4–6. Monitoring station coverage for telemetry receivers at Stillwater during the downstream juvenile alosine telemetry evaluation, October 2020.

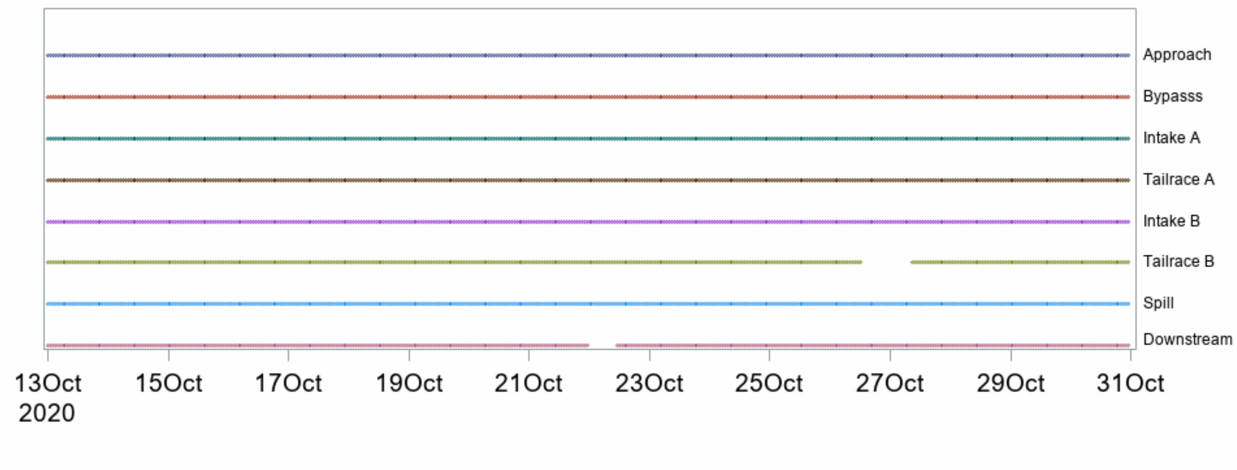

Figure 4–7. Monitoring station coverage for telemetry receivers at Orono during the downstream juvenile alosine telemetry evaluation, October 2020.

4.3 Capture, Tagging and Release

A total of 387 juvenile alosines were radio-tagged following collection from Soudabscook Stream and transported to holding tanks at Milford during October 2020. Releases took place upstream of Milford at the Elks Club boat launch (n = 130; Table 4-1), upstream of Stillwater at the Old Town Water District Facility (n = 130; Table 4-2), and upstream of Orono at the University of Maine steam plant boat launch (n = 127; Table 4-3). Releases were conducted over a series of five consecutive nights starting on October 13 and continuing through October 17, 2020. All releases were conducted around the time of sunset, and the order of release location was varied among release dates. Juvenile alosines selected for radio-tagging during the 2020 study ranged in total length from 113-144 mm (Tables 4-1 through 4-3). A full listing of juvenile alosines tagged during the 2020 Lower Penobscot passage evaluation is provided in Appendix A.

Table 4–1. Summary of release conditions and body size information for juvenile alosines radio-tagged and released into the Penobscot River upstream of Milford during October 2020.

Juvenile Alosines	Milford Release Group				
	#1	#2	#3	#4	#5
Release Location	Elks Club Boat Launch				
Release Date	13-Oct	14-Oct	15-Oct	16-Oct	17-Oct
Release Time	18:30	17:16	18:56	17:50	17:00
River Temperature (°C)	11.0	12.0	12.3	12.8	12.1
Station Discharge (cfs)	2514	4050	6209	5992	5940
Spill Flow (cfs)	523	0	1587	228	952
No. Tagged Released	25	25	25	25	30
No. Untagged Released	12	22	26	25	30
Min. Total Length (mm)	119	118	115	117	119
Max Total Length (mm)	139	137	136	143	136
Mean Total Length (mm)	127	129	126	129	128

Table 4–2. Summary of release conditions and body size information for juvenile alosines radio-tagged and released into the Penobscot River upstream of Stillwater during October 2020

Juvenile Alosines	Stillwater Release Group				
	#1	#2	#3	#4	#5
Release Location	Old Town Water District				
Release Date	13-Oct	14-Oct	15-Oct	16-Oct	17-Oct
Release Time	18:05	16:56	17:17	18:03	17:35
River Temperature (°C)	11.0	12.0	12.3	12.8	12.1
Station Discharge (cfs)	509	559	1947	2545	2531
Spill Flow (cfs)	83	1369	2153	787	1145
No. Tagged Released	25	25	25	26	29
No. Untagged Released	19	20	38	28	50
Min. Total Length (mm)	118	118	115	114	118
Max Total Length (mm)	138	134	135	138	142
Mean Total Length (mm)	128	126	125	129	127

Table 4–3. Summary of release conditions and body size information for juvenile alosines radio-tagged and released into the Penobscot River upstream of Orono during October 2020

Juvenile Alosines	Orono Release Group				
	#1	#2	#3	#4	#5
Release Location	University of Maine Steam Plant				
Release Date	13-Oct	14-Oct	15-Oct	16-Oct	17-Oct
Release Time	17:45	17:38	17:35	18:26	17:19
River Temperature (°C)	11.0	12.0	12.3	12.8	12.1
Station Discharge (cfs)	374	497	1925	2453	2457
Spill Flow (cfs)	158	1363	2115	819	1159
No. Tagged Released	25	25	25	27	25
No. Untagged Released	18	27	25	30	30
Min. Total Length (mm)	115	123	116	116	113
Max Total Length (mm)	139	134	144	139	138
Mean Total Length (mm)	128	127	129	130	127

4.4 Milford Project Residence and Downstream Passage

4.4.1 Return Duration

Of the 130 radio-tagged juvenile alosines released upstream of Milford during October 2020, 120 (92%) individuals were determined to have moved downriver and approached Milford Dam. The median return duration for individuals from release groups 2, 3, 4, and 5 (i.e., the time to move from release until initial detection at Station M1) was 1.0 hours (Figure 4-8; Table 4-4). When examined by release group, median values for return duration ranged from 0.4 to 1.3 hours and appeared to be shorter for the last two releases (conducted during higher river flows on October 16/17) than the earlier three releases. Radio-tagged alosines approached the dam quickly with approximately 96% arriving within four hours of release (range = 0.1-25.8 hours).

4.4.2 Project Residence Time

Residence time upstream of Milford was calculated for radio-tagged juvenile alosines which were determined to have passed downstream of the dam following detection at Monitoring Station M1. Project residence time for individuals approaching Milford on October 13 (i.e. release group number 1) was estimated as the difference in time from their initial release until downstream passage due to the outage at Station M1 during their approach period. The majority (84%) of radio-tagged juvenile alosines passed downstream of Milford Dam within four hours of their initial detection, and 96% did so within the first 24 hours of arrival. When examined by release group, median values for residence duration upstream of Milford ranged from 1.6 to 4.0 hours (Figure 4-9; Table 4-5). The median duration was longest for the October 13 release group, likely due to reliance on the release date-time as a surrogate for detection at Station M1.

4.4.3 Downstream Passage Route Selection

A total of 120 radio-tagged juvenile alosines released upstream of Milford were determined to have moved downriver and approached the dam. The distribution of observed passage date and time are presented in Figures 4-10 and 4-11. Downstream passage events for radio-tagged juvenile alosines at Milford occurred over a range of dates from the time of the initial release (October 13) through October 19. The occurrence of downstream passage events at Milford peaked on October 14. Recorded downstream passage events were limited during the daylight hours, with most passage occurring during the early evening (18:00-20:00 hrs).

Of the tagged juvenile alosines which were determined to have approached Milford, 82% (98 out of 120 individuals) passed downstream of the dam (Table 4-6). Downstream passage events at Milford occurred primarily via the “old” turbine units (i.e., Units 3, 4, 5, or 6; 63%) and the downstream bypass located towards the riverside of the powerhouse (18%). An additional 22 individuals (18% of all radio-tagged juveniles which approached the dam) did not pass downstream. Reasons for this may include predation, tag loss or handling effect, or failure to locate a passage route. When individuals not passing downstream of Milford are excluded, 77% of tagged fish passed downstream via the “old” turbines, 21% via the riverside downstream bypass, and 2% via spill.

4.4.4 Downstream Detections

Of the 98 radio-tagged juvenile alosines determined to have passed downstream of Milford, 93 individuals were subsequently detected at Station M11 located approximately 2.4 km downstream, and 89 individuals were subsequently detected at Station O8 located 9.4 km downstream. The median travel duration for radio-tagged individuals from Milford to Station O8 was 2.7 hours, ranging between 2.4 and 3.4 hours when examined by release group (Figure 4-12; Table 4-7). When examined by passage route, the median downstream transit duration to arrive at Station O8 following downstream passage at Milford was 2.6 hours for individuals using the bypass and 2.8 hours for individuals using Milford units 3, 4, 5 or 6. This study was not designed to evaluate downstream passage survival due to uncertainty over transmitter retention rates during downstream passage through turbines, spill or bypass structures.

Table 4–4. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the observed duration (hrs) for radio-tagged juvenile alosines to approach Milford following release

Milford - Approach Duration (hrs)					
Release Date	Minimum	Maximum	Q25	Q50 (Median)	Q75
13-Oct	-	-	-	-	-
14-Oct	0.1	13.4	0.6	0.9	1.0
15-Oct	0.9	1.5	1.1	1.3	1.3
16-Oct	0.1	14.3	0.2	0.4	1.1
17-Oct	0.1	25.8	0.3	0.5	1.6
All	**0.1**	**25.8**	**0.4**	**1.0**	**1.3**

Table 4–5. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the upstream residence duration (hrs) for radio-tagged juvenile alosines at Milford prior to downstream passage

Milford - Residence Duration (hrs)					
Release Date	Minimum	Maximum	Q25	Q50 (Median)	Q75
*13-Oct	0.7	135.6	1.9	4.0	8.1
14-Oct	1.5	5.7	1.5	1.8	2.8
15-Oct	1.5	2.4	1.6	1.6	1.7
16-Oct	0.7	49.5	1.1	1.6	2.1
17-Oct	0.8	16.0	1.6	1.9	3.5
All	**0.7**	**135.6**	**1.5**	**1.8**	**3.2**

*Estimate calculated from time of release at Elks Club

Table 4–6. Summary of downstream passage route use for juvenile alosines radio-tagged and released into the Penobscot River upstream of Milford during October 2020

Release Date	Milford Downstream Passage Route						
	No Detect	No Pass	Units 1-2	Units 3-6	Bypass A	Bypass B	Spill
13-Oct	0	2	0	20	0	3	0
14-Oct	3	5	0	15	0	1	0
15-Oct	1	3	0	15	0	6	0
16-Oct	1	2	0	15	0	6	1
17-Oct	5	10	0	10	0	5	1
All	10	22	0	75	0	21	2
% of Total Detected		18%	0%	63%	0%	18%	2%

Table 4–7. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the downstream transit duration (hrs) for radio-tagged juvenile alosines following downstream passage at Milford

Milford - Downstream Transit Duration (hrs)						
River Reach	Release Date	Minimum	Maximum	Q25	Q50 (Median)	Q75
Milford to Station M11 (2.4 km)	13-Oct	0.6	97.9	0.9	1.1	2.4
	14-Oct	0.7	2.5	0.8	0.8	1.1
	15-Oct	0.6	60.0	0.7	0.7	1.1
	16-Oct	0.7	47.6	0.7	1.0	4.4
	17-Oct	0.6	7.1	0.7	0.8	1.0
	All	**0.6**	**97.9**	**0.7**	**0.9**	**1.6**
Station M11 to Station O8 (7.0 km)	13-Oct	1.6	3.6	1.8	2.1	2.4
	14-Oct	1.6	25.9	1.7	1.9	2.1
	15-Oct	1.3	2.9	1.5	1.6	1.8
	16-Oct	1.4	2.9	1.5	1.7	1.8
	17-Oct	1.4	2.2	1.6	1.7	1.9
	All	**1.3**	**25.9**	**1.6**	**1.8**	**2.0**
Milford to Station O8 (9.4 km)	13-Oct	2.3	6.6	2.8	3.4	4.7
	14-Oct	2.3	27.0	2.5	2.9	3.1
	15-Oct	2.1	13.9	2.2	2.4	2.6
	16-Oct	2.1	49.4	2.4	2.6	6.2
	17-Oct	2.2	9.0	2.4	2.5	2.8
	All	**2.1**	**49.4**	**2.4**	**2.7**	**4.0**

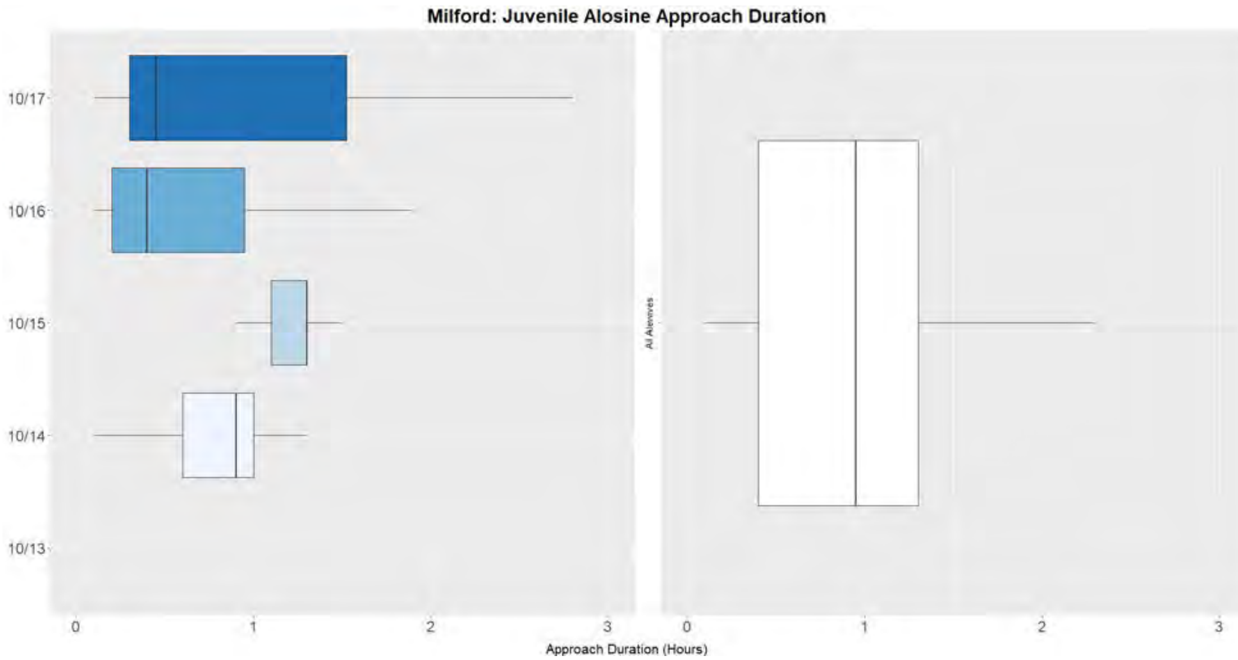

Figure 4–8. Boxplot of the approach duration for radio-tagged juvenile alosines at Milford during the October 2020 downstream passage assessment. [4]

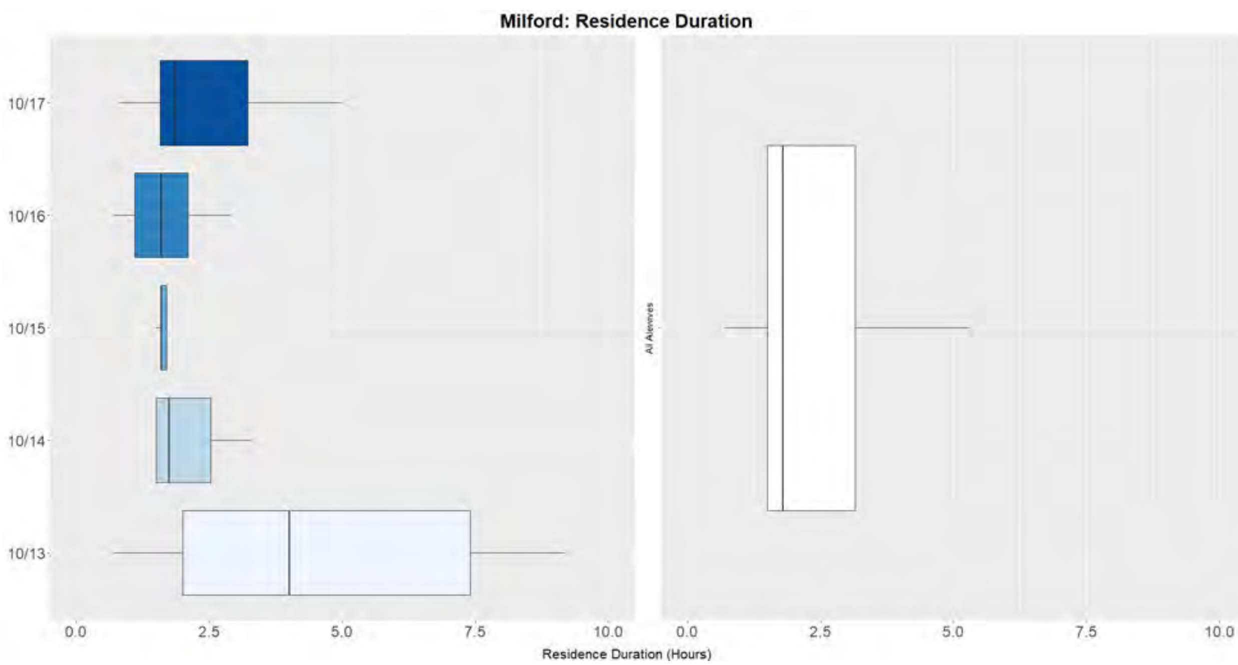

Figure 4–9. Boxplot of the upstream residence duration for radio-tagged juvenile alosines at Milford during the October 2020 downstream passage assessment.

[4] The solid line represents the median, while left and right portions of the box represent the first and third quartiles, respectively. Whiskers extend to the range of the data within the interquartile range (quartile*1.05) such that outliers outside of this range are not displayed.

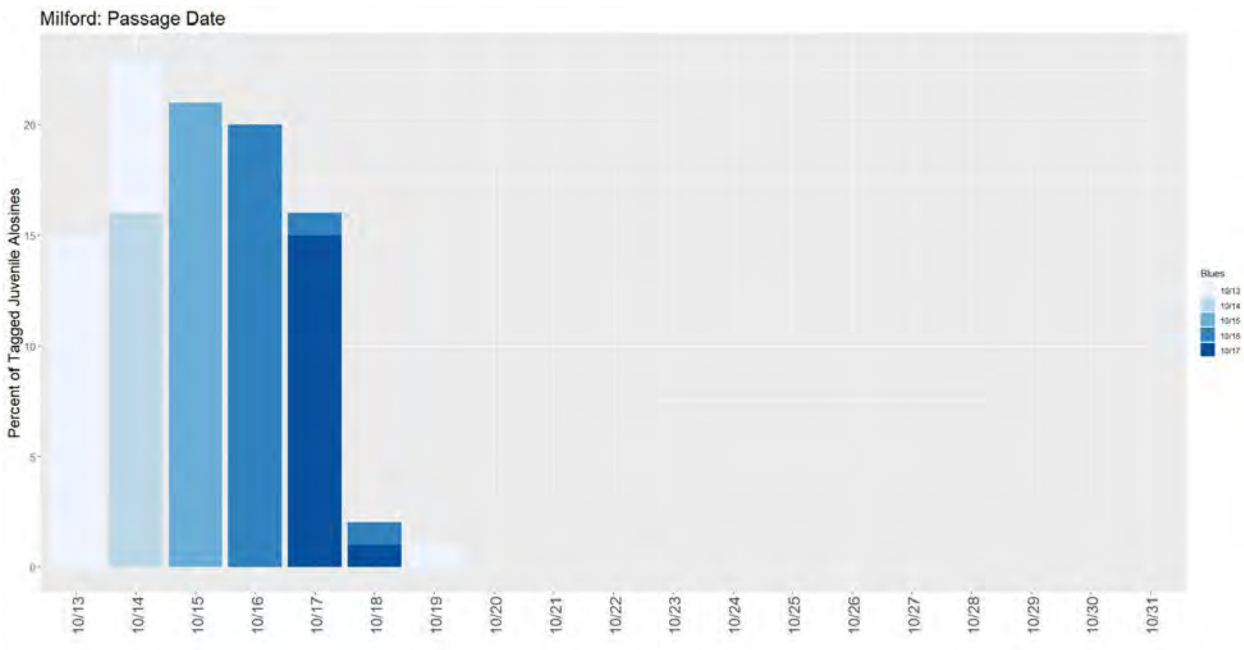

Figure 4–10. Distribution of downstream passage dates for radio-tagged juvenile alosines at Milford during the October 2020 downstream passage assessment.

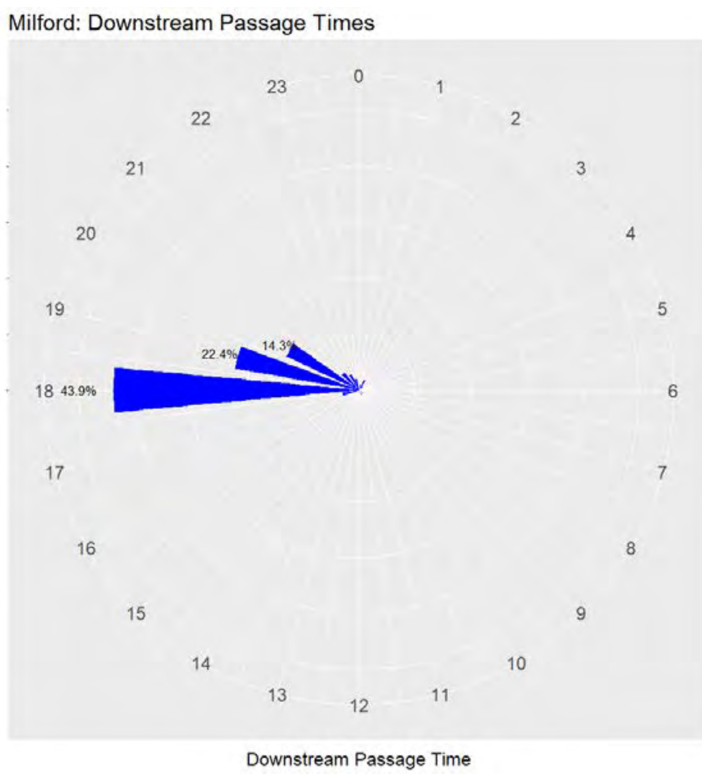

Figure 4–11. Distribution of downstream passage hours for radio-tagged juvenile alosines at Milford during the October 2020 downstream passage assessment.

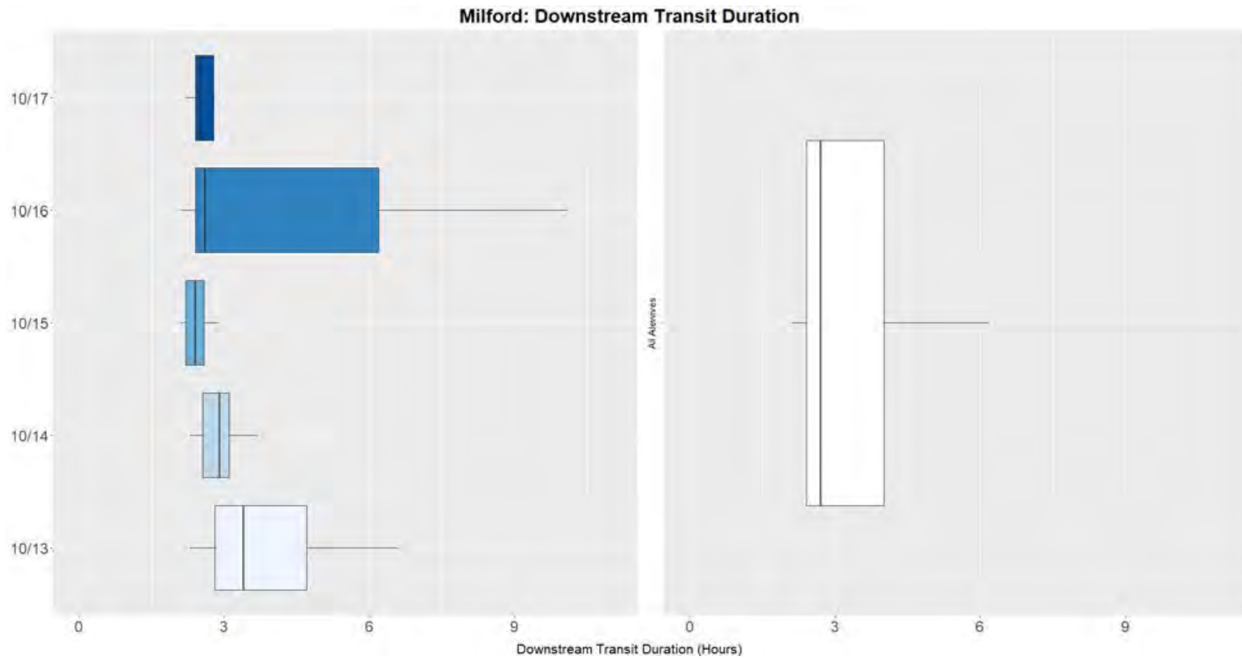

Figure 4–12. Boxplot of the downstream transit duration for radio-tagged juvenile alosines following passage at Milford during the October 2020 downstream passage assessment.

4.5 Stillwater Project Residence and Downstream Passage

4.5.1 Return Duration

Of the 130 radio-tagged juvenile alosines released upstream of Stillwater during October 2020, 106 (82%) individuals were determined to have moved downriver and were detected at Monitoring Station S1 indicating they were in the vicinity of the 200 m mark upstream of Stillwater Dam. The median return duration (i.e., the time to move from release until initial detection at Station S1) was 2.3 hours (Figure 4-13; Table 4-8). When examined by release group, median values for return duration ranged from 1.1 to 4.6 hours and appeared to be longer for the first two releases (conducted during lower river flows on October 13/14) than the latter three releases. Radio-tagged alosines approached the dam quickly with nearly 89% of those that approached arriving within six hours of release (range = 0.8-56.0 hours).

4.5.2 Project Residence Time

Residence time upstream of Stillwater was calculated for radio-tagged juvenile alosines which were determined to have passed downstream of the dam following detection at Monitoring Station S1. The majority (72%) of radio-tagged juvenile alosines passed downstream of Stillwater within four hours of their initial detection, and 85% did so within the first 24 hours of initial detection at Station S1. When examined by release group, median values for residence duration upstream of Stillwater ranged from 0.6 to 6.9 hours (Figure 4-14; Table 4-9).

4.5.3 Downstream Passage Route Selection

A total of 106 radio-tagged juvenile alosines released upstream of Stillwater were determined to have moved downriver and approached Stillwater Dam. The distribution of observed passage date and time are presented in Figures 4-15 and 4-16. Downstream passage events for radio-tagged juvenile alosines at Stillwater occurred over a range of dates from the time of the initial release (October 13) through October 20. The occurrence of downstream passage events at Stillwater peaked on October 17. Recorded downstream passage events were limited during the daylight hours, with most passage occurring during the early evening (18:00-22:00 hrs).

Of the tagged juvenile alosines which were determined to have approached Stillwater, 89% (94 out of 106 individuals) passed downstream of the dam (Table 4-10). Distribution of downstream passage events was fairly even between turbine units (48%) and the downstream bypasses (42%). Of individuals passing downstream via the turbine units, the majority (44 out of 50 individuals) did so via powerhouse A. Conversely, of the 44 individuals passing via the downstream bypasses, the majority of individuals (80%; 35 out of 44 individuals) did so via the powerhouse B facility. An additional 12 individuals (11% of all radio-tagged juveniles which approached the dam) did not pass downstream. Reasons for this may include predation, tag loss or handling effect, or failure to locate a passage route. When individuals not passing downstream of Stillwater are excluded, 47% of tagged fish passed downstream via powerhouse A, 37% via the powerhouse B bypass facility, 10% via the powerhouse A bypass facility and 6% via powerhouse B.

4.5.4 Downstream Detections

Of the 94 radio-tagged juvenile alosines determined to have passed downstream of Stillwater Dam, 72 individuals were subsequently detected at Station O1 located 1.6 km downriver and serving as the "approach" receiver for evaluating passage at Orono. The median travel duration for radio-tagged individuals from Stillwater to Orono was 4.9 hours, ranging between 3.8 and 6.2 hours when examined by release group (Figure 4-17; Table 4-11). When examined by passage route, the median downstream transit duration to arrive at Orono was 4.1 hours for individuals using bypass A, 6.3 hours for individuals using bypass B, 5.0 hours for individuals using powerhouse A, and 8.8 hours for individuals using powerhouse B. This study was not designed to evaluate downstream passage survival due to uncertainty over transmitter retention rates during downstream passage through turbines, spill or bypass structures.

Table 4–8. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the observed duration (hrs) for radio-tagged juvenile alosines to approach Stillwater following release

Stillwater - Approach Duration (hrs)					
Release Date	Minimum	Maximum	Q25	Q50 (Median)	Q75
13-Oct	1.9	6.6	2.8	3.2	4.2
14-Oct	2.7	11.6	3.5	4.6	7.5
15-Oct	1.3	2.4	1.4	1.6	2.2
16-Oct	1.2	56.0	1.5	2.1	4.1
17-Oct	0.8	3.5	0.9	1.1	1.9
All	**0.8**	**56**	**1.4**	**2.3**	**3.6**

Table 4–9. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the upstream residence duration (hrs) for radio-tagged juvenile alosines at Stillwater prior to downstream passage

Stillwater - Residence Duration (hrs)					
Release Date	Minimum	Maximum	Q25	Q50 (Median)	Q75
13-Oct	0.3	70.7	0.8	1.3	3.0
14-Oct	0.5	134.6	2.0	6.9	46.0
15-Oct	0.2	47.6	0.5	2.2	8.5
16-Oct	0.2	33.2	0.5	0.6	1.0
17-Oct	0.2	50.4	0.4	1.0	2.6
All	**0.2**	**134.6**	**0.5**	**1.1**	**6.9**

Table 4–10. Summary of downstream passage route use for juvenile alosines radio-tagged and released into the Penobscot River upstream of Stillwater during October 2020

Release Date	Stillwater Downstream Passage Route					
	No Detect	No Pass	Unit A	Bypass A	Unit B	Bypass B
13-Oct	1	4	1	3	4	12
14-Oct	10	2	5	3	0	5
15-Oct	9	2	9	1	0	4
16-Oct	1	3	12	1	0	9
17-Oct	3	1	17	1	2	5
All	24	12	44	9	6	35
% of Total Detected		11%	42%	8%	6%	33%

Table 4–11. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the downstream transit duration (hrs) for radio-tagged juvenile alosines following downstream passage at Stillwater

Stillwater - Downstream Transit Duration (hrs)					
Release Date	Minimum	Maximum	Q25	Q50 (Median)	Q75
13-Oct	2.4	40.7	3.3	5.5	22.1
14-Oct	2.2	119.7	3.7	6.1	11.6
15-Oct	1.9	5.5	3.0	3.8	4.2
16-Oct	1.9	10.9	3.3	6.2	7.6
17-Oct	1.4	38.8	2.9	5.2	8.4
All	**1.4**	**119.7**	**2.9**	**4.9**	**8.3**

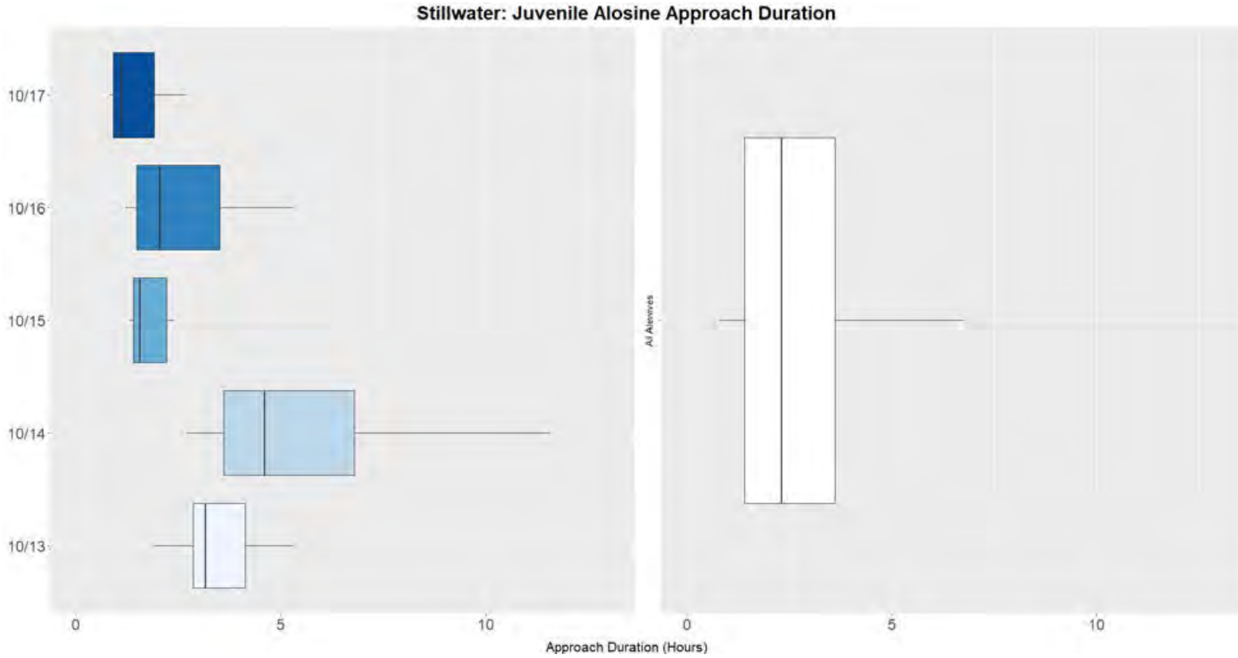

Figure 4–13. Boxplot of the approach duration for radio-tagged juvenile alosines at Stillwater during the October 2020 downstream passage assessment. [5]

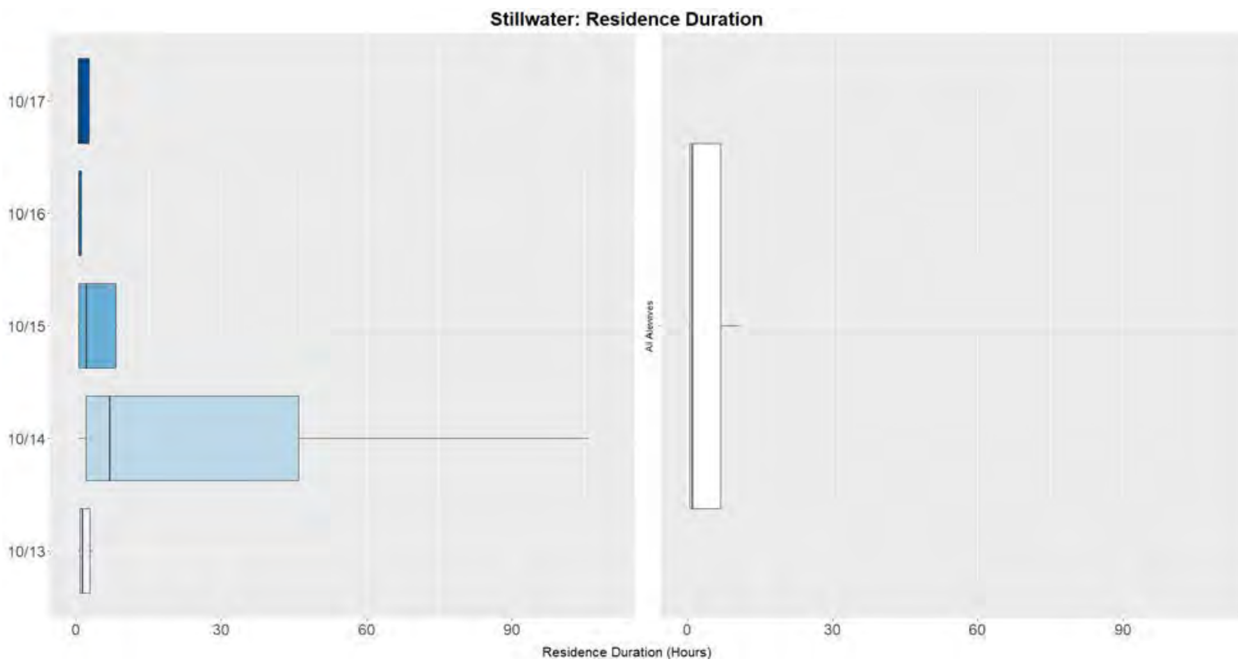

Figure 4–14. Boxplot of the upstream residence duration for radio-tagged juvenile alosines at Stillwater during the October 2020 downstream passage assessment.

[5] The solid line represents the median, while left and right portions of the box represent the first and third quartiles, respectively. Whiskers extend to the range of the data within the interquartile range (quartile*1.05) such that outliers outside of this range are not displayed.

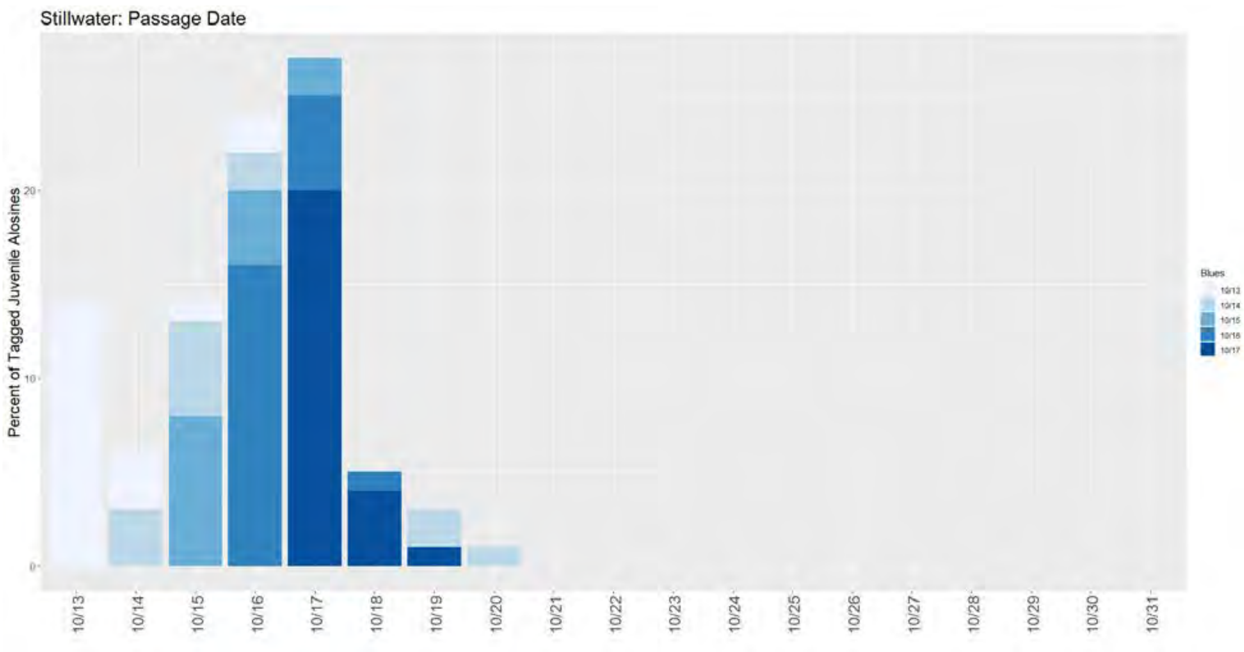

Figure 4–15. Distribution of downstream passage dates for radio-tagged juvenile alosines at Stillwater during the October 2020 downstream passage assessment.

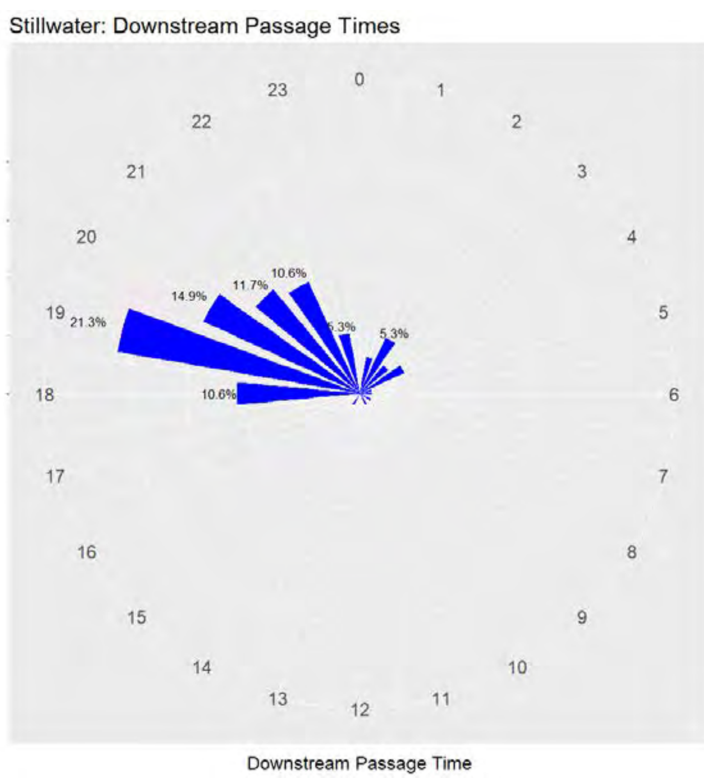

Figure 4–16. Distribution of downstream passage hours for radio-tagged juvenile alosines at Stillwater during the October 2020 downstream passage assessment.

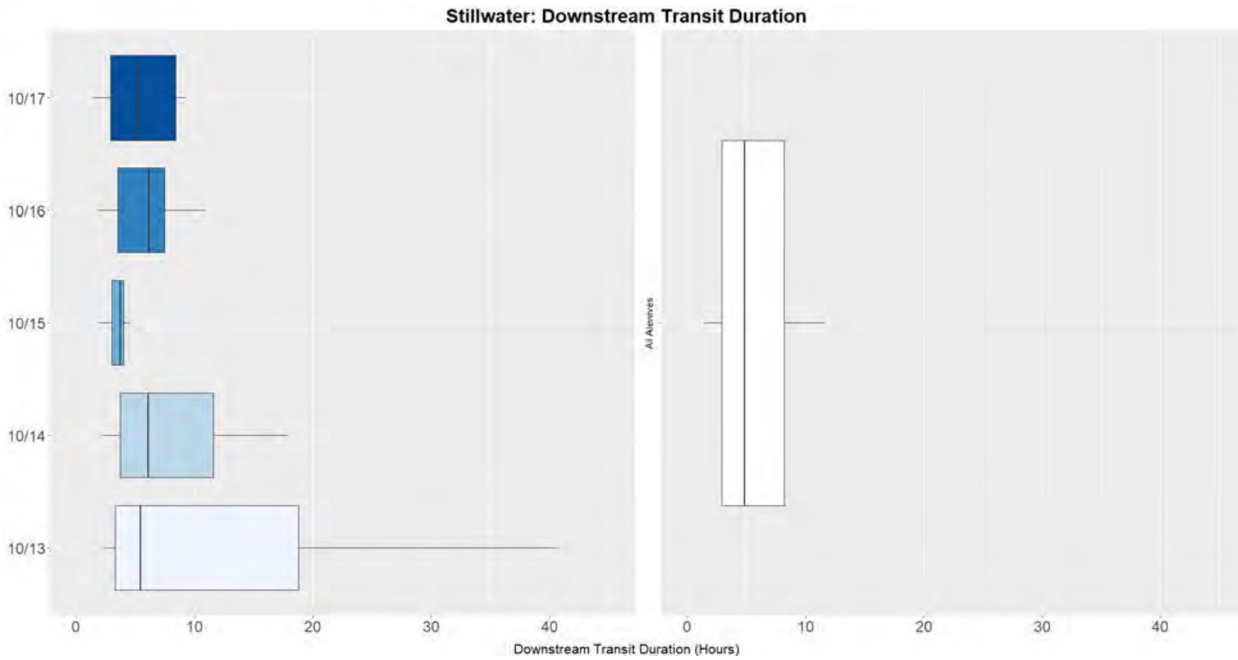

Figure 4–17. Boxplot of the downstream transit duration for radio-tagged juvenile alosines following passage at Stillwater during the October 2020 downstream passage assessment.

4.6 Orono Project Residence and Downstream Passage

4.6.1 Return Duration

Of the 127 radio-tagged juvenile alosines released immediately upstream of Orono during October 2020, 86 (68%) individuals were determined to have moved downriver and were detected at Monitoring Station O1 indicating they were in the vicinity of the 200 m mark upstream of Orono Dam. The median return duration (i.e., the time to move from release until initial detection at Station O1) was 3.7 hours (Figure 4-18; Table 4-12). When examined by release group, median values for return duration ranged from 1.8 to 7.4. The shortest median return duration for radio-tagged juvenile alosines released upstream of Orono occurred for the October 15 release group and coincided with the highest observed river flow at the time of release among all stocking dates. Radio-tagged alosines released at the University of Maine steam plant approached the dam quickly with nearly 73% arriving within six hours of release (range = 1.5-78.9 hours).

An additional 72 radio-tagged juvenile alosines originally released upstream of Stillwater also approached Orono. The median travel duration for radio-tagged individuals from Stillwater to Orono was 4.9 hours (see Section 4.5.4). Consideration of radio-tagged juvenile alosines from both release locations resulted in a total of 158 individuals which approached Orono and were available to evaluate project residence duration and downstream passage route utilization.

4.6.2 Project Residence Time

Residence time upstream of Orono was calculated for radio-tagged juvenile alosines which were determined to have passed downstream of Orono Dam following detection at Monitoring Station O1. The majority (88%) of radio-tagged juvenile alosines passed downstream of Orono within four hours of their initial detection, and 96% did so within the first 24 hours of initial detection at Station O1. When examined by release group, median values for residence duration upstream of Orono were similar among all groups released upstream of both Orono and at Stillwater and ranged from 0.4 to 0.7 hours (Figure 4-19; Table 4-13).

4.6.3 Downstream Passage Route Selection

A total of 158 radio-tagged juvenile alosines released upstream of Orono (Orono and Stillwater release locations) were determined to have moved downriver and approached Orono Dam. The distribution of observed passage date and time are presented in Figures 4-20 and 4-21. Downstream passage events for radio-tagged juvenile alosines at Orono occurred over a range of dates from the time of the initial release (October 13) through October 20. The occurrence of downstream passage events at Orono peaked on October 17. Recorded downstream passage events were limited during the daylight hours, with most passage occurring during the evening and overnight hours (19:00-05:00 hrs).

Of the tagged juvenile alosines which were determined to have approached Orono, 94% (148 out of 158 individuals) passed downstream of the dam (Table 4-14). Greater than 60% of all downstream passage events were of individuals which utilized the downstream bypass facility. Nearly 25% of radio-tagged alosines passed downstream of Orono via turbine units, with the majority of those individuals (97%) doing so via powerhouse B. Nearly 10% of radio-tagged individuals passed Orono via spill through the bypass reach. An additional 10 individuals (6% of all radio-tagged juveniles which approached the dam) did not pass downstream. Reasons for this may include predation, tag loss or handling effect, or failure to locate a passage route. When individuals not passing downstream of Orono are excluded, 67% of tagged fish passed via the downstream bypass facility, 24% via powerhouse B, 8% via spill, and 1% via powerhouse A.

4.6.4 Downstream Detections

Of the 148 radio-tagged juvenile alosines determined to have passed downstream of Orono, 115 individuals were subsequently detected at Station O8 located approximately 1.4 km downstream from the Orono powerhouse A tailrace. The median travel duration for radio-tagged individuals from Orono to Station O8 was 0.6 hours, ranging between 0.5 and 3.4 hours when examined by release group (Figure 4-22; Table 4-15). When examined by passage route, the median downstream transit duration to arrive at Station O8 following downstream passage at Orono was 0.6 hours for individuals using the bypass, 1.2 hours for individuals passing via spill, and 0.5 hours for individuals using powerhouse B. This study was not designed to evaluate downstream passage survival due to uncertainty over transmitter retention rates during downstream passage through turbines, spill or bypass structures.

Table 4–12. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the observed duration (hrs) for radio-tagged juvenile alosines to approach Orono following release

Orono - Approach Duration (hrs)						
Release		Minimum	Maximum	Q25	Q50 (Median)	Q75
Location	Date					
Stillwater	13-Oct	2.4	40.7	3.3	5.5	22.1
	14-Oct	2.2	119.7	3.7	6.1	11.6
	15-Oct	1.9	5.5	3.0	3.8	4.2
	16-Oct	1.9	10.9	3.3	6.2	7.6
	17-Oct	1.4	38.8	2.9	5.2	8.4
	All	**1.4**	**119.7**	**2.9**	**4.9**	**8.3**
Orono	13-Oct	2.8	8.9	4.5	5.6	7.2
	14-Oct	2.7	78.9	4.2	7.4	10.0
	15-Oct	1.5	9.7	1.6	1.8	2.1
	16-Oct	1.7	12.2	3.5	5.2	7.1
	17-Oct	1.5	9.8	1.9	2.2	2.7
	All	**1.5**	**78.9**	**2.0**	**3.7**	**6.2**
All		**1.4**	**119.7**	**2.5**	**4.6**	**7.4**

Table 4–13. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the upstream residence duration (hrs) for radio-tagged juvenile alosines at Orono prior to downstream passage

Orono - Residence Duration (hrs)						
Release		Minimum	Maximum	Q25	Q50 (Median)	Q75
Location	Date					
Stillwater	13-Oct	0.2	1.8	0.4	0.6	1.1
	14-Oct	0.3	1.5	0.6	0.7	0.9
	15-Oct	0.3	2.3	0.4	0.5	1.7
	16-Oct	0.2	0.7	0.3	0.4	0.5
	17-Oct	0.3	62.5	0.3	0.4	0.5
	All	**0.2**	**62.5**	**0.3**	**0.4**	**0.7**
Orono	13-Oct	0.2	1.8	0.4	0.6	1.1
	14-Oct	0.3	1.5	0.6	0.7	0.9
	15-Oct	0.3	2.3	0.4	0.5	1.7
	16-Oct	0.2	0.7	0.3	0.4	0.5
	17-Oct	0.3	62.5	0.3	0.4	0.5
	All	**0.2**	**111.0**	**0.3**	**0.5**	**0.8**
All		**0.2**	**111.0**	**0.3**	**0.5**	**0.7**

Table 4–14. Summary of downstream passage route use for juvenile alosines radio-tagged and released into the Penobscot River upstream of Orono during October 2020

Release		Orono Downstream Passage Route					
Location	Date	No Detect	No Pass	Unit A	Unit B	Bypass	Spill
Stillwater	13-Oct	11	1	0	1	10	2
	14-Oct	16	3	0	0	3	3
	15-Oct	16	1	0	1	5	2
	16-Oct	6	0	0	12	8	0
	17-Oct	9	3	0	7	9	1
Orono	13-Oct	10	0	0	0	14	1
	14-Oct	15	1	0	0	8	1
	15-Oct	7	0	0	2	15	1
	16-Oct	1	1	1	8	15	1
	17-Oct	8	0	0	5	12	0
All		99	10	1	36	99	12
% of Total Detected			6%	1%	23%	63%	8%

Table 4–15. Minimum, maximum, mean, and quarterly percentiles (P 25, P 50 (median), and P 75) of the downstream transit duration (hrs) for radio-tagged juvenile alosines following downstream passage at Orono

Orono - Downstream Transit Duration (hrs)						
Release		Minimum	Maximum	Q25	Q50 (Median)	Q75
Location	Date					
Stillwater	13-Oct	0.4	100.4	0.6	0.6	1.2
	14-Oct	0.2	8.5	0.7	3.4	7.1
	15-Oct	0.5	24.5	0.5	0.8	1.3
	16-Oct	0.3	24.3	0.5	0.6	1.8
	17-Oct	0.3	3.8	0.3	0.5	1.3
	All	**0.2**	**100.4**	**0.5**	**0.6**	**1.5**
Orono	13-Oct	0.4	9.2	0.5	0.6	1.3
	14-Oct	0.6	11.9	0.6	0.9	4.3
	15-Oct	0.3	3.2	0.5	0.5	1.0
	16-Oct	0.3	36.7	0.5	0.8	2.6
	17-Oct	0.3	10.6	0.4	0.6	1.0
	All	**0.3**	**36.7**	**0.5**	**0.6**	**1.3**
All		**0.2**	**100.4**	**0.5**	**0.6**	**1.3**

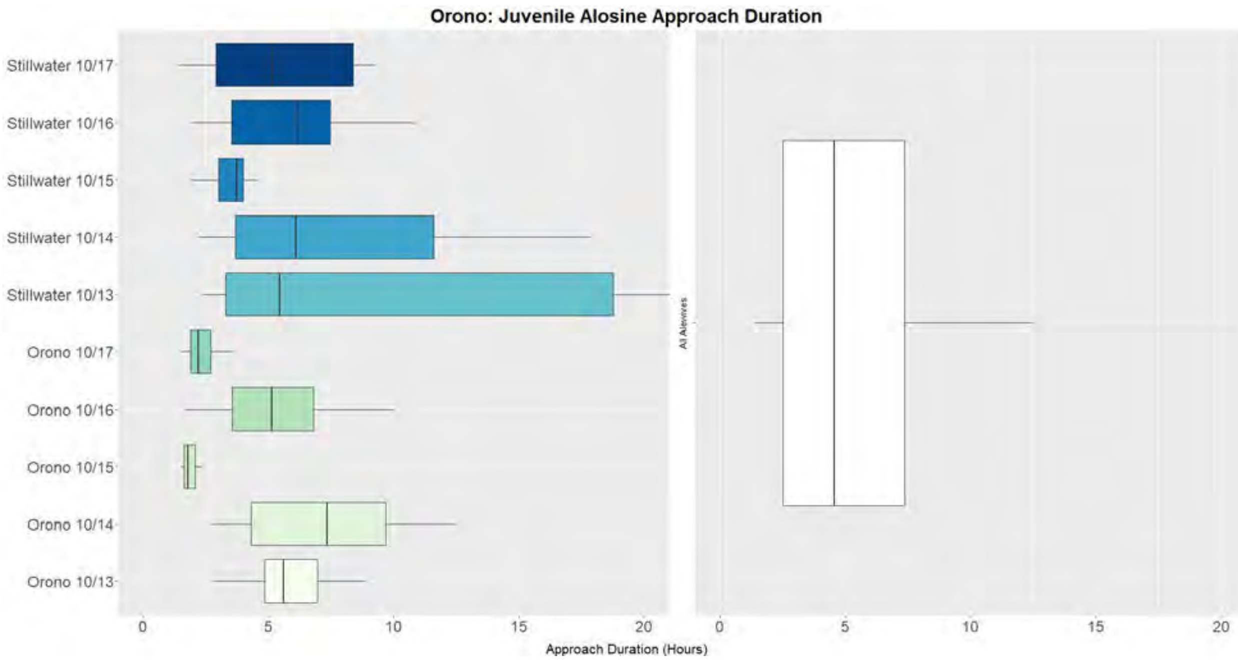

Figure 4–18. Boxplot of the approach duration for radio-tagged juvenile alosines at Orono during the October 2020 downstream passage assessment. [6]

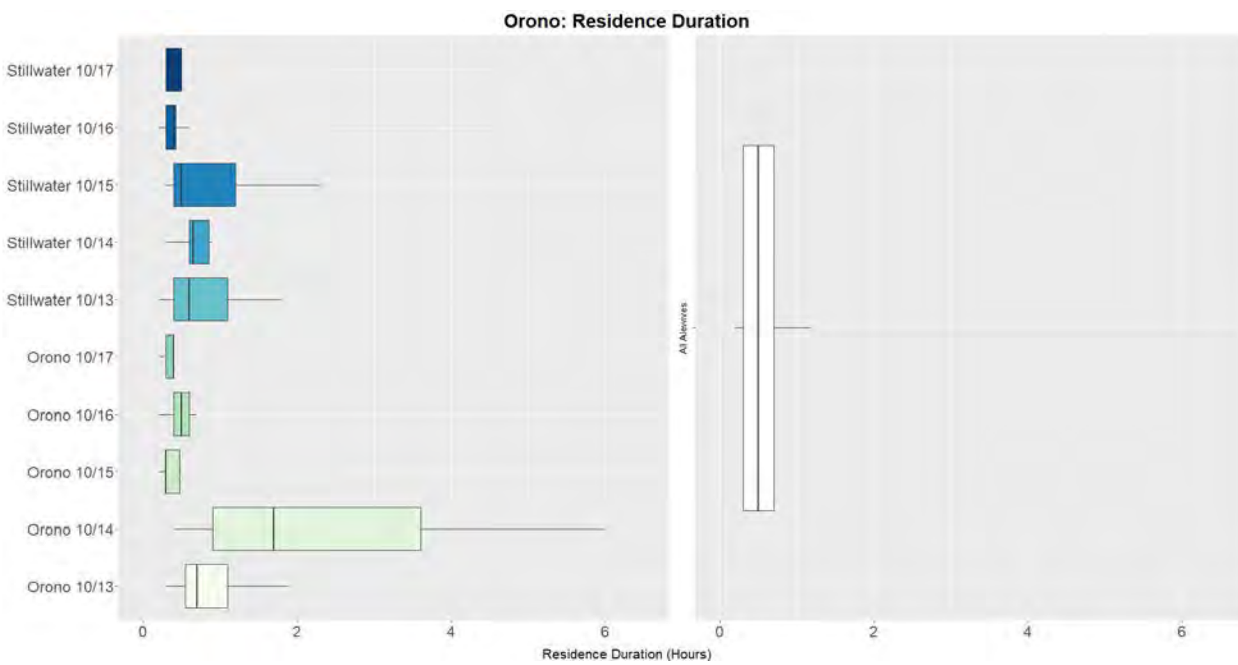

Figure 4–19. Boxplot of the upstream residence duration for radio-tagged juvenile alosines at Orono during the October 2020 downstream passage assessment.

[6] The solid line represents the median, while left and right portions of the box represent the first and third quartiles, respectively. Whiskers extend to the range of the data within the interquartile range (quartile*1.05) such that outliers outside of this range are not displayed.

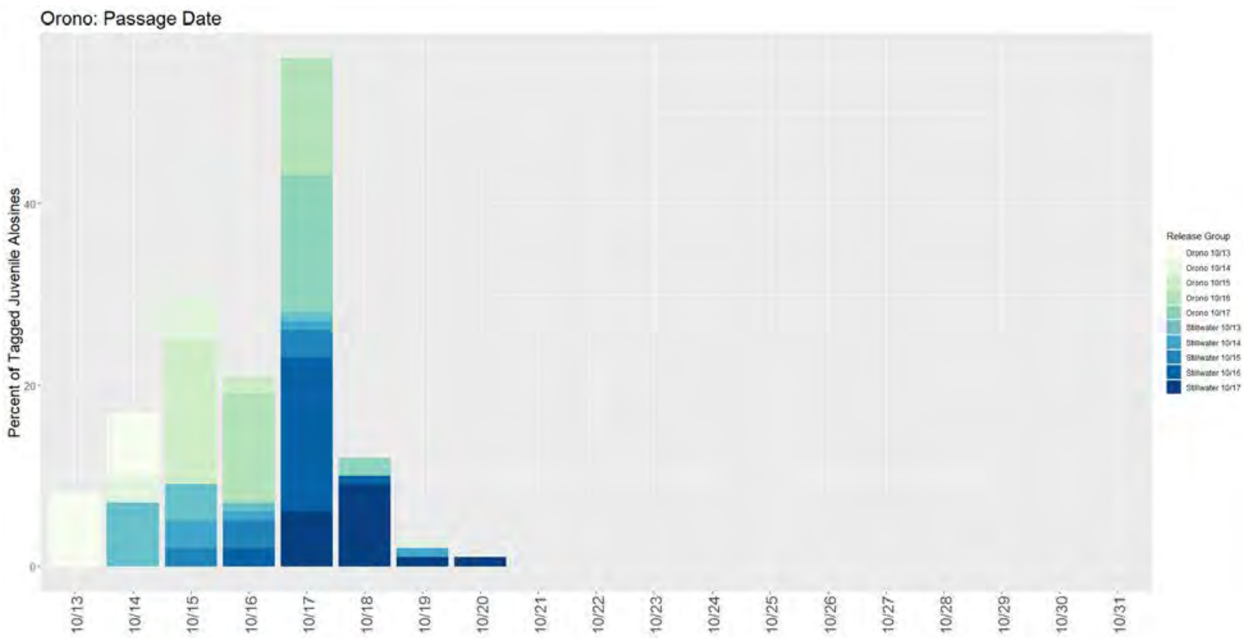

Figure 4–20. Distribution of downstream passage dates for radio-tagged juvenile alosines at Orono during the October 2020 downstream passage assessment.

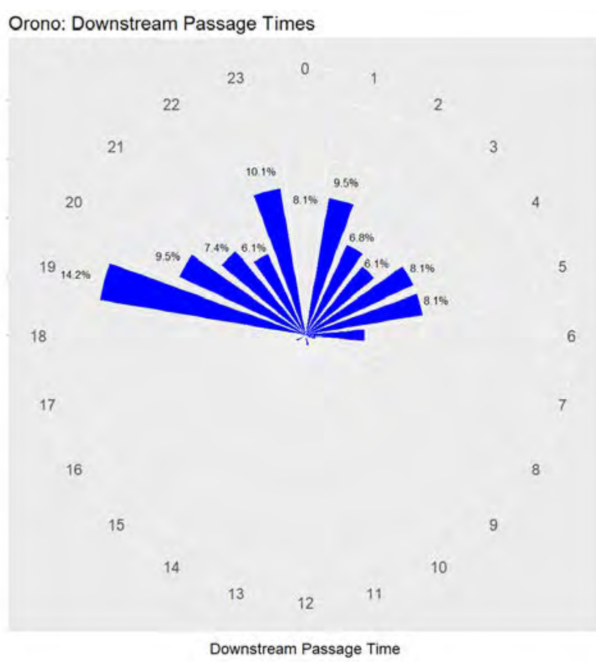

Figure 4–21. Distribution of downstream passage hours for radio-tagged juvenile alosines at Orono during the October 2020 downstream passage assessment.

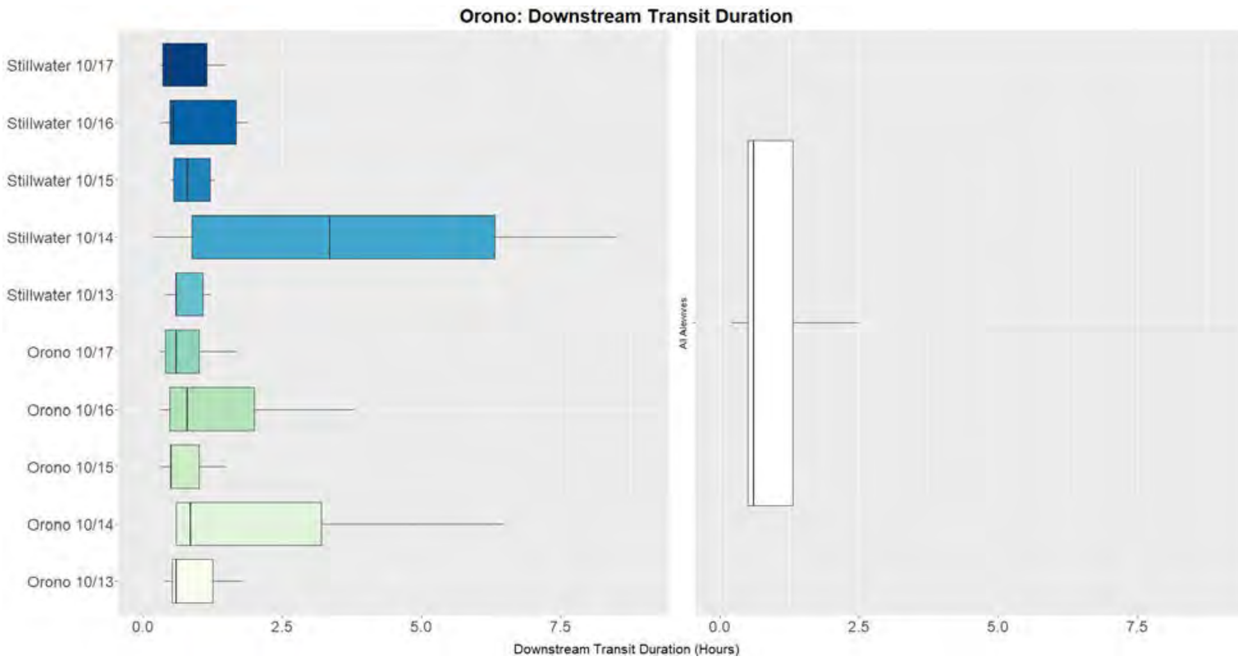

Figure 4–22. Boxplot of the downstream transit duration for radio-tagged juvenile alosines following passage at Orono during the October 2020 downstream passage assessment.

5 Summary

This study was intended to evaluate the residence time from arrival until downstream passage as well as the proportional downstream passage route utilization for juvenile alosines at the Milford, Stillwater, and Orono Projects on the Lower Penobscot River. A total of 387 juvenile alosines were tagged and released at one of three locations upstream of Milford, Stillwater or Orono, and their subsequent downstream arrival and passage was monitored via a series of fixed-location telemetry receivers within the Project areas. All of the juvenile alosines utilized for this study were collected from Souadabscook Stream and ranged in total length from 113-144 mm. Radio transmitters were bonded to small fish hooks and then externally affixed to each individual prior to their release. Releases of radio-tagged juveniles were conducted over a 5 day period from October 13 to 17, 2020.

Of the 130 radio-tagged individuals released upstream of Milford, 92% continued downstream following handling and tagging and were determined to have approached Milford Dam. Of those individuals, 18% did not pass downstream, resulting in a total of 98 individuals with which to estimate the proportional use of downstream passage routes at the Project. Dependent on their time of arrival, juvenile alosines approaching Milford had opportunities to pass downstream via spill, the two downstream bypass entrances, turbine units, or the downstream end of the exit flume of the upstream fish passage facility. Radio-tagged juvenile alosines were primarily observed passing downstream of Milford via the set of older turbine units (i.e., Units 3, 4, 5 and 6) and the downstream bypass entrance located on the riverside of the powerhouse.

Approximately 82% of the 130 radio-tagged individuals released upstream of Stillwater were determined to have approached Stillwater Dam. Of those individuals, 11% did not pass downstream, resulting in a total of 94 individuals with which to estimate the proportional use of downstream passage routes at the Project. Dependent on their time of arrival, juvenile alosines approaching Stillwater had opportunities to pass downstream via spill, the downstream bypass facilities, or the turbines at powerhouses A and B. Distribution of downstream passage events at Stillwater was fairly even between turbine units (48%) and the downstream bypasses (42%). A higher proportion of individuals passed downstream via the bypass at powerhouse B than A, and through turbine units at powerhouse A than B.

When radio-tagged individuals released upstream of Stillwater are also considered, a total of 257 juvenile alosines were released at points within the Stillwater Branch upstream of Orono. Of those fish, approximately 74% were determined to have approached Orono Dam. Of those individuals, 6% did not pass downstream, resulting in a total of 148 individuals with which to estimate the proportional use of downstream passage routes at the Project. Dependent on their time of arrival, juvenile alosines approaching Orono had opportunities to pass downstream via spill, the downstream bypass facility, or turbines at powerhouses A and B. Greater than 60% of all downstream passage events were of individuals which utilized the downstream bypass facility.

Downstream movement for juvenile alosines tagged as part of this study was relatively quick. When the upstream residence duration for all individuals is considered, the median value was 1.8 hours at Milford (25th percentile = 1.5 hours; 75th percentile = 3.2 hours), 1.1 hours at Stillwater (25th percentile = 0.5 hours; 75th percentile = 6.9 hours), and 0.5 hours at Orono (25th percentile = 0.3 hours; 75th percentile = 0.8 hours). Juvenile alosines were subsequently detected at downstream locations following passage at each of the three Projects. The median duration of radio-tagged juvenile alosines to transit the 9.4 km reach from Milford to Station O8 was 2.7 hours, the 1.6 km reach from Stillwater to Orono (i.e., Orono headpond) was 4.9 hours and the 1.4 km reach from Orono to Station O8 was 0.6 hours.

6 Appendices

Appendix A. Transmitter and length information for juvenile alosines radio-tagged and released upstream of Milford, Stillwater and Orono during October 2020.

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Milford	149.320	72	125	Elks Club	10/13/2020
Milford	149.320	92	139	Elks Club	10/13/2020
Milford	149.320	103	135	Elks Club	10/13/2020
Milford	149.320	118	127	Elks Club	10/13/2020
Milford	149.320	125	126	Elks Club	10/13/2020
Milford	149.320	130	120	Elks Club	10/13/2020
Milford	149.320	135	125	Elks Club	10/13/2020
Milford	149.320	142	125	Elks Club	10/13/2020
Milford	149.340	82	128	Elks Club	10/13/2020
Milford	149.340	119	125	Elks Club	10/13/2020
Milford	149.340	120	119	Elks Club	10/13/2020
Milford	149.340	121	124	Elks Club	10/13/2020
Milford	149.340	126	129	Elks Club	10/13/2020
Milford	149.340	127	124	Elks Club	10/13/2020
Milford	149.340	130	124	Elks Club	10/13/2020
Milford	149.340	139	123	Elks Club	10/13/2020
Milford	149.360	19	131	Elks Club	10/13/2020
Milford	149.360	22	125	Elks Club	10/13/2020
Milford	149.360	23	125	Elks Club	10/13/2020
Milford	149.360	37	123	Elks Club	10/13/2020
Milford	149.360	43	132	Elks Club	10/13/2020
Milford	149.360	50	131	Elks Club	10/13/2020
Milford	149.360	76	126	Elks Club	10/13/2020
Milford	149.360	87	128	Elks Club	10/13/2020
Milford	149.360	121	127	Elks Club	10/13/2020
Milford	149.320	62	126	Elks Club	10/14/2020
Milford	149.320	79	128	Elks Club	10/14/2020
Milford	149.320	84	137	Elks Club	10/14/2020
Milford	149.320	97	125	Elks Club	10/14/2020
Milford	149.320	107	119	Elks Club	10/14/2020
Milford	149.320	119	127	Elks Club	10/14/2020
Milford	149.320	148	121	Elks Club	10/14/2020
Milford	149.320	157	128	Elks Club	10/14/2020
Milford	149.320	178	137	Elks Club	10/14/2020
Milford	149.340	90	126	Elks Club	10/14/2020
Milford	149.340	104	129	Elks Club	10/14/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Milford	149.340	108	134	Elks Club	10/14/2020
Milford	149.340	114	133	Elks Club	10/14/2020
Milford	149.340	140	118	Elks Club	10/14/2020
Milford	149.340	156	135	Elks Club	10/14/2020
Milford	149.340	160	125	Elks Club	10/14/2020
Milford	149.340	165	125	Elks Club	10/14/2020
Milford	149.360	13	130	Elks Club	10/14/2020
Milford	149.360	20	125	Elks Club	10/14/2020
Milford	149.360	91	133	Elks Club	10/14/2020
Milford	149.360	93	127	Elks Club	10/14/2020
Milford	149.360	94	130	Elks Club	10/14/2020
Milford	149.360	132	136	Elks Club	10/14/2020
Milford	149.360	136	133	Elks Club	10/14/2020
Milford	149.320	63	120	Elks Club	10/15/2020
Milford	149.320	71	115	Elks Club	10/15/2020
Milford	149.320	121	115	Elks Club	10/15/2020
Milford	149.320	147	125	Elks Club	10/15/2020
Milford	149.320	161	124	Elks Club	10/15/2020
Milford	149.320	162	126	Elks Club	10/15/2020
Milford	149.320	163	115	Elks Club	10/15/2020
Milford	149.320	174	124	Elks Club	10/15/2020
Milford	149.320	185	130	Elks Club	10/15/2020
Milford	149.340	76	125	Elks Club	10/15/2020
Milford	149.340	87	128	Elks Club	10/15/2020
Milford	149.340	98	130	Elks Club	10/15/2020
Milford	149.340	99	133	Elks Club	10/15/2020
Milford	149.340	122	128	Elks Club	10/15/2020
Milford	149.340	138	135	Elks Club	10/15/2020
Milford	149.340	144	125	Elks Club	10/15/2020
Milford	149.340	145	128	Elks Club	10/15/2020
Milford	149.360	15	124	Elks Club	10/15/2020
Milford	149.360	41	136	Elks Club	10/15/2020
Milford	149.360	44	135	Elks Club	10/15/2020
Milford	149.360	52	122	Elks Club	10/15/2020
Milford	149.360	54	130	Elks Club	10/15/2020
Milford	149.360	89	115	Elks Club	10/15/2020
Milford	149.360	108	125	Elks Club	10/15/2020
Milford	149.360	124	130	Elks Club	10/15/2020
Milford	149.320	83	134	Elks Club	10/16/2020
Milford	149.320	108	127	Elks Club	10/16/2020
Milford	149.320	120	133	Elks Club	10/16/2020
Milford	149.320	136	126	Elks Club	10/16/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Milford	149.320	140	133	Elks Club	10/16/2020
Milford	149.320	158	143	Elks Club	10/16/2020
Milford	149.320	172	132	Elks Club	10/16/2020
Milford	149.320	187	137	Elks Club	10/16/2020
Milford	149.340	31	127	Elks Club	10/16/2020
Milford	149.340	41	126	Elks Club	10/16/2020
Milford	149.340	44	117	Elks Club	10/16/2020
Milford	149.340	47	119	Elks Club	10/16/2020
Milford	149.340	51	132	Elks Club	10/16/2020
Milford	149.340	52	132	Elks Club	10/16/2020
Milford	149.340	64	135	Elks Club	10/16/2020
Milford	149.340	75	127	Elks Club	10/16/2020
Milford	149.360	16	128	Elks Club	10/16/2020
Milford	149.360	28	125	Elks Club	10/16/2020
Milford	149.360	48	121	Elks Club	10/16/2020
Milford	149.360	49	131	Elks Club	10/16/2020
Milford	149.360	81	130	Elks Club	10/16/2020
Milford	149.360	97	128	Elks Club	10/16/2020
Milford	149.360	99	126	Elks Club	10/16/2020
Milford	149.360	118	127	Elks Club	10/16/2020
Milford	149.360	120	129	Elks Club	10/16/2020
Milford	149.320	65	128	Elks Club	10/17/2020
Milford	149.320	77	133	Elks Club	10/17/2020
Milford	149.320	100	136	Elks Club	10/17/2020
Milford	149.320	105	134	Elks Club	10/17/2020
Milford	149.320	109	123	Elks Club	10/17/2020
Milford	149.320	132	132	Elks Club	10/17/2020
Milford	149.320	145	126	Elks Club	10/17/2020
Milford	149.320	152	133	Elks Club	10/17/2020
Milford	149.320	183	128	Elks Club	10/17/2020
Milford	149.320	188	123	Elks Club	10/17/2020
Milford	149.340	27	132	Elks Club	10/17/2020
Milford	149.340	34	132	Elks Club	10/17/2020
Milford	149.340	50	119	Elks Club	10/17/2020
Milford	149.340	53	131	Elks Club	10/17/2020
Milford	149.340	62	124	Elks Club	10/17/2020
Milford	149.340	118	125	Elks Club	10/17/2020
Milford	149.340	123	128	Elks Club	10/17/2020
Milford	149.340	124	122	Elks Club	10/17/2020
Milford	149.340	132	128	Elks Club	10/17/2020
Milford	149.340	164	129	Elks Club	10/17/2020
Milford	149.360	24	126	Elks Club	10/17/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Milford	149.360	57	134	Elks Club	10/17/2020
Milford	149.360	64	123	Elks Club	10/17/2020
Milford	149.360	66	130	Elks Club	10/17/2020
Milford	149.360	72	123	Elks Club	10/17/2020
Milford	149.360	74	124	Elks Club	10/17/2020
Milford	149.360	75	130	Elks Club	10/17/2020
Milford	149.360	111	131	Elks Club	10/17/2020
Milford	149.360	116	131	Elks Club	10/17/2020
Milford	149.360	123	129	Elks Club	10/17/2020
Milford	149.360	125	129	Elks Club	10/17/2020
Orono	149.320	85	129	U. Maine Steam Plant	10/13/2020
Orono	149.320	88	126	U. Maine Steam Plant	10/13/2020
Orono	149.320	90	128	U. Maine Steam Plant	10/13/2020
Orono	149.320	93	130	U. Maine Steam Plant	10/13/2020
Orono	149.320	111	129	U. Maine Steam Plant	10/13/2020
Orono	149.320	112	134	U. Maine Steam Plant	10/13/2020
Orono	149.320	124	130	U. Maine Steam Plant	10/13/2020
Orono	149.320	128	128	U. Maine Steam Plant	10/13/2020
Orono	149.340	73	128	U. Maine Steam Plant	10/13/2020
Orono	149.340	78	127	U. Maine Steam Plant	10/13/2020
Orono	149.340	80	118	U. Maine Steam Plant	10/13/2020
Orono	149.340	84	129	U. Maine Steam Plant	10/13/2020
Orono	149.340	86	134	U. Maine Steam Plant	10/13/2020
Orono	149.340	89	122	U. Maine Steam Plant	10/13/2020
Orono	149.340	93	130	U. Maine Steam Plant	10/13/2020
Orono	149.340	105	129	U. Maine Steam Plant	10/13/2020
Orono	149.340	113	139	U. Maine Steam Plant	10/13/2020
Orono	149.360	11	126	U. Maine Steam Plant	10/13/2020
Orono	149.360	18	115	U. Maine Steam Plant	10/13/2020
Orono	149.360	26	137	U. Maine Steam Plant	10/13/2020
Orono	149.360	61	119	U. Maine Steam Plant	10/13/2020
Orono	149.360	62	125	U. Maine Steam Plant	10/13/2020
Orono	149.360	90	122	U. Maine Steam Plant	10/13/2020
Orono	149.360	105	127	U. Maine Steam Plant	10/13/2020
Orono	149.360	114	132	U. Maine Steam Plant	10/13/2020
Orono	149.320	73	128	U. Maine Steam Plant	10/14/2020
Orono	149.320	74	126	U. Maine Steam Plant	10/14/2020
Orono	149.320	78	128	U. Maine Steam Plant	10/14/2020
Orono	149.320	122	125	U. Maine Steam Plant	10/14/2020
Orono	149.320	123	123	U. Maine Steam Plant	10/14/2020
Orono	149.320	144	125	U. Maine Steam Plant	10/14/2020
Orono	149.320	164	124	U. Maine Steam Plant	10/14/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Orono	149.320	184	123	U. Maine Steam Plant	10/14/2020
Orono	149.340	92	124	U. Maine Steam Plant	10/14/2020
Orono	149.340	107	126	U. Maine Steam Plant	10/14/2020
Orono	149.340	111	128	U. Maine Steam Plant	10/14/2020
Orono	149.340	131	133	U. Maine Steam Plant	10/14/2020
Orono	149.340	153	129	U. Maine Steam Plant	10/14/2020
Orono	149.340	154	128	U. Maine Steam Plant	10/14/2020
Orono	149.340	155	131	U. Maine Steam Plant	10/14/2020
Orono	149.340	161	130	U. Maine Steam Plant	10/14/2020
Orono	149.360	30	131	U. Maine Steam Plant	10/14/2020
Orono	149.360	40	127	U. Maine Steam Plant	10/14/2020
Orono	149.360	73	134	U. Maine Steam Plant	10/14/2020
Orono	149.360	84	125	U. Maine Steam Plant	10/14/2020
Orono	149.360	100	130	U. Maine Steam Plant	10/14/2020
Orono	149.360	109	126	U. Maine Steam Plant	10/14/2020
Orono	149.360	117	130	U. Maine Steam Plant	10/14/2020
Orono	149.360	128	125	U. Maine Steam Plant	10/14/2020
Orono	149.360	135	125	U. Maine Steam Plant	10/14/2020
Orono	149.320	69	119	U. Maine Steam Plant	10/15/2020
Orono	149.320	81	131	U. Maine Steam Plant	10/15/2020
Orono	149.320	129	117	U. Maine Steam Plant	10/15/2020
Orono	149.320	146	132	U. Maine Steam Plant	10/15/2020
Orono	149.320	150	123	U. Maine Steam Plant	10/15/2020
Orono	149.320	153	116	U. Maine Steam Plant	10/15/2020
Orono	149.320	154	132	U. Maine Steam Plant	10/15/2020
Orono	149.340	85	126	U. Maine Steam Plant	10/15/2020
Orono	149.340	100	121	U. Maine Steam Plant	10/15/2020
Orono	149.340	110	129	U. Maine Steam Plant	10/15/2020
Orono	149.340	125	137	U. Maine Steam Plant	10/15/2020
Orono	149.340	133	123	U. Maine Steam Plant	10/15/2020
Orono	149.340	135	127	U. Maine Steam Plant	10/15/2020
Orono	149.340	142	135	U. Maine Steam Plant	10/15/2020
Orono	149.340	143	126	U. Maine Steam Plant	10/15/2020
Orono	149.340	162	127	U. Maine Steam Plant	10/15/2020
Orono	149.340	182	134	U. Maine Steam Plant	10/15/2020
Orono	149.360	59	134	U. Maine Steam Plant	10/15/2020
Orono	149.360	65	134	U. Maine Steam Plant	10/15/2020
Orono	149.360	67	144	U. Maine Steam Plant	10/15/2020
Orono	149.360	95	121	U. Maine Steam Plant	10/15/2020
Orono	149.360	98	135	U. Maine Steam Plant	10/15/2020
Orono	149.360	129	134	U. Maine Steam Plant	10/15/2020
Orono	149.360	134	133	U. Maine Steam Plant	10/15/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Orono	149.360	138	125	U. Maine Steam Plant	10/15/2020
Orono	149.320	66	136	U. Maine Steam Plant	10/16/2020
Orono	149.320	76	133	U. Maine Steam Plant	10/16/2020
Orono	149.320	115	135	U. Maine Steam Plant	10/16/2020
Orono	149.320	117	116	U. Maine Steam Plant	10/16/2020
Orono	149.320	126	127	U. Maine Steam Plant	10/16/2020
Orono	149.320	133	127	U. Maine Steam Plant	10/16/2020
Orono	149.320	137	133	U. Maine Steam Plant	10/16/2020
Orono	149.320	143	124	U. Maine Steam Plant	10/16/2020
Orono	149.340	26	132	U. Maine Steam Plant	10/16/2020
Orono	149.340	37	123	U. Maine Steam Plant	10/16/2020
Orono	149.340	39	127	U. Maine Steam Plant	10/16/2020
Orono	149.340	49	126	U. Maine Steam Plant	10/16/2020
Orono	149.340	56	127	U. Maine Steam Plant	10/16/2020
Orono	149.340	57	132	U. Maine Steam Plant	10/16/2020
Orono	149.340	66	126	U. Maine Steam Plant	10/16/2020
Orono	149.340	72	127	U. Maine Steam Plant	10/16/2020
Orono	149.340	79	133	U. Maine Steam Plant	10/16/2020
Orono	149.340	136	137	U. Maine Steam Plant	10/16/2020
Orono	149.360	17	131	U. Maine Steam Plant	10/16/2020
Orono	149.360	21	135	U. Maine Steam Plant	10/16/2020
Orono	149.360	34	132	U. Maine Steam Plant	10/16/2020
Orono	149.360	58	139	U. Maine Steam Plant	10/16/2020
Orono	149.360	60	130	U. Maine Steam Plant	10/16/2020
Orono	149.360	78	127	U. Maine Steam Plant	10/16/2020
Orono	149.360	83	125	U. Maine Steam Plant	10/16/2020
Orono	149.360	85	131	U. Maine Steam Plant	10/16/2020
Orono	149.360	130	132	U. Maine Steam Plant	10/16/2020
Orono	149.320	67	129	U. Maine Steam Plant	10/17/2020
Orono	149.320	87	127	U. Maine Steam Plant	10/17/2020
Orono	149.320	95	130	U. Maine Steam Plant	10/17/2020
Orono	149.320	96	127	U. Maine Steam Plant	10/17/2020
Orono	149.320	116	126	U. Maine Steam Plant	10/17/2020
Orono	149.320	141	127	U. Maine Steam Plant	10/17/2020
Orono	149.320	168	119	U. Maine Steam Plant	10/17/2020
Orono	149.320	169	132	U. Maine Steam Plant	10/17/2020
Orono	149.320	177	126	U. Maine Steam Plant	10/17/2020
Orono	149.340	38	130	U. Maine Steam Plant	10/17/2020
Orono	149.340	40	123	U. Maine Steam Plant	10/17/2020
Orono	149.340	63	122	U. Maine Steam Plant	10/17/2020
Orono	149.340	69	124	U. Maine Steam Plant	10/17/2020
Orono	149.340	83	125	U. Maine Steam Plant	10/17/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Orono	149.340	88	126	U. Maine Steam Plant	10/17/2020
Orono	149.340	152	123	U. Maine Steam Plant	10/17/2020
Orono	149.340	158	113	U. Maine Steam Plant	10/17/2020
Orono	149.340	163	131	U. Maine Steam Plant	10/17/2020
Orono	149.360	31	132	U. Maine Steam Plant	10/17/2020
Orono	149.360	32	132	U. Maine Steam Plant	10/17/2020
Orono	149.360	70	125	U. Maine Steam Plant	10/17/2020
Orono	149.360	80	138	U. Maine Steam Plant	10/17/2020
Orono	149.360	96	127	U. Maine Steam Plant	10/17/2020
Orono	149.360	122	124	U. Maine Steam Plant	10/17/2020
Orono	149.360	127	133	U. Maine Steam Plant	10/17/2020
Stillwater	149.320	80	131	Old Town Water District	10/13/2020
Stillwater	149.320	86	138	Old Town Water District	10/13/2020
Stillwater	149.320	99	131	Old Town Water District	10/13/2020
Stillwater	149.320	127	118	Old Town Water District	10/13/2020
Stillwater	149.320	155	127	Old Town Water District	10/13/2020
Stillwater	149.320	165	126	Old Town Water District	10/13/2020
Stillwater	149.320	181	126	Old Town Water District	10/13/2020
Stillwater	149.320	189	126	Old Town Water District	10/13/2020
Stillwater	149.340	89	126	Old Town Water District	10/13/2020
Stillwater	149.340	102	123	Old Town Water District	10/13/2020
Stillwater	149.340	109	130	Old Town Water District	10/13/2020
Stillwater	149.340	112	137	Old Town Water District	10/13/2020
Stillwater	149.340	115	129	Old Town Water District	10/13/2020
Stillwater	149.340	116	127	Old Town Water District	10/13/2020
Stillwater	149.340	128	134	Old Town Water District	10/13/2020
Stillwater	149.340	157	122	Old Town Water District	10/13/2020
Stillwater	149.360	14	129	Old Town Water District	10/13/2020
Stillwater	149.360	25	133	Old Town Water District	10/13/2020
Stillwater	149.360	36	120	Old Town Water District	10/13/2020
Stillwater	149.360	53	124	Old Town Water District	10/13/2020
Stillwater	149.360	56	131	Old Town Water District	10/13/2020
Stillwater	149.360	71	132	Old Town Water District	10/13/2020
Stillwater	149.360	107	136	Old Town Water District	10/13/2020
Stillwater	149.360	112	125	Old Town Water District	10/13/2020
Stillwater	149.360	139	120	Old Town Water District	10/13/2020
Stillwater	149.320	64	127	Old Town Water District	10/14/2020
Stillwater	149.320	98	134	Old Town Water District	10/14/2020
Stillwater	149.320	134	121	Old Town Water District	10/14/2020
Stillwater	149.320	138	119	Old Town Water District	10/14/2020
Stillwater	149.320	149	128	Old Town Water District	10/14/2020
Stillwater	149.320	159	129	Old Town Water District	10/14/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Stillwater	149.320	166	120	Old Town Water District	10/14/2020
Stillwater	149.320	173	124	Old Town Water District	10/14/2020
Stillwater	149.340	81	130	Old Town Water District	10/14/2020
Stillwater	149.340	101	125	Old Town Water District	10/14/2020
Stillwater	149.340	103	132	Old Town Water District	10/14/2020
Stillwater	149.340	106	125	Old Town Water District	10/14/2020
Stillwater	149.340	117	128	Old Town Water District	10/14/2020
Stillwater	149.340	129	120	Old Town Water District	10/14/2020
Stillwater	149.340	137	130	Old Town Water District	10/14/2020
Stillwater	149.340	146	126	Old Town Water District	10/14/2020
Stillwater	149.340	147	126	Old Town Water District	10/14/2020
Stillwater	149.360	42	130	Old Town Water District	10/14/2020
Stillwater	149.360	46	120	Old Town Water District	10/14/2020
Stillwater	149.360	47	133	Old Town Water District	10/14/2020
Stillwater	149.360	51	120	Old Town Water District	10/14/2020
Stillwater	149.360	68	124	Old Town Water District	10/14/2020
Stillwater	149.360	77	124	Old Town Water District	10/14/2020
Stillwater	149.360	92	125	Old Town Water District	10/14/2020
Stillwater	149.360	110	118	Old Town Water District	10/14/2020
Stillwater	149.320	61	128	Old Town Water District	10/15/2020
Stillwater	149.320	82	127	Old Town Water District	10/15/2020
Stillwater	149.320	101	123	Old Town Water District	10/15/2020
Stillwater	149.320	102	127	Old Town Water District	10/15/2020
Stillwater	149.320	113	122	Old Town Water District	10/15/2020
Stillwater	149.320	131	135	Old Town Water District	10/15/2020
Stillwater	149.320	151	126	Old Town Water District	10/15/2020
Stillwater	149.320	186	127	Old Town Water District	10/15/2020
Stillwater	149.340	30	125	Old Town Water District	10/15/2020
Stillwater	149.340	36	119	Old Town Water District	10/15/2020
Stillwater	149.340	43	125	Old Town Water District	10/15/2020
Stillwater	149.340	46	124	Old Town Water District	10/15/2020
Stillwater	149.340	58	117	Old Town Water District	10/15/2020
Stillwater	149.340	65	130	Old Town Water District	10/15/2020
Stillwater	149.340	77	129	Old Town Water District	10/15/2020
Stillwater	149.340	159	128	Old Town Water District	10/15/2020
Stillwater	149.360	11	124	Old Town Water District	10/15/2020
Stillwater	149.360	29	115	Old Town Water District	10/15/2020
Stillwater	149.360	38	124	Old Town Water District	10/15/2020
Stillwater	149.360	63	130	Old Town Water District	10/15/2020
Stillwater	149.360	79	130	Old Town Water District	10/15/2020
Stillwater	149.360	88	128	Old Town Water District	10/15/2020
Stillwater	149.360	106	122	Old Town Water District	10/15/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Stillwater	149.360	115	125	Old Town Water District	10/15/2020
Stillwater	149.360	133	124	Old Town Water District	10/15/2020
Stillwater	149.320	70	122	Old Town Water District	10/16/2020
Stillwater	149.320	75	132	Old Town Water District	10/16/2020
Stillwater	149.320	91	130	Old Town Water District	10/16/2020
Stillwater	149.320	104	126	Old Town Water District	10/16/2020
Stillwater	149.320	110	114	Old Town Water District	10/16/2020
Stillwater	149.320	156	128	Old Town Water District	10/16/2020
Stillwater	149.320	160	135	Old Town Water District	10/16/2020
Stillwater	149.320	167	128	Old Town Water District	10/16/2020
Stillwater	149.320	170	130	Old Town Water District	10/16/2020
Stillwater	149.340	29	135	Old Town Water District	10/16/2020
Stillwater	149.340	33	136	Old Town Water District	10/16/2020
Stillwater	149.340	35	138	Old Town Water District	10/16/2020
Stillwater	149.340	45	134	Old Town Water District	10/16/2020
Stillwater	149.340	54	137	Old Town Water District	10/16/2020
Stillwater	149.340	55	127	Old Town Water District	10/16/2020
Stillwater	149.340	59	132	Old Town Water District	10/16/2020
Stillwater	149.340	74	134	Old Town Water District	10/16/2020
Stillwater	149.360	12	128	Old Town Water District	10/16/2020
Stillwater	149.360	27	129	Old Town Water District	10/16/2020
Stillwater	149.360	35	131	Old Town Water District	10/16/2020
Stillwater	149.360	45	123	Old Town Water District	10/16/2020
Stillwater	149.360	69	124	Old Town Water District	10/16/2020
Stillwater	149.360	82	125	Old Town Water District	10/16/2020
Stillwater	149.360	102	127	Old Town Water District	10/16/2020
Stillwater	149.360	119	120	Old Town Water District	10/16/2020
Stillwater	149.360	140	128	Old Town Water District	10/16/2020
Stillwater	149.320	68	133	Old Town Water District	10/17/2020
Stillwater	149.320	94	128	Old Town Water District	10/17/2020
Stillwater	149.320	106	126	Old Town Water District	10/17/2020
Stillwater	149.320	114	128	Old Town Water District	10/17/2020
Stillwater	149.320	139	129	Old Town Water District	10/17/2020
Stillwater	149.320	171	122	Old Town Water District	10/17/2020
Stillwater	149.320	175	142	Old Town Water District	10/17/2020
Stillwater	149.320	176	128	Old Town Water District	10/17/2020
Stillwater	149.320	179	127	Old Town Water District	10/17/2020
Stillwater	149.320	180	128	Old Town Water District	10/17/2020
Stillwater	149.340	28	121	Old Town Water District	10/17/2020
Stillwater	149.340	32	123	Old Town Water District	10/17/2020
Stillwater	149.340	42	128	Old Town Water District	10/17/2020
Stillwater	149.340	48	128	Old Town Water District	10/17/2020

Project	Frequency	ID	Total Length (mm)	Release Location	Release Date
Stillwater	149.340	68	122	Old Town Water District	10/17/2020
Stillwater	149.340	70	126	Old Town Water District	10/17/2020
Stillwater	149.340	71	127	Old Town Water District	10/17/2020
Stillwater	149.340	91	121	Old Town Water District	10/17/2020
Stillwater	149.340	134	127	Old Town Water District	10/17/2020
Stillwater	149.340	141	136	Old Town Water District	10/17/2020
Stillwater	149.360	33	131	Old Town Water District	10/17/2020
Stillwater	149.360	55	129	Old Town Water District	10/17/2020
Stillwater	149.360	86	123	Old Town Water District	10/17/2020
Stillwater	149.360	103	131	Old Town Water District	10/17/2020
Stillwater	149.360	104	128	Old Town Water District	10/17/2020
Stillwater	149.360	113	127	Old Town Water District	10/17/2020
Stillwater	149.360	126	118	Old Town Water District	10/17/2020
Stillwater	149.360	131	133	Old Town Water District	10/17/2020
Stillwater	149.360	137	120	Old Town Water District	10/17/2020

Appendix B. Summary of questions and topics discussed at the January 27, 2021 resource agency and PIN study discussion meeting.

Question 1: *Can you speak in a general sense about a comparison of results for downstream passage survival of juvenile alosines estimated using the USFWS TBSA model versus collected empirically via radio telemetry?*

Response 1: Historically, Normandeau has not estimated survival of juvenile alosines using radio telemetry due to uncertainty around retention of transmitters hooked externally to the fish and the potential to bias estimates if tags are shed during passage and the fish is not injured. This study (along with accompanying TBSA analysis) is the first time Normandeau has merged juvenile alosine route selection information with a desktop approach to estimate survival.

Question 2: *Have HI-Z turbine tag (i.e., balloon tag) studies been conducted for juvenile alosines? If so, how many studies have been done?*

Response 2: Normandeau has conducted HI-Z turbine tag studies on juvenile alosines at other hydroelectric projects. Previous studies have been successful at collecting estimates of initial survival, but in some cases estimation of latent survival has been hindered by poor control fish survival. Table B-1 below provides a summary of juvenile alosine studies conducted to date by Normandeau.

Question 3: *Can release locations be provided on a map in the final report?*

Response 3: Figure 3-1 has been added to the final report showing release locations on a map.

Question 4: *For fish passing Stillwater and Orono, was there a comparison of fish passing at Orono based on original release location upstream of two dams versus one dam?*

Response 4: Upstream residence time information at Orono for fish released upstream at Stillwater and at Orono is provided in Table 4-13 and Figure 4-19. The median residence duration at Orono was 0.4 hours (quartile range = 0.3-0.7 hours) for fish released upstream of Stillwater Dam, and it was 0.5 hours (quartile range = 0.3-0.8 hours) for fish released upstream of the Orono Dam. Downstream passage route utilization is provided in Table 4-14. When the percentages of radio-tagged juvenile alosines confirmed to have passed downstream of Orono are examined by release location, the majority used the downstream bypass (55% of those originating upstream of Stillwater, and 76% of those originating upstream of Orono). The remainder of tagged juvenile alosines originating upstream of Stillwater Dam passed downstream at Orono via Powerhouse B (33% of individuals) and on spill (13% of individuals). The remainder of tagged juvenile alosines originating upstream of Orono passed downstream at Orono via Powerhouse A (1% of individuals), Powerhouse B (18% of individuals), and on spill (5% of individuals).

Question 5: *Can you explain the reasoning for conducting releases of tagged fish during the evening hours?*

Response 5: That decision was made based on early juvenile alosine studies conducted on the Merrimack River. Initial releases there were conducted during the afternoon and exhibited high rates of apparent predation based on upstream movement of tags. Release strategies were modified to let tagged fish go closer to sunset, as well as to paint the white transmitters black to reduce visibility. These modifications were made with the intent of maximizing the number of fish reaching the dam from which to draw conclusions on residence time and passage route.

Question 6: *Were there any observations of predation documented? Were there any qualitative observations of fish moving at the same time as tagged fish?*

Response 6: The 2020 telemetry study was not designed with a large manual tracking component that would be required to better infer on predation. Limited manual tracking was conducted during the study and focused on presence of tags in the immediate forebay or tailrace areas. Brookfield fishway personnel regularly observed juvenile alosines moving past all three Projects during both day and night hours, particularly during peak movement periods within the downstream passage season.

Question 7: *Any insight into the losses of juvenile alosines within the Project impoundments?*

Response 7: No definitive evidence. Speculative reasons for failure to approach or pass at a dam may be predation, delayed effects from handling, tag loss, or simple failure to locate a passage route.

Table B-1. Summary of previously conducted HI-Z turbine tag studies focused on downstream passage of juvenile alosines.

Station	State	Study Year	River	Species	Average size (mm)	Turbine Type	No. of blades	Runner speed (rpm)	Runner diameter (in)	Discharge (cfs)	Project Head (ft)	1 h survival	1 h SE	48 h survival	48 h SE
Columbia	SC	1998	Broad/Congaree	Blueback Herring	141	H-Francis	14	164	64	800	28	0.936		0.881	0.073
Conowingo	MD	2011	Susquehanna	American Shad	119	Francis	13	81.8	203	5,080	89	0.899	0.034	0.899	0.034
Conowingo	MD	1993	Susquehanna	American Shad	125	Mixed Flow	6	120	225	8,000	90	0.949	0.043	0.929	0.045
Crescent	NY	1991	Mohawk	Blueback herring	91	Kaplan	5	144	108	1,520	27	0.960	0.0408	0.960	0.0408
Hadley Falls (Holyoke)	MA	1991	Connecticut	American Shad	82	Kaplan	5	128	170	4,200	52	0.973	0.0821		
Hadley Falls (Holyoke)	MA	1991	Connecticut	American Shad	82	Kaplan	5	128	170	1,550	52	1.000	0.0561		
Hadley Falls (Holyoke)	MA	1991	Connecticut	American Shad	82	Propeller	5	150	156	4,200	52	0.891	0.0617		
Holtwood	PA	1991	Susquehanna	American Shad	125	Francis (single runner)	16	94.7	164	3,500	51	0.894	0.05	0.78 (24-h)	0.0847
Holtwood	PA	1991	Susquehanna	American Shad	125	Francis (double runner)	17	102.8	112	3,500	51	0.835	0.0525	0.68 (24-h)	0.0684
Holtwood	PA	1997	Susquehanna	American Shad	119	Francis (single runner)	13	94.7	164	3,000	51	0.905	0.116		
Safe Harbor	PA	1990	Susquehanna	American Shad	118	Mixed Flow	7	76.6	240	9,200	55	0.960	0.015	0.830	0.071
Safe Harbor	PA	1990	Susquehanna	American Shad	118	Mixed Flow	7	76.6	240	9,200	55	0.980	0.010	0.980	0.010
Safe Harbor	PA	1990	Susquehanna	American Shad	118	Kaplan	5	109.1	220	8,300	55	0.980	0.010	0.980	0.010
Stevens Creek	SC	1993	Savannah	Blueback Herring	203	Francis	14	75	135	1,000	28	0.953	0.0163	0.943	0.0209
Turners Falls (Cabot Station)	MA	2015	Connecticut	American Shad	96	Francis	13	97.3	136	2,304	60	0.952	0.020		
Turners Falls (Station No. 1)	MA	2015	Connecticut	American Shad	96	Francis	13	200	54	651	44	0.766	0.048		
Turners Falls (Station No. 1)	MA	2015	Connecticut	American Shad	96	Francis	13&15	257&200	39&55	591	44	0.678	0.050		
Vernon	VT/NH	1995	Connecticut	American Shad	92	Francis	15	74	156	1,834	34	0.947	0.022	0.946	0.031
Vernon	VT/NH	2015	Connecticut	American Shad	98	Francis	13	133	62.5	1,000	35	0.917	0.055		
Vernon	VT/NH	2015	Connecticut	American Shad	104	Kaplan	5	144	122	1,200	35	0.952	0.047		
York Haven	PA	2000	Susquehanna	American Shad	114	Francis	18	84	78	850	23	0.771	0.0676	0.771	
York Haven	PA	2000	Susquehanna	American Shad	118	Kaplan	4	200	93	1100	21	0.927	0.064	0.927	

Appendix C. Correspondence related to the distribution and comment on the draft juvenile alosine downstream passage route study report.

From: Bernier, Kevin [mailto:Kevin.Bernier@brookfieldrenewable.com]
Sent: Thursday, December 10, 2020 10:41 AM
To: Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Harold Peterson <harold.peterson@bia.gov>; Marchelle M Foster <marchelle.foster@bia.gov>; Antonio Bentivoglio <antonio_bentivoglio@fws.gov>; Kenneth J Hogan <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Bryan Sojkowski <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Julianne Rosset (julianne_rosset@fws.gov) <julianne_rosset@fws.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: External: Lower Penobscot juvenile alosine draft study reports

Please find attached for your review two draft reports prepared by Normandeau Associates covering juvenile alosine downstream studies conducted this fall at the Milford, Stillwater, and Orono Projects. As you probably recall, these studies resulted from our discussions last winter, whereby the general consensus was to focus on downstream-migrating juvenile alosines in 2020 (after a successful pilot study had been conducted at the West Enfield Project in 2019), followed by evaluations of upstream alosine passage in 2021. FERC had previously provided direction requesting that the studies address data gaps on upstream-migrating adult alosines and downstream-migrating juvenile alosines at these Projects.

Please provide any comments **by January 11, 2021**; I will also be distributing a draft report in the near future on this fall's downstream eel study at the Medway Project. A Teams Meeting will likely then be scheduled in early January to review these reports and answer any questions. In the meantime, please feel free to contact me with any questions.

Kevin Bernier
Senior Compliance Specialist
Brookfield Renewable
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C 207 951 5006
kevin.bernier@brookfieldrenewable.com
www.brookfieldrenewable.com

From: Sferra, Christopher [mailto:Christopher.Sferra@maine.gov]
Sent: Friday, December 11, 2020 4:55 PM
To: Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; Clark, Casey <Casey.Clark@maine.gov>; Simpson, Mitch <Mitch.Simpson@maine.gov>; Dan McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; harold.peterson@bia.gov; marchelle.foster@bia.gov; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Kenneth J Hogan <kenneth_hogan@fws.gov>; anna_harris@fws.gov; jeff.murphy <jeff.murphy@noaa.gov>; donald.dow@noaa.gov; Sojkowski, Bryan <bryan_sojkowski@fws.gov>; Valliere, Jason <Jason.Valliere@maine.gov>; Dunham, Kevin <Kevin.Dunham@maine.gov>; Perry, John <John.Perry@maine.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>
Subject: RE: Lower Penobscot juvenile alosine draft study reports

Hello all,

MDEP has reviewed the juvenile alosine draft study reports for the Milford, Orono and Stillwater Projects and has no comments on the reports at this time. The Department will defer to comments provided by the state and federal resource agencies. Thanks and have a good weekend.

Christopher Sferra (he/him)
Environmental Specialist III, Hydropower Unit
Bureau of Land Resources
Maine Department of Environmental Protection
Cell: (207) 446 - 1619
www.maine.gov/dep

Brookfield
Renewable

December 28, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Stillwater Project (FERC No. 2712); Orono Project (FERC No. 2710); Milford Project (FERC No. 2534); Time Extension Request for 2020 Diadromous Fish Passage Report

Dear Secretary Bose:

On behalf of the licensees for the Projects listed below, Brookfield Renewable (Brookfield) is submitting this time extension request for filing the 2020 Diadromous Fish Passage Report for the following hydroelectric projects located on the Penobscot River in Maine:

- **Milford Project (FERC No. 2534),** licensed to Black Bear Hydro Partners, LLC (Black Bear)
- **Orono Project (FERC No. 2710),** licensed to Black Bear; Black Bear SO, LLC; and Black Bear Development Holdings, LLC
- **Stillwater Project (FERC No. 2712),** licensed to Black Bear; Black Bear SO, LLC; and Black Bear Development Holdings, LLC

Pursuant to Commission Orders "*Amending License and Revising Annual Charges*" for the Orono and Stillwater Projects (both dated September 14, 2012) and "*Approving Fish Passage Design Drawings Under Articles 407 and 408*" for the Milford Project (dated October 9, 2012), the licensees constructed and installed upstream and downstream fish passage systems at the Milford, Stillwater (downstream only), and Orono Projects in 2013 and 2014 to facilitate the passage of diadromous fish species on the Penobscot River. To evaluate the performance of the new fish passage facilities at passing alosines (collectively American shad, blueback herring, and sea run alewives) and American eels (also required by the 2012 Commission Orders), the licensees have performed monitoring studies at these Projects since 2014.

In reply to the 2019 Diadromous Fish Passage Report filed by the licensees on January 13, 2020, the Commission noted (in a letter dated March 6, 2020) that the 2020 Diadromous Fish Passage Study Plans were due for Commission review by April 15, 2020. The Commission further requested that the 2020 Diadromous Fish Passage Report be filed by January 15, 2021. Following agency consultation, Brookfield, again on behalf of the licensees, submitted two 2020 Study Plans to the Commission on April 15, 2020 for these Projects, entitled "*Study Plan for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization*" and "*Study Plan for the Desktop Assessment of Juvenile Alosine Project Passage Survival*". Together, and as requested by the resource agencies[1] and Penobscot Indian Nation (PIN), these two studies will allow whole station survival estimates of juvenile alosines to be generated for each Project.

[1] Maine Department of Environmental Protection (MDEP); Maine Department of Marine Resources (MDMR); Maine Department of Inland Fisheries and Wildlife (MDIFW); United States Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS); Bureau of Indian Affairs

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Both of these studies were successfully completed in the fall of 2020, and draft reports were distributed for 30-day review to resource agencies and PIN on December 10, 2020. In reply, the resource agencies and PIN have unanimously requested an additional 30 days for review (see attached e-mails). **Therefore, the licensees respectfully request a one-month time extension from the Commission for filing the 2020 Diadromous Fish Passage Report, or to February 15, 2021.**

Please feel free to contact me by e-mail at Kevin.Bernier@brookfieldrenewable.com or by phone at (207) 951-5006 if you have any questions or comments.

Sincerely,

Kevin Bernier

Kevin Bernier
Senior Compliance Specialist

Attachments

cc: S. Ledwin, M. Simpson, C. Clark, G. Wippelhauser, J. Valliere; MDMR
D. McCaw, J. Banks; PIN
H. Peterson; BIA
B. Sojkowski, J. Rosset, K. Hogan, A. Bentivoglio; USFWS
J. Murphy, D. Dow; NMFS
J. Perry, K. Dunham, K. Gallant; MDIFW
K. Howatt, C. Sferra; MDEP
H. Frank; FERC
S. Michaud, N. Stevens, B. Brochu, J. Cole, R. Dill, K. Maloney, L. Macomber; Brookfield
D. Trested, Normandeau

Brookfield Files: HSSE 4a/Stillwater/01; HSSE 4a/Orono/01; HSSE 4a/Milford/01

1024 Central Street
Millinocket, ME 04462
www.brookfieldrenewable.com
Tel: 207.723.4341
Fax: 207.723.3948

From: Bernier, Kevin
To: Gail Wippelhauser; Casey.Clark@maine.gov; Mitch Simpson; Daniel McCaw; John.Banks@penobscotnation.org; Harold Peterson; Marchelle M Foster; Antonio Bentivoglio; Kenneth J Hogan; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Bryan Sojkowski; Kathy Howatt; Christopher Sferra; Jason Valliere; Kevin Dunham; John Perry; Julianne Rosset (julianne_rosset@fws.gov); Gallant, Kevin; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov)
Cc: Maloney, Kelly; Brochu, Robert; Cole, James; Drew Trested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: Lower Penobscot juvenile alosine draft study reports
Date: Thursday, December 10, 2020 10:39:00 AM
Attachments: 20201210 Draft Penobscot TBSA Report.pdf
20201210 Draft Penobscot Juv Passage Report.pdf
image001.jpg

Please find attached for your review two draft reports prepared by Normandeau Associates covering juvenile alosine downstream studies conducted this fall at the Milford, Stillwater, and Orono Projects. As you probably recall, these studies resulted from our discussions last winter, whereby the general consensus was to focus on downstream-migrating juvenile alosines in 2020 (after a successful pilot study had been conducted at the West Enfield Project in 2019), followed by evaluations of upstream alosine passage in 2021. FERC had previously provided direction requesting that the studies address data gaps on upstream-migrating adult alosines and downstream-migrating juvenile alosines at these Projects.

Please provide any comments **by January 11, 2021**; I will also be distributing a draft report in the near future on this fall's downstream eel study at the Medway Project. A Teams Meeting will likely then be scheduled in early January to review these reports and answer any questions. In the meantime, please feel free to contact me with any questions.

Kevin Bernier
Senior Compliance Specialist

Brookfield Renewable
1024 Central Street, Millinocket, ME 04462
C 207 951 5006
kevin.bernier@brookfieldrenewable.com
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From: Bernier, Kevin
To: Clark, Casey; jeff.murphy
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 12:58:00 PM

Black Bear's current deadline for filing the final juvenile alosine study reports with FERC is January 15, 2021. Thus, we would need to get a 30-day time extension from FERC in order provide the additional time for review requested by USFWS, NMFS, and MDMR. Since the push from the resource agencies and PIN in recent years has been for earlier deadlines for finalizing these diadromous fish passage reports, Black Bear is requesting that the other consulting agencies (MDIFW; MDEP; BIA) and PIN weigh in before we make the time extension request to FERC. Thank you.

Kevin Bernier
Senior Compliance Specialist

Brookfield Renewable
C 207 951 5006

From: Clark, Casey
To: jeff.murphy; Bernier, Kevin
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 12:13:30 PM

Hello Kevin,

DMR also supports additional time to review the study reports. And I would like to participate in the early January meeting that USFWS referenced. Can you please share details for the meeting.

-Casey

Casey Clark
Resource Management Coordinator
Maine Department of Marine Resources
Office: (207) 624-6594 (currently forwarding)
Cell: (207) 350-9791
Email: casey.clark@maine.gov
www.maine.gov/dmr/

From: Jeff Murphy - NOAA Federal
To: Bernier, Kevin
Cc: Gail Wippelhauser; Casey.Clark@maine.gov; Mitch Simpson; Rosset, Julianne; Daniel McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow@noaa.gov; Sojkowski, Bryan; Kathy Howatt; Christopher Sferra; Jason Valliere; Kevin Dunham; John Perry; Gallant, Kevin; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov); Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 11:56:34 AM

Hello Kevin - NMFS supports receiving additional time to review the study reports.
Thank you, Jeff.

From: Peterson, Harold S
To: Bernier, Kevin
Cc: Dan McCaw; Mokhtarzadeh, Christina; Frozena, Jennifer L
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 2:17:50 PM

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Good afternoon,

After speaking with Penobscot Nation about this request BIA is in support of additional time to review these reports.

Sincerely,
-Harold Peterson

cc: Dan McCaw, PIN
cc: Christina Mokhtarzadeh, BIA
cc: Jennifer Frozena, DOI SOL

From: Rosset, Julianne
To: Bernier, Kevin; Gail Wippelhauser; Casey.Clark@maine.gov; Mitch Simpson; Daniel McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Sojkowski, Bryan; Kathy Howatt; Christopher Sferra; Jason Valliere; Kevin Dunham; John Perry; Gallant, Kevin; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov)
Cc: Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 11:47:22 AM

Hi Kevin,

Thank you for the additional TBSA model information.

Can we please have an additional 30 days to provide comments on the Lower Penobscot juvenile alosine draft study reports? That would be a deadline for comment of Wednesday February 10, 2021. We'd like some time to digest the information that will be presented at the Teams meeting in early January before providing our comments to Brookfield.

Thank you for considering this request.

Kind regards,
Julianne

Julianne Rosset

USFWS Fish and Wildlife Biologist

Migratory Fish/Hydropower

306 Hatchery Road, East Orland, ME 04431

603-309-4842 (cell)

fws.gov/mainefieldoffice/|facebook.com/usfwsnortheast/

From: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Sent: Wednesday, December 16, 2020 8:46 AM
To: Rosset, Julianne <julianne_rosset@fws.gov>; Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov <Casey.Clark@maine.gov>; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org <John.Banks@penobscotnation.org>; Peterson, Harold S <Harold.Peterson@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov <Jeff.Murphy@noaa.Gov>; donald.dow@noaa.gov <donald.dow@noaa.gov>; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>;

Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; dtrested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Julianne – welcome to Maine, and I look forward to working with you. The attached folder contains the archived output files for each TBSA model run included in the draft lower Penobscot juvenile alosine report. As you can see, the file names identify the specific unit(s)/project analyzed; note that the files with just a station name are for the whole station estimates at each location. The outputs include the full set of turbine, route selection, and fish population parameters that were used. Please let us know if there are any additional questions.

Thank you, Kevin Bernier

From: Rosset, Julianne <julianne_rosset@fws.gov>
Sent: Wednesday, December 16, 2020 8:00 AM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; Marchelle M Foster <marchelle.foster@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; dtrested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>

Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hello Kevin,

My name is Julianne Rosset and I am one of the new USFWS Fish and Wildlife Biologists based out of the Maine Field Office in East Orland.

Thank you for providing the 2020 downstream juvenile alosine study results for the Lower Penobscot. After a cursory review, we noticed the TBSA model inputs were not provided. Could Brookfield please provide the parameters utilized within the TBSA model? This will allow the natural resource agencies to clearly understand which turbine units were analyzed and what went into estimating the reported project-survival values.

Thank you,
Julianne

Julianne Rosset

USFWS Fish and Wildlife Biologist

Migratory Fish/Hydropower

306 Hatchery Road, East Orland, ME 04431

603-309-4842 (cell)

fws.gov/mainefieldoffice/|facebook.com/usfwsnortheast/

From: Dan McCaw
To: Bernier, Kevin; Clark, Casey; jeff.murphy
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; John Banks; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 2:13:54 PM

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Hello Kevin,

The Penobscot Nation has supported earlier deadlines in the past for the submission of study reports. That effort has been to enable the incorporation of the study results into the development of studies for the next season. The PiN still believes this to be important.

However, we are in a unique position where the FERC coordinator position for USFWS has been recently filled after many months being vacant. If our partners at USFWS, MDMR, and NOAA need additional time in the middle of a global pandemic and a personnel change to review these important studies, the Penobscot Nation will support them. As these studies tie into the quest to establish evaluation criteria for fish passage at all three lower Penobscot projects, it it imperative that adequate time is given to complete the needed consultation.

Thank you for reaching out. Please let me know if you have any questions.

Dan McCaw

From: Howatt, Kathy
To: Bernier, Kevin
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; jeff.murphy; Clark, Casey; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: Lower Penobscot juvenile alosine draft study reports
Date: Tuesday, December 22, 2020 7:39:47 AM

Good morning Kevin,

The Department supports the resource agencies request for an extension of time to review and comment on the draft Lower Penobscot Juvenile Alosine Study Reports. We have the great pleasure of welcoming Julianne Rosset to the USFWS team and should provide her sufficient time to understand the projects' fish passage facilities as well as to review the report and develop comments. Further, year-end reports and other commitments at this time of year will make a few extra days for our own review welcome. Thank you for considering this request.

Kathy

Kathy Davis Howatt
Hydropower Coordinator, Bureau of Land Resources
Maine Department of Environmental Protection
Phone: 207-446-2642
www.maine.gov/dep

Correspondence to and from this office is considered a public record and may be subject to a request under the Maine Freedom of Access Act. Information that you wish to keep confidential should not be included in email correspondence.

From: Perry, John
To: Bernier, Kevin
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Clark, Casey; jeff.murphy; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Tuesday, December 22, 2020 9:38:24 AM
Attachments: image002.png

Hi Kevin,

MDIFW supports the request for an extension of time to review and comment on the Study Reports.

Thank you,

John

John Perry
Environmental Review Coordinator
Maine Department of Inland Fisheries and Wildlife
284 State Street, 41 SHS
Augusta, Maine 04333-0041
Tel (207) 287-5254; Cell (207) 446-5145
Fax (207) 287-6395
www.mefishwildlife.com

Correspondence to and from this office is considered a public record and may be subject to a request under the Maine Freedom of Access Act. Information that you wish to keep confidential should not be included in email correspondence.

From: Bernier, Kevin [mailto:Kevin.Bernier@brookfieldrenewable.com]
Sent: Monday, January 11, 2021 12:11 PM
To: sean.m.ledwin@maine.gov; mitch.simpson@maine.gov; Casey Clark (casey.clark@maine.gov) <casey.clark@maine.gov>; Gail.Wippelhauser@maine.gov; Jason.Valliere@maine.gov; 'dan.mccaw@penobscotnation.org' <dan.mccaw@penobscotnation.org>; john.banks@penobscotnation.org; harold.peterson@bia.gov; 'bryan_sojkowski@fws.gov' <bryan_sojkowski@fws.gov>; Julianne_Rosset@fws.gov; kenneth_hogan@fws.gov; 'antonio_bentivoglio@fws.gov' <antonio_bentivoglio@fws.gov>; Jeff Murphy - NOAA Federal <jeff.murphy@noaa.gov>; Donald Dow <Donald.Dow@noaa.gov>; John Perry (john.perry@maine.gov) <john.perry@maine.gov>; kevin.dunham@maine.gov; Kevin.Gallant@maine.gov; Kathy Howatt (Kathy.howatt@maine.gov) (Kathy.howatt@maine.gov) <Kathy.howatt@maine.gov>; Christopher Sferra <christopher.sferra@maine.gov>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Dill, Richard <Richard.Dill@brookfieldrenewable.com>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>
Subject: RE: FERC Filing: EOT Request Lower Penobscot Juv Alosine Reports

FERC has approved our time extension request for submittal of the 2020 lower Penobscot diadromous fish passage report (see attached), so the new deadline for the resource agencies and PIN to provide comments on the two draft juvenile alosine downstream study reports (distributed on December 10th) is **February 10, 2021.**

Please let me know if you have any questions.

Kevin Bernier
Senior Compliance Specialist

Brookfield Renewable
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Document Accession #: 20210111-3025 Filed Date: 01/11/2021

FEDERAL ENERGY REGULATORY COMMISSION
Washington, D. C. 20426

OFFICE OF ENERGY PROJECTS

Project No. 2534-100--Maine
Milford Hydroelectric Project
Black Bear Hydro Partners, LLC

Project No. 2710-070--Maine
Orono Hydroelectric Project

Project No. 2712-086--Maine
Stillwater Hydroelectric Project
Black Bear Hydro Partners, LLC;
Black Bear SO, LLC; and Black Bear
Development Holdings, LLC

January 11, 2021

VIA FERC Service

Kelly Maloney
License Compliance Manager
Black Bear Hydro Partners, LLC
150 Main Street
Lewiston, ME 04240

Subject: Extension of Time for 2020 Diadromous Fish Passage Report.

Dear Ms. Maloney:

This letter is in response to your 30-day extension of time request, filed December 28, 2020, for your 2020 Diadromous Fish Passage Report. By letter dated March 6, 2020, Commission staff requested you to file your 2020 report by January 15, 2021. You state that your 2020 study plans, titled "Study Plan for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization" and "Study Plan for the Desktop Assessment of Juvenile Alosine Project Passage Survival" were both completed in the fall of 2020. You provided draft reports to the resource agencies and the Penobscot Indian Nation (PIN) on December 10, 2020. The U.S. Fish and Wildlife Service, due to new personnel, requested additional time to review the report, and the other agencies and the PIN agreed to the extension. You are requesting a one-month extension to file your report until February 15, 2021.

Project No. 2534-100 et al. - 2 -

Your request is reasonable and will provide the resource agencies and the PIN needed time to review and provide comments on the report. Your request is approved. Please file your 2020 Diadromous Fish Passage Report with the Commission by February 15, 2021.

Thank you for your cooperation. If you have any questions regarding this matter, please contact me at (202) 502-8171.

Sincerely,

Andrea Claros

Andrea Claros
Aquatic Resources Branch
Division of Hydropower Administration
and Compliance

From: Rosset, Julianne [mailto:julianne_rosset@fws.gov]
Sent: Wednesday, December 16, 2020 8:00 AM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; Marchelle M Foster <marchelle.foster@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hello Kevin,

My name is Julianne Rosset and I am one of the new USFWS Fish and Wildlife Biologists based out of the Maine Field Office in East Orland.

Thank you for providing the 2020 downstream juvenile alosine study results for the Lower Penobscot. After a cursory review, we noticed the TBSA model inputs were not provided. Could Brookfield please provide the parameters utilized within the TBSA model? This will allow the natural resource agencies to clearly understand which turbine units were analyzed and what went into estimating the reported project-survival values.

Thank you.
Julianne

Julianne Rosset
USFWS Fish and Wildlife Biologist
Migratory Fish/Hydropower
306 Hatchery Road, East Orland, ME 04431
603-309-4842 (cell)
fws.gov/mainefieldoffice/|facebook.com/usfwsnortheast/

From: Rosset, Julianne [mailto:julianne_rosset@fws.gov]
Sent: Wednesday, January 6, 2021 3:36 PM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hi Kevin -

Something that isn't clear to me from the data provided is what turbines were modeled at each Project - all of them? Perhaps that's something we can discuss on the call later this month if the answer isn't straightforward. Also, I saw that an EOT request was filed by Brookfield - should the agencies assume the new due date for our comments on the draft lower Penobscot juvenile alosine report will be February 10th?

Thanks so much.
Julianne

Julianne Rosset
USFWS Fish and Wildlife Biologist
Migratory Fish/Hydropower
306 Hatchery Road, East Orland, ME 04431
603-309-4842 (cell)
fws.gov/mainefieldoffice/|facebook.com/usfwsnortheast/

From: Rosset, Julianne [mailto:julianne_rosset@fws.gov]
Sent: Wednesday, February 10, 2021 12:38 PM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Gail Wippelhauser <Gail.Wippelhauser@maine.gov>; Casey.Clark <Casey.Clark@maine.gov>; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; jeff.murphy@noaa.gov; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.Howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <John.Perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Greetings -

This is the United States Fish and Wildlife Service's (Service) response to the Milford (FERC No. 2534), Stillwater (FERC No. 2712), and Orono (FERC No. 2710) Hydroelectric Project's *Study Report for the Desktop Assessment of Juvenile Alosine Project Survival* and the *Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization* (collectively, Reports) which were both distributed to the resource agencies by Brookfield Renewable (Brookfield) on December 10, 2020. We reviewed the Reports, attended the January 27, 2021 virtual meeting, and have the following comments.

<u>Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization</u>

The Service recommends Brookfield update the passage route utilization report to include the following information:

- At Milford, it was reported that 63% of fish utilized the turbine units as a route of passage but 18% of the fish that approached Milford never passed. Therefore, it should be reported that out of the fish that passed the Milford dam, 77% passed through the units. This also increases the percentage of fish that utilized the downstream bypass from 18% to 21% (these values were reported correctly within the desktop assessment report).
- The Service recommends Brookfield include a table showing project effects associated with impoundment losses versus losses in the natural reach. For example, 18% of fish were lost in the Milford impoundment while fish that passed the Milford dam and moved roughly 1.5 miles downstream saw a loss of only 5%. Please provide a comparison of residence duration and project residence time for fish that passed multiple sites versus a single project (i.e. provide the median project residence time for fish that passed Milford, Stillwater, and Orono, as well as for fish that passed Stillwater and Orono versus fish that just passed Orono, or Stillwater, or Milford). This assessment will aid in the resource agencies understanding of whether or not a cumulative effect to downstream juvenile migration is apparent.
- Please include a map to indicate the locations where fish were released above the Milford, Stillwater, and Orono projects.

<u>Study Report for the Desktop Assessment of Juvenile Alosine Project Passage Survival</u>

Juvenile alosine passage occurred primarily via the turbine units at Milford (63%), while only 18% used the existing downstream bypass facility (specifically the surface bypass on the river side of the powerhouse). At Stillwater, 48% of the released juvenile alosines passed via the turbine units, while only 42% used the existing downstream bypass facility. At Orono, 25% of the released juvenile alosines passed via the turbines while 60% used the existing downstream bypass.

The Service notes, as discussed at the January 27, 2021 meeting, the desktop assessment does not account for injury, latent mortality, or cumulative mortality of alosine species; rather the desktop assessment is an estimate of immediate survival.

Thank you for this opportunity to comment. The Service looks forward to working with Brookfield to develop the 2021 Diadromous Fish Passage Study Plan in a timely manner so that studies can be performed in the 2021 fish passage season.

Kind regards,
Julianne

Julianne Rosset
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Migratory Fish/Hydropower
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From: Jeff Murphy - NOAA Federal [mailto:jeff.murphy@noaa.gov]
Sent: Wednesday, February 10, 2021 3:48 PM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Cc: Rosset, Julianne <julianne_rosset@fws.gov>; Gail Wippelhauser <Gail.Wippelhauser@maine.gov>; Casey.Clark <Casey.Clark@maine.gov>; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.Howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <John.Perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hello Kevin - Thanks for seeking NMFS' comments on the draft Study Report for the Desktop Assessment of Juvenile Alosine Project Survival and the draft Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization. We concur with USFWS' comments submitted earlier today and offer several additional comments.

- The juvenile alosine route utilization study at Milford, Orono, and Stillwater was well conducted and we support the report's findings. As indicated in the report, turbine passage is by far the most utilized route of downstream passage for juvenile alosines at the Milford Project (77%). Downstream passage via turbines was also a significant route of passage for juvenile herring at Stillwater (48%) and Orono (25%). Based upon these results, we can conclude that the 1" trashracks installed at each project are not highly effective in preventing turbine passage of small fish (<150 mm).
- As noted by the USFWS, the desktop assessment of juvenile alosine survival at Milford, Orono, and Stillwarer does not account for injury, latent mortality, or cumulative mortality of alosine species. These factors in addition to immediate mortality of downstream migrating alosines must be quantified through actual field studies in order for the resource agencies to assess the impacts of operating the projects on our restoration goals for the Penobscot River. Otherwise, the best available information that we presently have demonstrates that turbine passage at the projects is the most dangerous route of passage presently available for downstream migrants and must be minimized through project operation or structural changes.
- We appreciate your willingness to work with us to meet our goals of safe, timely, and effective passage for downstream migrants at your lower projects in the Penobscot River. Based upon our call today, I understand that we will have further opportunities to identify additional downstream assessments at the projects and/or mitigation measures going forward.

Please don't hesitate to contact me with any questions concerning these comments. Thank you, Jeff.

From: Clark, Casey [mailto:Casey.Clark@maine.gov]
Sent: Wednesday, February 10, 2021 5:40 PM
To: jeff.murphy <jeff.murphy@noaa.gov>; Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Cc: Rosset, Julianne <julianne_rosset@fws.gov>; Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; Simpson, Mitch <Mitch.Simpson@maine.gov>; Dan McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; donald.dow <Donald.Dow@noaa.gov>; Sojkowski, Bryan <bryan_sojkowski@fws.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>; Sferra, Christopher <Christopher.Sferra@maine.gov>; Valliere, Jason <Jason.Valliere@maine.gov>; Dunham, Kevin <Kevin.Dunham@maine.gov>; Perry, John <John.Perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Dear Kevin:
I have reviewed the Draft Study Report for the Draft Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization and the Desktop Assessment of Juvenile Alosine Project Survival (collectively, Reports) for the Milford (FERC No. 2534), Stillwater (FERC No. 2712), and Orono (FERC No. 2710) Hydroelectric Projects for the Department of Marine Resources. Thank you for the opportunity to comment on these draft study reports. I also concur with the comments of USFWS and NOAA earlier today.

Route of passage Study comments:
We request that you include a written description of each of the release locations and include GPS coordinates for each. In addition, we request that you include a map or diagram that clearly labels the release locations and the routes of passage for each project. Finally, we also request that you include a table or written description of distance from release location to each route of passage location. As some routes of passage are a wide area, as opposed to a narrow point, we request that you mark the minimum and maximum distance from the release location to the edges of these routes of passage.

In section 4.4-4.6, you report route of passage for study fish that were released above Stillwater and passed Stillwater, fish that were released above Orono and passed Orono, and fish that were released above Milford and passed Milford. We request that you also report on all results for fish that were released above Stillwater in regards to their detections at the Orono project including but not limited to the following metrics:

- approach time from Stillwater to Orono,
- project residence time,
- downstream passage route selection for both Stillwater and Orono,
- percent success of passage at Orono for all fish that successfully passed Stillwater,
- detections downstream of Orono
- and any other metrics that you can report

We also request that you perform an appropriate statistical test of significant difference (E.g. T-test) to compare the results for the fish that were released above Orono in regards to their passage of Orono and the fish that were released above Stillwater in regards to their passage of Orono. Please report the method and results of these tests.

The size of the juvenile alosines captured for this study (total length 113-144mm) was limited due to the constraints of the tagging method. That size constraint did not allow the study to include smaller juvenile alosines (40mm-100mm) that migrate past the three projects in the lower Penobscot. As a 40mm alosine does not have the same swimming ability of larger fish, we have to assume that route of passage would differ for this smaller size class. We request that you include a statement in the study report to describe bias in the study results due to the size constraint of the study fish.

Juvenile alosines (age zero alewife, blueback herring, and American Shad) have been documented by NOAA in the Penobscot estuary. In brief, juvenile alosines are present in the Penobscot Estuary starting in July (30-40mm fish) and are seen through the end of sampling in September (>120mm fish). Data from other rivers indicate that juveniles reach total lengths in excess of 150mm in late fall. Data from the work is available in following publication:
Justin R. Stevens, Rory Saunders and William Duffy. (2019). Evidence of Life Cycle Diversity of River Herring in the Penobscot River Estuary, Maine USA.

<u>TBSA Model comments:</u>
In Section 5, the report states, "the observed route selection probabilities for each Project were imported into a project-specific, multi-route TBSA model to evaluate the predicted whole-station survival for a population of 1,000 3.5 inch (S.D.±1.0 inches) fish." However the TBSA model only estimates immediate mortality associated with blade strike. We request that you include the following statement to more accurately describe the context of the results of this study. "This study is an estimation of immediate mortality from turbine strike and does not estimate other potential sources of immediate mortality (E.g. barotrauma, shear force) nor does it estimate injury, latent mortality, or indirect impacts to fish such as predation. As such the results of this study can only be interpreted as minimum estimates of mortality at each project."

Passage selection is the most important aspect of downstream passage survival. While the TBSA model estimates blade strike mortality, the impact of pressure and shear-force is much greater than turbine strike, especially on smaller fish such as juvenile alosines.

The study states, "When at full capacity (i.e., 6,730 cfs) and at normal pond elevation, the calculated intake velocity at Milford is 1.5 ft/sec." For the entirety of the modeling exercise, Milford was assumed to be at "normal pond & full generation" the intake velocity was assumed to be 1.5 ft/sec. However, Milford was not at full capacity for 3 out of the 5 release groups (3037; 4050; 7796; 6220; and 6892 cfs respectively for each release group as reported in table 4-1 of the route of passage study) and Milford was not at full generation as reported in section 4.1 of the route of passage study. We request that you correct the language in the last paragraph of Section 6 to more accurately describe flow and generation conditions.

The study also states, "Flows conditions lower than those observed during the 2020 field evaluation would likely result in reduced generation and prioritization of most efficient units." We request that you include a description of the "most efficient units" for each project and a summary of how they are prioritized.

In Section 5-2 and 5-3 you include results for fish that passed the Stillwater and Orono projects, separately. We request that you include results for fish that were released above Stillwater, passed Stillwater, and subsequently passed Orono. We request that you report these results separate from results already reported. We also request that you perform an appropriate statistical test of significant difference (E.g. T-test) to compare the results for the fish that were released above Orono in regards to their passage of Orono and the fish that were released above Stillwater in regards to their passage of Orono. Please report the method and results of these tests.

Regards,
Casey

Casey Clark
Resource Management Coordinator
Maine Department of Marine Resources
Office: (207) 624-6594 (currently forwarding)
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Written comments on the draft juvenile alosine downstream passage route utilization study report were provided by MDMR, USFWS, MDEP and NMFS. Questions or requests related to the technical draft report are reproduced here along with the associated response.

Question 1: *At Milford, it was reported that 63% of fish utilized the turbine units as a route of passage, but 18% of the fish that approached Milford never passed. Therefore, it should be reported that out of the fish that passed the Milford dam, 77% passed through the units. This also increases the percentage of fish that utilized the downstream bypass from 18% to 21% (these values were reported correctly within the desktop assessment report).*

Response 1: The requested information has been added to the Results section for each of the three Projects.

Question 2: *The Service recommends Brookfield include a table showing project effects associated with impoundment losses versus losses in the natural reach. For example, 18% of fish were lost in the Milford impoundment, while fish that passed the Milford Dam and moved roughly 1.5 miles downstream saw a loss of only 5%.*

Response 2: Passage rates at the three Project dams and arrival rates at the subsequent downstream receivers are provided in Table C-1 below. Note that losses at any of these locations are not likely to be exclusively "project effects". Individuals failing to pass at a Project or be detected downstream may have been predated, succumbed to tagging and transport stress, shed their transmitter upstream of the Project or during the act of passage, or failed to locate a downstream passage route. This study was not designed to evaluate passage survival or potential project related mortality upstream of the dams. As stated in the study plan objectives, the intent of this study was to evaluate residence time and downstream passage route for the proportion of tagged individuals which approached and passed downstream of each Project dam.

Table C-1. Percentage of radio-tagged juvenile alosines passing Project or arriving at downstream receiver.

Project	Reach	Distance	Passage/Arrival %
Milford	Approach to Passage	~400 m	81.7%
	Passage to DS Receiver	2.4 km	94.9%
Stillwater	Approach to Passage	~ 200 m	88.7%
	Passage to DS Receiver	1.6 km	76.6%
Orono	Approach to Passage	~200 m	93.7%
	Passage to DS Receiver	1.4 km	77.7%

Question 3: *Please provide a comparison of residence duration and project residence time for fish that passed multiple sites versus a single project (i.e. provide the median project residence time for fish that passed Milford, Stillwater, and Orono, as well as for fish that passed Stillwater and Orono versus fish that just passed Orono, or Stillwater, or Milford). This assessment will aid*

in the resource agencies understanding of whether or not a cumulative effect to downstream juvenile migration is apparent.

Response 3: Please see responses to Questions 6 and 7 below.

Question 4: *Please include a map to indicate the locations where fish were released above the Milford, Stillwater, and Orono Projects.*

Response 4: The requested map has been added as Figure 3-1.

Question 5: *We request that you include a written description of each of the release locations and include GPS coordinates for each. In addition, we request that you include a map or diagram that clearly labels the release locations and the routes of passage for each project. Finally, we also request that you include a table or written description of distance from release location to each route of passage location. As some routes of passage are a wide area, as opposed to a narrow point, we request that you mark the minimum and maximum distance from the release location to the edges of these routes of passage.*

Response 5: A release location map has been added as Figure 3-1. Release locations were as follows:

- Milford – Elks Club Boat Launch - 44°56'38.11"N, 68°39'25.77"W
- Stillwater – Old Town Water District - 44°55'23.95"N, 68°41'30.07"W
- Orono – U. Maine Steam Plant Boat Launch - 44°53'58.57"N, 68°40'26.79"W

Route diagrams have been provided in Appendix E.

All distances to potential routes below are approximate from the release location, and they assume a straight-line approach from the release coordinates:

- Milford – spill (western edge): 0.8 km
- Milford – spill (eastern edge): 1.0 km
- Milford – waste gate: 1.0 km
- Milord – intakes (Unit 1 side): 1.01 km
- Milford – intakes (Unit 6 side): 1.06 km
- Milford Bay 2 bypass: 1.02 km
- Milford Bay 7 bypass: 1.04 km

- Stillwater – spill (western edge): 1.7 km
- Stillwater – spill (eastern edge): 1.6 km
- Stillwater – Stillwater Station A bypass: 1.8 km
- Stillwater – Powerhouse A intakes (western edge): 1.8 km
- Stillwater – Powerhouse A intakes (eastern edge): 1.8 km
- Stillwater – Stillwater Station B bypass: 1.6 km

- Stillwater – Powerhouse B (western edge): 1.6 km
- Stillwater – Powerhouse B (eastern edge): 1.6 km

- Orono – spill (western edge): 2.3 km
- Orono – spill (eastern edge): 2.4 km
- Orono – bypass: 2.35 km
- Orono – Powerhouse A/B intake structure (western edge): 2.34 km
- Orono – Powerhouse A/B intake structure (eastern edge): 2.35 km

Question 6: *In section 4.4-4.6, you report route of passage for study fish that were released above Stillwater and passed Stillwater, fish that were released above Orono and passed Orono, and fish that were released above Milford and passed Milford. We request that you also report on all results for fish that were released above Stillwater in regards to their detections at the Orono project, including but not limited to the following metrics:*

- *approach time from Stillwater to Orono,*
- *project residence time,*
- *downstream passage route selection for both Stillwater and Orono,*
- *percent success of passage at Orono for all fish that successfully passed Stillwater,*
- *detections downstream of Orono*
- *and any other metrics that you can report*

Response 6: Information collected at Orono for individuals originating upstream of both Stillwater Dam and Orono Dam was provided in the initial draft report for approach duration (Table 4-12; Figure 4-18), residence time (Table 4-13; Figure 4-19), passage route (Table 4-14), and downstream transit (Table 4-15; Figure 4-22). Each table has a subsection labeled as "Stillwater" or "Orono", and those values are representative of that release location. Figures are color-coded by release location and release date for ease of comparison.

Question 7: *We also request that you perform an appropriate statistical test of significant difference (E.g. T-test) to compare the results for the fish that were released above Orono in regards to their passage of Orono and the fish that were released above Stillwater in regards to their passage of Orono. Please report the method and results of these tests.*

Response 7: A two sample t-test was conducted to compare Stillwater and Orono-released fish for statistical significance. Residence duration and downstream transit times were not found to be statistically significant between groups ($p = 0.88$ and $p = 0.30$, respectively). To compare route selection between groups, a chi squared test for categorical variables was conducted. Route selection was found to differ significantly between the two groups ($p < 0.01$).

Question 8: *The size of the juvenile alosines captured for this study (total length 113-144mm) was limited due to the constraints of the tagging method. That size constraint did not allow the study to include smaller juvenile alosines (40mm-100mm) that migrate past the three projects in the lower Penobscot. As a 40mm alosine does not have the same swimming ability of larger* *fish, we have to assume that route of passage would differ for this smaller size class. We request that you include a statement in the study report to describe bias in the study results due to the size constraint of the study fish.*

Response 8: As has been previously discussed, the body size of juvenile alosines collected for radio telemetry studies is a limiting factor in the size and timing of these evaluations due to the size and weight of currently available radio transmitters for marking these fish. Normandeau first conducted a tank-based pilot study to evaluate the feasibility of externally attaching Lotek NTQ-1 transmitters to juvenile alosines on the Merrimack River during 2012. During that evaluation, it was determined that a minimum body length of 100 mm is required for an individual alosine to be able to support the affixed transmitter and maintain positioning in the water column. Normandeau conducted an additional feasibility test for external NTQ-1 tag attachment to juvenile alosines at the Lockwood Project during the fall of 2015. During that evaluation, juvenile alosines were obtained from the fish ladder at the Brunswick Project on the Androscoggin River and transported to Lockwood, where a subset of tagged and untagged fish was maintained for a 7-day period. Tank-held tagged and untagged juvenile alosines were observed daily for tag retention, post-tagging survival, as well as for potential differences in swimming, schooling, startle, and feeding behaviors. Transmitter retention over the duration of the monitoring period was 97%. Based on daily control-adjusted values, survival of tagged juvenile herring was 100% at 72 hours, but it declined to 60% at the conclusion of the 7-day period. It should be noted that for this evaluation (1) individual fish shedding transmitters were counted as a mortality, as they would no longer be useful to a field evaluation of fish movements, and (2) a sharp drop in tank water temperature occurred at the 72-hour mark of the study.

Appendix D. PowerPoint presentation slides from the January 27, 2021 resource agency and PIN study discussion meeting.

Evaluation of Downstream Juvenile Alosine Passage Route Utilization

Lower Penobscot River Projects

Milford Hydroelectric Project (FERC No. 2534)

Stillwater Hydroelectric Project (FERC No. 2712)

Orono Hydroelectric Project (FERC No. 2710)

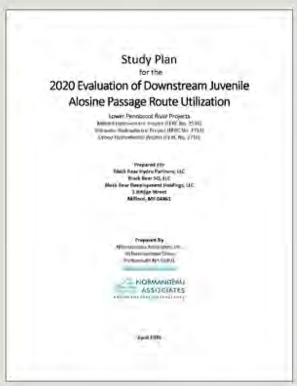
Prepared For:
Black Bear Hydro Partners, LLC
Black Bear SO, LLC
Black Bear Development Holdings, LLC
1 Bridge Street
Milford, ME 04461

Prepared By:
Normandeau Associates, Inc.
30 International Drive
Portsmouth, NH 03801

NORMANDEAU ASSOCIATES ENVIRONMENTAL CONSULTANTS

Study Development and Objectives

- Downstream passage for adult alosines evaluated at Project locations during 2017/2018
- 2019 "proof of concept" studies included evaluation of upstream herring passage at Milford and tagging and monitoring of juvenile alosines for route selection at West Enfield
- Study concept for downstream juvenile passage evaluation initially discussed following review of 2019 field studies
- Draft plan distributed to resource agencies for review and final version filed with FERC April 15, 2020



Study Objectives:

- Evaluate residence time from arrival until downstream passage for radio-tagged juvenile alosines at Milford, Stillwater and Orono; and
- Determine the proportional downstream passage route selection of radio-tagged juvenile alosines at Milford, Stillwater and Orono.

Study Development and Objectives

Targeted Penobscot River conditions as described in Study Plan:

- Penobscot River flows within the 20th to 80th percentile for average daily October flows based on West Enfield USGS gage data for the 1990-2019 time period (5,040-14,850 cfs);
- At Milford, the two surface bypass and one low-level bypass entrances are open for the duration of the study period;
- At Stillwater, the surface and low-level bypass entrances are open at powerhouses A and B for the duration of the study period;
- At Orono, the single downstream surface and low-level bypass are open for the duration of the study period;
- Milford, Stillwater and Orono turbine units are operated as ISO and riverine flow conditions permit; and
- Spill conditions at Milford, Stillwater, and Orono are a result of natural inflows in excess of Project capacity.

Methodology: Tagging and Release

- Juvenile alosines collected via dip net from Souadabscook Stream
- Dry fly hook bonded to Lotek NTQ-1 transmitters
- Lightly anesthetized with diluted club soda prior to handling/tagging
- Length verified to ensure 100 mm
- Transmitter hooked to dorsal musculature of fish

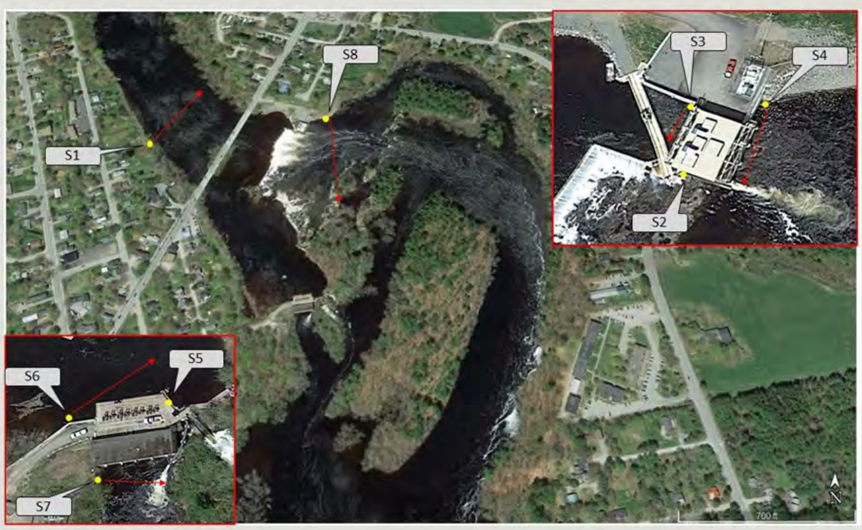
- Immediately transferred to holding tank within truck mounted transport tank with recirculating Penobscot River water
- Transported to shoreline release location upstream of each Project
  - Elks Club boat launch – 0.8 km above Milford
  - Old Town Water District Facility – 1.5 km above Stillwater
  - U. Maine steam plant boat launch – 2.2 km above Orono
- Releases conducted at dusk
- Each group released in conjunction with untagged individuals for "schooling"

Methodology: Monitoring at Milford

Milford:

- Installed and maintained eleven receivers
  - Approach
  - Intakes
  - Tailrace
  - Spillway
  - Waste gate
  - Fishway exit flume
  - Bay 2 & 7 bypasses
  - "new" units (1 &2)
  - "old" units (3-5)
  - 2.4 km downstream

Methodology: Monitoring at Stillwater



Stillwater:

- Installed and maintained eight receivers
  - Approach
  - Powerhouse A
    - Intake
    - Tailrace
    - Downstream bypass
  - Powerhouse B
    - Intake
    - Tailrace
    - Downstream bypass
  - Spillway

Methodology: Monitoring at Orono

Orono:
- Installed and maintained eight receivers
  - Approach
  - Powerhouse A
    - Intake
    - Tailrace
  - Powerhouse B
    - Intake
    - Tailrace
  - Downstream bypass
  - Spillway
  - 1.4 km downstream

Methodology: Data Analysis

- Return Duration: calculated as time from release upstream of dam to detection at "approach" station
- Residence Time: calculated as duration of time from detection at approach until confirmation of downstream passage at each Project
- Downstream Passage Route Selection: identification of arrival and passage route based upon review of full time series of detections across all receivers for each individual – hourly operations data integrated into time series to identify periods of spill/generation at potential passage routes
- Dependent on river flow and generational status, passage routes at each Project may include:

Milford:
- DS bypass facility
- Turbines
- Spill

Stillwater:
- DS bypass facility A
- Powerhouse A
- DS bypass facility B
- Powerhouse B
- Spill

Orono:
- DS bypass facility
- Powerhouse A
- Powerhouse B
- Spill

Study Results: Tagging and Release

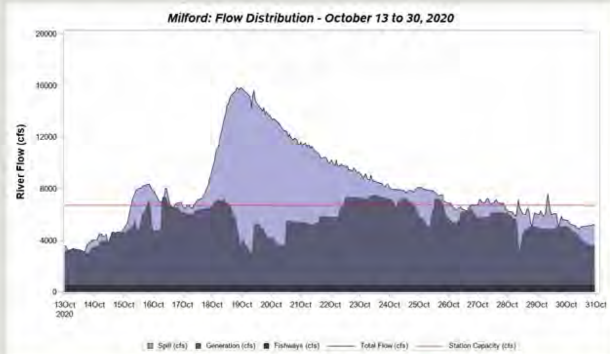
- A total of 387 juvenile alosines radio-tagged and released at one of three release locations
  - Milford n = 130; Stillwater n = 130; and Orono n = 127
- Conducted October 13, 14, 15, 16, and 17
- Release order varied among Projects for each release date
- Transmitters operated on one of three frequencies – monitored at all three Project locations

Study Results: River & Operational Conditions

- USGS gage values ranged from 3,000 to 20,500 cfs over course of period
- Release 1 fell just outside of the 20th-80th percentile range for release conditions but coincided with a increase in river flow due to a precipitation event
- Releases 2-5 were conducted at river flows within the 20th-80th percentile range
- River temperatures declined over the course of the monitoring period

Study Results: River & Operational Conditions

- Flows exceeded station capacity on October 15
- Spill flow passed via waste gate then inflatable gate system
- DS bypass facility operated for duration of the study period – passing ≥ 300 cfs between two surface and one low level entrance
- Turbines operated following upstream passage season unit prioritization guidelines
  - Units 5 & 6 online for the duration of the study period
  - Units 1 & 2 offline until prior to 3rd release
  - All units in operation once river flows increased

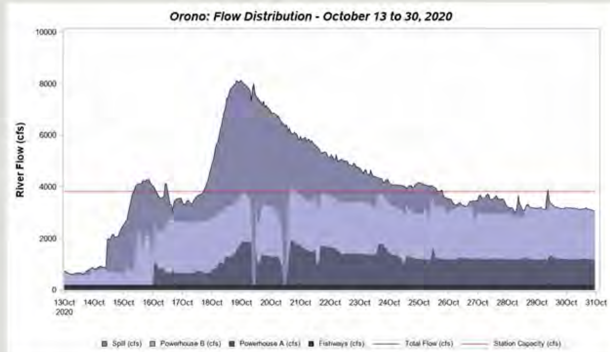


Study Results: River & Operational Conditions

- Flows exceeded station capacity on October 15
- Spill flow passed over spillway flashboards
- DS bypass facilities at A and B operated for duration of the study period (70 cfs per powerhouse)
- Powerhouse A turbines (Francis) were offline until prior to release 3 on October 15
- Powerhouse B (Kaplan/vertical propeller) had at least one unit online for duration of study

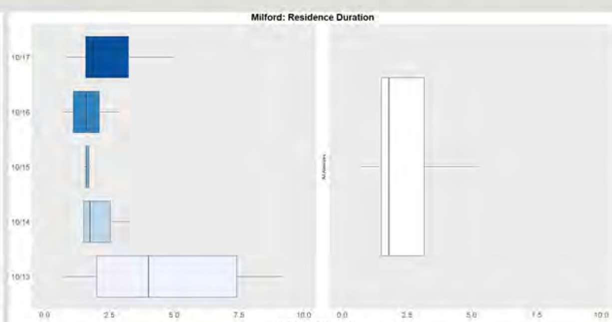
Study Results: River & Operational Conditions

- Flows exceeded station capacity on October 15
- Spill flow passed over spillway flashboards
- DS bypass facility operated for duration of the study period (200 cfs)
- Powerhouse A turbines (Francis) were offline until prior to release 4 on October 16
- Powerhouse B (Kaplan/vertical propeller) had at least one unit online for duration of study

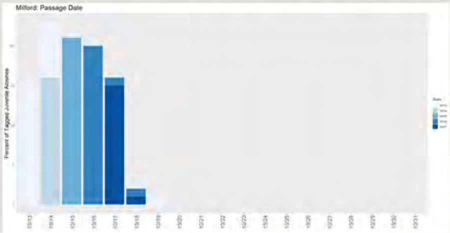


Study Results: Milford

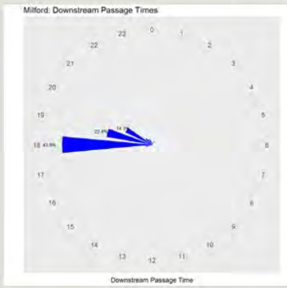
- 92% of tagged fish moved DS and approached the dam
- Median approach duration = 1.0 hrs (P25-P75 = 0.4-1.3 hrs)
- 96% arrived within four hours following release
- Median residence = 1.8 hrs (P25-P75 = 1.5-3.2 hrs)
- 84% passed within four hours of initial detection
- 96% passed within 24 hours of initial detection

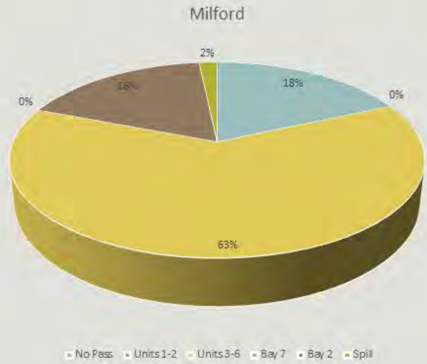


Study Results: Milford

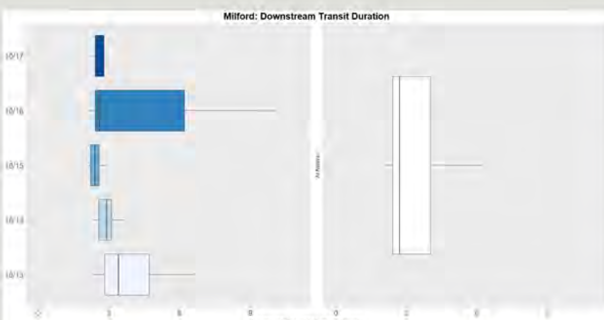


- Passage events recorded from October 13 through October 19
- Primarily 1800-2000
- 63% of passage via the "old" units (3-6)
- 18% of passage via the riverside downstream bypass (Bay 2)





Study Results: Milford



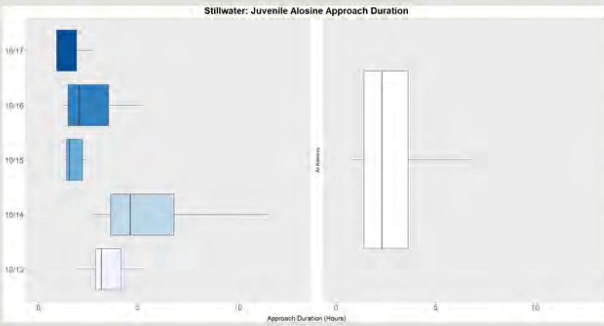
Downstream Continuation:

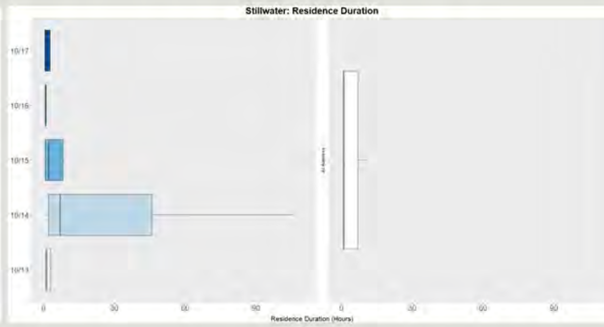
- 95% detected 2.4 km downstream at M11
- 93% detected 9.4 km downstream at O8
- Median travel to O8 = 2.7 hrs (P25-P75 = 2.4-4.0 hrs)
    - Via bypass – median = 2.6 hours
    - Via turbines – median = 2.8 hours

NOTE: study was not designed to evaluate downstream passage survival due to uncertainty over transmitter retention rates during downstream passage through turbines, spill or bypass structures

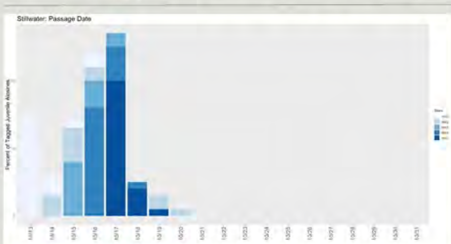
Study Results: Stillwater

- 82% of tagged fish moved DS and approached the dam
- Median approach duration = 2.3 hrs (P25-P75 = 1.4-3.6 hrs)
- 89% arrived within six hours following release
- Median residence = 1.1 hrs (P25-P75 = 0.5-6.9 hrs)
- 72% passed within four hours of initial detection
- 85% passed within 24 hours of initial detection

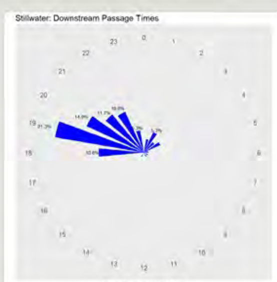


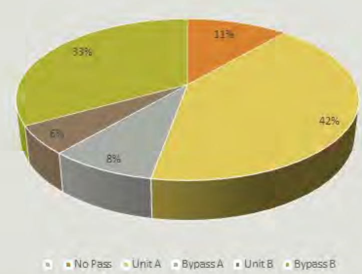


Study Results: Stillwater

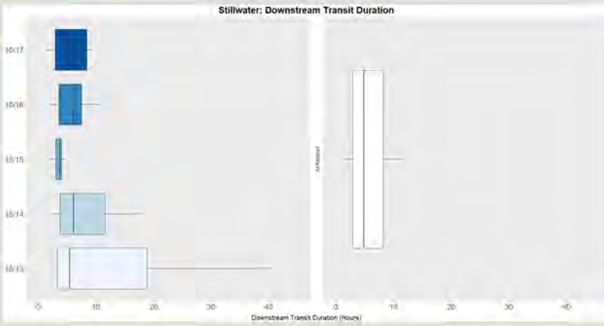


- Passage events recorded from October 13 through October 20
- Primarily 1800-2200
- 89% of fish which approached passed downstream
  - 48% via turbines – 41% via bypasses
- Turbine passage primarily at Powerhouse A
- Bypass passage primarily at Powerhouse B





Study Results: Stillwater



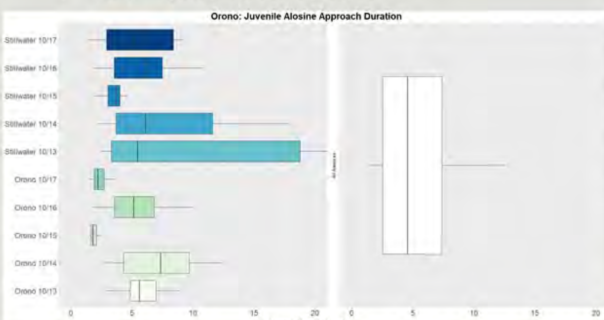
Downstream Continuation:

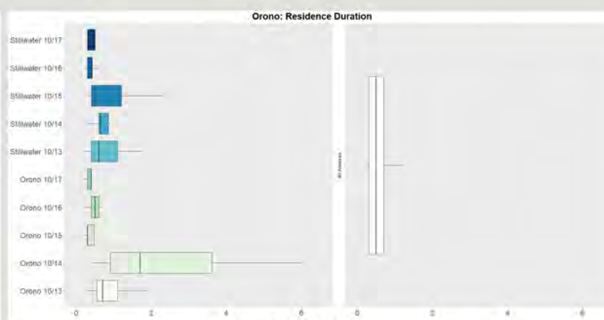
- 77% detected 1.6 km downstream at O1 (i.e., the Orono "approach" receiver
- Median travel to O1 = 4.9 hrs (P25-P75 = 2.9-8.3 hrs)
  - Via bypass A – median = 4.1 hours
  - Via powerhouse A – median = 5.0 hours
  - Via bypass B – median = 6.3 hours
  - Via powerhouse B – median = 8.8 hours

NOTE: study was not designed to evaluate downstream passage survival due to uncertainty over transmitter retention rates during downstream passage through turbines, spill or bypass structures

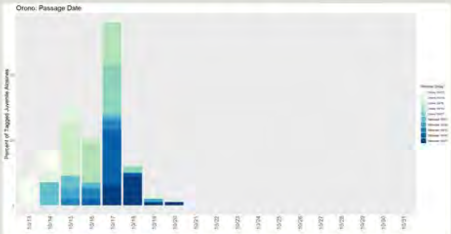
Study Results: Orono

- 68% of tagged fish moved DS and approached the dam
- Median approach duration = 3.7 hrs (P25-P75 = 2.0-6.2 hrs)
- 73% arrived within six hours following release
- Additional 72 fish from Stillwater
  - Median impoundment time = 4.9 hrs
- Median residence = 0.5 hrs (P25-P75 = 0.3-0.7 hrs)
- 88% passed within four hours of initial detection
- 96% passed within 24 hours of initial detection

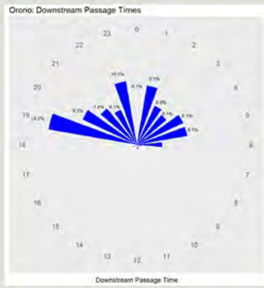


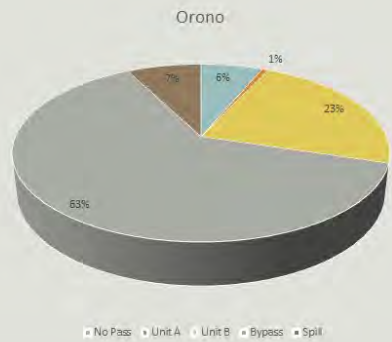


Study Results: Orono

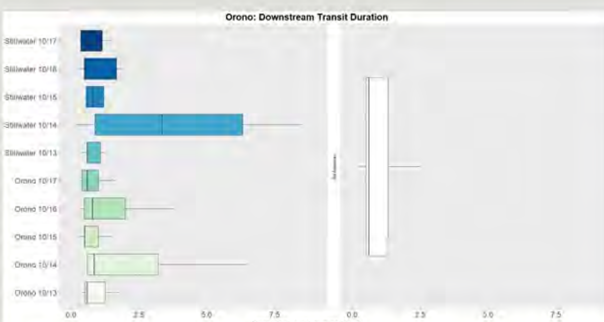


- Passage events recorded from October 13 through October 20
- Primarily 1900-0500
- 63% of passage via the downstream bypass
- Turbine passage more prevalent via Powerhouse B (23%) than Powerhouse A (1%)





Study Results: Orono



Downstream Continuation:

- 78% detected 1.4 km downstream at O8
- Median travel to O8 = 0.6 hrs (P25-P75 = 0.5-1.3 hrs)
  - Via bypass – median = 0.6 hours
  - Via powerhouse B – median = 0.5 hours

NOTE: study was not designed to evaluate downstream passage survival due to uncertainty over transmitter retention rates during downstream passage through turbines, spill or bypass structures

Summary

- 2015 pilot study to evaluate downstream passage of juvenile alosines was unsuccessful due to high post-tagging (48 hr) mortality of test and control fish
- Similar to the 2019 study at West Enfield – the techniques utilized for marking individual juvenile alosines in 2020 was useful for providing information on passage timing and route utilization at Milford, Stillwater and Orono
- Souadabscook Stream again provided an ample supply of suitably sized individuals for this type of analysis
- Downstream passage route information was collected over a range of inflows representative of seasonal flows between the 20th and 80th percentiles at the West Enfield USGS gage
- Although inferences into passage survival via this technique may be biased by the uncertainty of tag retention and continued downstream detections, route distribution information collected here is very valuable in the development of passage survival estimates via available desktop methods

Appendix E. Potential passage route locations – Milford, Stillwater and Orono.


MILFORD
Bay 7 Bypass
Bay 2 Bypass
Spillway
Waste Gate
Powerhouse – Units
1, 2, 3, 4, 5, 6
Google Earth
Earth Point
500 ft


STILLWATER
Spillway
Bypass A
Powerhouse A
Bypass B
Powerhouse B
Google Earth
Earth Point
300 ft


ORONO
Intake Rack
Spillway
Bypass
Powerhouse B
Powerhouse A
Google Earth
Earth Point
300 ft

Study Report
for the
Desktop Assessment of Juvenile Alosine Project Passage Survival

Lower Penobscot River Projects
Milford Hydroelectric Project (FERC No. 2534)
Stillwater Hydroelectric Project (FERC No. 2712)
Orono Hydroelectric Project (FERC No. 2710)

Prepared For
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Black Bear SO, LLC
Black Bear Development Holdings, LLC
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NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

February 2021

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1 Introduction

Affiliates of Brookfield Renewable (Brookfield) own and operate hydroelectric projects in the Penobscot River watershed pursuant to licenses issued by the Federal Energy Regulatory Commission (FERC). Among those projects, the Milford Project (FERC No. 2534) is licensed to Black Bear Hydro Partners, LLC, and the Stillwater (FERC No. 2712) and Orono (FERC No 2710) Projects are licensed to Black Bear Hydro Partners, LLC, Black Bear SO, LLC, and Black Bear Development Holdings, LLC (collectively, "Black Bear").

Background:

Pursuant to the amended Project licenses and a 2004 settlement agreement between the licensees, state and federal agencies, Penobscot Indian Nation (PIN), and other stakeholders, the licensees developed a comprehensive upstream and downstream fish passage program to facilitate the passage of diadromous species on the Penobscot River. FERC license amendment orders for Orono, Stillwater, and Milford contain Articles 411, 408 and 409, respectively, requiring the licensees to develop study plans to monitor the effectiveness of the fish passage facilities. All fish passage monitoring plans are to be developed in consultation with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), PIN, Maine Department of Marine Resources (MDMR), and Maine Department of Inland Fisheries and Wildlife (MDIFW).

A Diadromous Fish Passage Study Plan (DFPSP) describing studies to evaluate the performance of the new fish passage facilities for alosines and American eels was approved by FERC on February 11, 2014. Pursuant to the DFPSP, the licensees performed qualitative monitoring studies in 2014 to evaluate the use of the new fishways and to assess the availability of alosines and adult eels for future quantitative studies at the three hydroelectric Projects. In 2015, Black Bear proposed and performed quantitative radio tagging studies of upstream migrating adult river herring at Milford and Orono and conducted a pilot downstream radio tagging study of juvenile alosines. Neither study provided meaningful results, as ninety percent of the radio tagged adult river herring fell back downriver after tagging/release and did not return, and almost all of the juvenile river herring (including tagged and control fish) died with 48 hours. Based on the 2015 study results, the licensees did not propose any quantitative studies of alosines for 2016, other than upstream passage tallies of alosine fish species at the Milford and Orono fish lifts. Black Bear instead focused on American eel passage in 2016 at the three Projects by studying both upstream juvenile eel passage (via nighttime surveys and video/direct tally evaluations of the new and modified upstream eelways) and downstream adult (silver-phase) eel passage utilizing radio-tagged eels from an out of basin supplier. The upstream juvenile eel passage surveys and video observations were repeated during 2017 at Stillwater to evaluate modifications made to the upstream eel passage entrance.

Black Bear has most recently evaluated downstream passage of adult American shad at Milford (2017 and 2018), Stillwater (2017), and Orono (2017) and of adult river herring during 2018 at Milford, Stillwater and Orono. The 2017 and 2018 adult alosine downstream passage studies evaluated residence duration upstream of each dam, downstream passage route selection, and project reach survival. During the spring of 2019, Black Bear conducted a "proof of concept" evaluation to develop a set of methodologies to be used in the evaluation of adult river herring upstream passage effectiveness. The revised approach led to a successful evaluation of the existing Milford fish lift for upstream passage of adult river herring during spring 2019. During the most recent field season (October 2020), Black Bear evaluated downstream passage route selection for radio-tagged juvenile alosines at the Milford, Stillwater and Orono Projects.

Study Plan Development:

Prior to preparing this desktop evaluation, Black Bear developed a draft study plan for review by the resource agencies[1]. A draft version of the study plan was distributed to members of the MDMR, NMFS, USFWS, MDIFW, Maine Department of Environmental Protection (MDEP) and the PIN on February 20, 2020. Black Bear requested that any comments related to the draft Desktop Assessment of Juvenile Alosine Project Passage Survival Study Plan be submitted in writing by March 23, 2020. The draft study plan was discussed during a conference call between Black Bear, the resource agencies, and PIN on March 18, 2020. Following receipt and incorporation of agency comments, the final study plan was filed with FERC on April 15, 2020.

Study Report Development:

The 2020 Desktop Assessment of Juvenile Alosine Project Passage Survival study was conducted following the methodologies presented in the April 15, 2020 FERC-filed study plan. A draft report summarizing results from that effort was distributed by the licensees for the Milford, Stillwater, and Orono Projects to the agencies and PIN on December 10, 2020. As part of the December 10 distribution correspondence, Black Bear indicated a virtual meeting would be held in early January to discuss the study results and requested receipt of written comments related to the draft report by January 11, 2021. At the request of the agencies and PIN, the licensees for the Milford, Stillwater, and Orono Projects submitted a time extension request to the Commission on December 28, 2020 for submittal of the annual eel and alosine study report for these lower Penobscot facilities. The Commission approved this request on January 11, 2021, thereby extending the report submittal deadline to February 15, 2021.

A consultation meeting to discuss the 2020 study results was held virtually on January 27, 2021, and Normandeau provided an overview of the study methods and results to representatives from Brookfield, NMFS, USFWS, MDMR, MDEP and the PIN. A summary of questions and comments from the January 27 meeting is provided in Appendix A. Correspondence related to the distribution of the draft study report, as well as written comments received following agency review, are provided in Appendix B. A copy of the PowerPoint slides presented by Normandeau at the January 27, 2021 meeting is also provided in Appendix C.

[1] Normandeau Associates, Inc. (Normandeau). 2020. Study Plan for the Desktop Assessment of Juvenile Alosine Project Passage Survival. Plan prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, and Black Bear Development Holdings, LLC. Plan dated April 2020.

1.1 Study Goal and Objectives

Although radio-tagging studies for juvenile alosines have resulted in meaningful findings with regards to downstream passage route selection at hydroelectric projects (e.g., Normandeau 2020a; Normandeau 2020b), the question of post-passage survival at these locations remains. Uncertainty around the rate of transmitter retention by juvenile alosines during downstream passage has the likelihood to bias passage survival estimates. As a result, the goal of this study was to estimate survival of juvenile alosines as they out-migrate at the Milford, Stillwater, and Orono Projects. Specifically, this report will:

- Provide a description of the physical characteristics of each Project (including the intake location(s) and dimensions, turbine characteristics, calculated approach velocities, and trash rack spacing);
- Summarize route-specific passage survival rates estimated for diadromous fish species during field evaluations at the three Projects;
- Estimate blade strike probabilities for juvenile alosines; and
- Generate estimates of total station survival for juvenile alosines at Milford, Stillwater, and Orono using the Turbine Blade Strike Analysis (TBSA) tool.

2 Project Descriptions

2.1 Milford

2.1.1 General Project Description

Following removal of the downstream Great Works and Veazie dams in 2012 and 2013, respectively, the Milford Project dam, located in the towns of Milford and Old Town, Maine, became the lowermost dam on the main stem of the Penobscot River. The Milford Project has a generating capacity of 8,230 kilowatts (kW), six generating units, a minimum hydraulic capacity of 500 cfs, and a maximum hydraulic capacity of 6,730 cfs. The downstream fish passage facilities at the Milford Project consist of two surface bypass flumes passing through the powerhouse wall at the western end and center of the powerhouse. The entrances are located at the face of the interior full-depth trashracks, which have 1-inch clear spacing. Each surface bypass is capable of passing up to 280 cfs. The licensee has also installed a low-level bypass for American eels at the bottom of the trashracks, directly below the surface bypass entrance at the west end of the powerhouse. The low-level bypass is designed to pass up to 70 cfs and has a 4-foot by 4-foot entrance that reduces to a 24-inch-diameter pipe, which in turn discharges into an unused turbine bay. The two surface bypasses are opened for the duration of the juvenile alosine outmigration period, while the low-level bypass is open from August 15 to November 15 annually to provide downstream eel passage. In addition to the downstream passage facility described above, a bypass sluice is also located at the downstream end of the exit flume of the upstream fish passage facility. This sluice can be used for incidental downstream passage of fish that end up in the exit flume. Non-generational flow can also be passed via a 25 foot-wide bottom-opening sluice gate located adjacent to the mid-channel side of the powerhouse. When fully opened under normal headpond conditions, the sluice gate is capable of passing approximately 2,000 cfs.

2.1.2 Intake Structure and Turbine Characteristics

Milford has a single intake structure which provides inflow to a total of six generating units (Table 2-1). Units at Milford include a pair of vertical propeller turbines (Units 1 and 2; 550 cfs maximum capacity), a fixed blade propeller turbine (Unit 3; 1,370 cfs maximum capacity), and three Kaplan turbines (Units 4, 5, and 6; each 1,420 cfs maximum capacity). The top of the intake sits above the normal pond elevation of 101.7 feet and extends to a depth approximately 24.5 feet below the normal pond elevation. The intake rack is constructed with 1.0 inch rack spacing and encompasses an area of 4,346 ft^2. When at full capacity (i.e., 6,730 cfs) and at normal pond elevation, the calculated intake velocity at Milford is 1.5 ft/sec. Table 2-2 provides a summary of turbine parameters considered as part of this modeling exercise for Milford.

2.2 Stillwater

2.2.1 General Project Description

The Stillwater Project is a run-of-river project located on the Stillwater Branch of the Penobscot River in Orono, Maine, approximately 3.7 river kilometers upstream from the confluence of the Stillwater Branch with the main stem of the Penobscot River. The confluence of the Stillwater Branch with the Penobscot River is approximately 53 river kilometers upstream from the Atlantic Ocean, and 8 river kilometers downstream of the Milford Project. The Project has a generating capacity of 4,170 kW, a minimum hydraulic capacity of 100 cfs, and a maximum hydraulic capacity of 3,498 cfs. Powerhouse A has four generating units, and Powerhouse B has three units.

In 2013, the licensees replaced the downstream bypass facility at the Stillwater A powerhouse and constructed a new downstream passage facility at the Stillwater B powerhouse. The new downstream fishways include full-depth trash racks with 1-inch clear spacing at the powerhouse intakes and consist of a single surface bypass and a single low-level bypass (for American eels) at Stillwater Powerhouses A and B. At Stillwater A, the bypass entrances are located at the left side of the intake (looking downstream) between the forebay wall and trashracks. The low-level and surface bypasses discharge into the tailwater through a 36-inch-diameter conduit. At Stillwater B, the entrance to the surface bypass is located at the downstream-most end of the trashracks, perpendicular to the face of the trashracks. The surface bypass is a 4-foot by 4-foot notch in the intake wall that discharges into a 5-foot-deep plunge pool. An attraction flow of 70 cfs is provided to the bypass and is controlled by removable stoplogs. The two Stillwater surface bypasses are opened for the duration of the juvenile alosine outmigration period.

2.2.2 Intake Structure and Turbine Characteristics

Stillwater has two separate intake structures with each intake integral to one of the two powerhouses (A or B; Table 2-1). Stillwater A contains four Francis turbines, each with a rated capacity between 380 or 560 cfs. Units at Stillwater B include a pair of vertical propeller turbines (Units 2 and 3; each 586 cfs maximum capacity) and a single Kaplan turbine (Unit 1; 586 cfs maximum capacity). The tops of the intake structures sit above the normal pond elevation of 94.7 feet and extend to a depth approximately 19.4 and 19.1 feet below the normal pond elevation at Powerhouses A and B, respectively. The intake racks at both powerhouses are constructed with 1.0 inch rack spacing. The Powerhouse A rack encompasses an area of 1,350 ft^2 and the Powerhouse B rack encompasses an area of 1,604 ft^2. When at full capacity (i.e., 1,700 cfs at Powerhouse A and 1,758 cfs at Powerhouse B) and at normal pond elevation, the calculated intake velocities at Stillwater A and B are 1.3 and 1.1 ft/sec, respectively. Table 2-3 provides a summary of turbine parameters considered as part of this modeling exercise for Stillwater.

2.3 Orono

2.3.1 General Project Description

The Orono Project is a run-of-river project located on the Stillwater Branch just upstream from the confluence with the main stem of the Penobscot River in Orono, Maine. Powerhouse A is equipped with four generating units, and Powerhouse B is equipped with three units. The total generating capacity of the Project is 6,548 kW; it has minimum and maximum hydraulic capacities of 100 cfs and 3,822 cfs, respectively. A new downstream fish passage system at the Orono Project, which was commissioned in 2014, consists of full-depth angled trashracks with 1-inch clear spacing across both powerhouse intakes, a single downstream surface bypass, and a single low-level bypass for American eels. An attraction flow of up to 150 cfs is provided to the downstream surface bypass through an 8-foot-wide, adjustable entrance. Attraction flow is controlled by a 3-foot-wide adjustable weir that discharges into a plunge pool below the dam. The Orono surface bypass is opened for the duration of the juvenile alosine outmigration period.

2.3.2 Intake Structure and Turbine Characteristics

Two powerhouses are installed at Orono with Powerhouse A containing four Francis turbines (each with a rated capacity of 370 or 500 cfs) and Powerhouse B containing a pair of vertical propeller turbines (Units 2 and 3; each with 694 cfs maximum capacity) and a single Kaplan turbine (Unit 1; 694 cfs maximum capacity). Orono Powerhouses A and B share a common intake structure (Table 2-1). The top of the rack structure sits above the normal pond elevation of 73.0 feet and extends to a depth approximately 15.1 feet below the normal pond elevation. The intake rack is constructed with 1.0 inch rack spacing and encompasses an area of 2,488 ft^2 (1,057 ft^2 for Orono A, and 1,431 ft^2 for Orono B). When at full capacity (i.e., 1,740 cfs at Powerhouse A and 2,082 at Powerhouse B) and at normal pond elevation, the calculated intake velocities at Orono A and B are 1.6 and 1.5 ft/sec. Table 2-4 provides a summary of turbine parameters considered as part of this modeling exercise for Orono

Table 2–1. Intake structure characteristics for the Milford, Stillwater and Orono powerhouses.

Project Facility	Milford	Stillwater A	Stillwater B	Orono A	Orono B
Normal headpond elevation (ft)	101.7	94.65	94.65	73	73
Intake rack position	Full Depth	Full Depth	Full Depth	Full Depth	Full Depth
Intake rack width (ft)	177.4	69.6	84.0	70.0	94.8
Intake rack height (ft)	24.5	19.4	19.1	15.1	15.1
Intake rack area (ft^2)	4346	1350	1604	1057	1431
Intake rack clear spacing (in)	1.0	1.0	1.0	1.0	1.0
Calculated approach velocity ft/sec	1.5	1.3	1.1	1.6	1.5

Table 2–2. Physical parameters for turbine units in operation at Milford.

Turbine ID	Milford					
	1	2	3	4	5	6
Turbine Type	Vertical Propeller	Vertical Propeller	Fixed Blade Propeller	Kaplan	Kaplan	Kaplan
Number of Blades	4	4	4	4	4	4
Runner Diameter (ft)	5.6	5.6	9.1	9.1	9.1	9.1
Head (ft)	18	18	20	20	20	20
Rotational Speed (rpm)	257	257	120	120	120	120
Max Discharge (cfs)	550	550	1370	1420	1420	1420

Table 2–3. Physical parameters for turbine units in operation at Stillwater.

Turbine ID	Stillwater A				Stillwater B		
	1	2	3	4	1	2	3
Turbine Type	Francis	Francis	Francis	Francis	Kaplan	Vertical Propeller	Vertical Propeller
Number of Blades	14	14	14	14	4	4	4
Runner Diameter (ft)	3.5	3.5	3.5	3.5	5.6	5.6	5.6
Runner Diameter at Inlet (ft)	2.5	2.5	2.5	2.5	n/a	n/a	n/a
Runner Diameter at Discharge (ft)	3.5	3.5	3.5	3.5	n/a	n/a	n/a
Runner Height (ft)	2.6	2.6	2.6	2.6	n/a	n/a	n/a
Head (ft)	19	19	19	19	18.75	18.75	18.75
Rotational Speed (rpm)	150	150	150	180	300	300	300
Max Discharge (cfs)	380	380	380	560	586	586	586

Table 2–4. Physical parameters for turbine units in operation at Orono.

Turbine ID	Orono A				Orono B		
	1	2	3	4	1	2	3
Turbine Type	Francis	Francis	Francis	Francis	Kaplan	Vertical Propeller	Vertical Propeller
Number of Blades	14	14	14	14	4	4	4
Runner Diameter (ft)	2.8	2.8	3.6	3.6	5.6	5.6	5.6
Runner Diameter at Inlet (ft)	1.6	1.6	2.6	2.6	n/a	n/a	n/a
Runner Diameter at Discharge (ft)	2.8	2.8	3.6	3.6	n/a	n/a	n/a
Runner Height (ft)	2.6	2.6	2.6	2.6	n/a	n/a	n/a
Head (ft)	25	25	25	25	26.5	26.5	26.5
Rotational Speed (rpm)	225	220	225	212	300	300	300
Max Discharge (cfs)	370	370	500	500	694	694	694

3 Summary of Available Empirical Data

Black Bear has conducted numerous empirical evaluations for downstream passage route selection and passage success of diadromous fish species at the Milford, Stillwater and Orono Projects. These studies have evaluated Atlantic salmon smolts, adult American shad, adult river herring and adult American eel. Sections 3.1 through 3.3 provide a summary of route utilization and passage success as observed during the following field evaluations:

1. HDR Engineering, Inc. 2015. Atlantic Salmon Passage Study Report. Report Prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, Black Bear Development Holdings, LLC, and Bangor-Pacific Hydro Associates.

2. Kleinschmidt. 2016. 2015 Atlantic Salmon Smolt Downstream Passage Study for West Enfield, Milford, Stillwater and Orono. Report prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, Black Bear Development Holdings, LLC, and Bangor-Pacific Hydro Associates.

3. HDR Engineering, Inc. 2017. 2016 Diadromous Fish Passage Report for Alosines and American Eels (Milford, Stillwater, and Orono Projects). Report prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, and Black Bear Development Holdings, LLC.

4. Normandeau Associates, Inc. 2017. Evaluation of Spring 2016 Atlantic Salmon Smolt Downstream Passage for the Lower Penobscot River Projects. Report prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, Black Bear Development Holdings, LLC, and Bangor-Pacific Hydro Associates.

5. Normandeau Associates, Inc. 2018. Evaluation of 2017 Atlantic Salmon Smolt Downstream Passage for the Lower Penobscot River Projects. Report prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, Black Bear Development Holdings, LLC, and Bangor-Pacific Hydro Associates.

6. Normandeau Associates, Inc. 2019. Evaluation of 2018 Atlantic Salmon Smolt Downstream Passage for the Lower Penobscot River Projects. Report prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, Black Bear Development Holdings, LLC, and Bangor-Pacific Hydro Associates.

7. Normandeau Associates, Inc. 2018. Assessment of Adult American Shad Outmigration at the Milford (FERC No. 2534), Stillwater (FERC No. 2712) and Orono (FERC No. 2710) Projects, Penobscot River, Maine. Report prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, and Black Bear Development Holdings, LLC.

8. Normandeau Associates, Inc. 2019. 2018 Evaluation of Adult American Shad and River Herring Downstream Passage for the Penobscot River Projects (West Enfield, Milford, Stillwater, and Orono). Report prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, Black Bear Development Holdings, LLC, and Bangor-Pacific Hydro Associates.

3.1 Milford

Table 3-1 provides a summary of the passage route utilization and associated route-specific survival estimates for diadromous fish species reported during recent radio telemetry evaluations of outmigrating diadromous fish species at Milford. Downstream passage survival at Milford has varied among species and routes. Larger-bodied fish species (i.e., adult American eel and American shad) have been excluded from turbine passage due to the presence of the 1-inch rack spacing at the powerhouse intake. Observed turbine entrainment survival has ranged from 83.2%-98.1% for Atlantic salmon smolts during five years of study and was estimated at 100% for adult river herring during the 2018 evaluation. Downstream passage success through the Bay #2 bypass has been consistently high among species and years ranging from 100% for Atlantic salmon smolts (2015 through 2018) to 93% (adult river herring in 2018). In contrast, downstream passage survival through the Bay #7 bypass located near the center of the powerhouse was observed to be higher for smaller bodied fish (100% during all five years of Atlantic salmon smolt evaluations) but lower for larger-bodied adult alosines. It should be noted that following the poor survival results observed for adult alosines during the 2018 field evaluation, Black Bear inspected the downstream bypass conveyance structure and repaired a damaged area which was protruding into the conveyance flow. In general, fish passed via spill (either the Obermeyer inflatable sections or the waste gate) have demonstrated high survival based on downstream detections. Annual survival estimates for diadromous fish species based on radio telemetry studies at Milford have generally met or exceeded 96%.

3.2 Stillwater

Table 3-2 provides a summary of the passage route utilization and associated route-specific survival estimates for diadromous fish species reported during recent radio telemetry evaluations of outmigrating diadromous fish species at Stillwater. Downstream passage of radio-tagged diadromous fish species at Stillwater have generally occurred primarily via the downstream bypass at Powerhouse B or via spill flows. In general, estimates for downstream passage survival via spill flow at Stillwater have met or exceeded 96% during study years when that route was available. Downstream passage survival via the bypass at Powerhouse B was lowest for Atlantic salmon smolts during the 2015 (80%) and 2016 (89.8%) spring season field evaluations. Following the 2016 study season, Black Bear modified the downstream fishway to increase survival by (1) increasing the height of the plunge pool wall to reduce the likelihood of fish landing on top of the wall or splashing overboard, and (2) installing stop logs at the downstream of the plunge pool to back water up, thereby increasing the depth of the plunge pool water surface and reducing the height of the drop. Downstream passage survival estimates for the Powerhouse B fish bypass reported for diadromous fish species at Stillwater have been at 100% since those modifications were made.

The intake structures at Stillwater Powerhouses A and B feature 1 inch rack spacing and, as a result, have reduced most turbine passage for larger bodied diadromous fish species (i.e., American eel, American shad). Following the 2016 American eel evaluation, it was determined that a damaged section of the intake racks permitted the entrainment of 12% of radio-tagged eels at Powerhouse A (with a corresponding 50% downstream survival estimate). Empirical estimates of turbine survival for smaller bodied Atlantic salmon smolts have ranged from 57.1-100% at Powerhouse A and 60-100% at Powerhouse B. The contribution of turbine use to the overall picture of downstream smolt route utilization was 10% or less during four of the five study years.

3.3 Orono

Table 3-3 provides a summary of the passage route utilization and associated route-specific survival estimates for diadromous fish species reported during recent radio telemetry evaluations of outmigrating diadromous fish species at Orono. Similar to the pattern observed at Stillwater, downstream passage of radio-tagged diadromous fish species at Orono has generally occurred primarily via the downstream bypass or spill flow. When all species are considered, downstream passage survival via spill has ranged from 100 to 94%, with most studies documenting rates at or towards the upper end of that range. The downstream bypass at Orono has proven to be very safe for downstream passage of Atlantic salmon smolts with estimates of survival that met or exceeded 96% during each of the five study years. Survival estimates for adult alosines using the downstream bypass at Orono were estimated at 90% for both adult American shad and river herring.

One inch intake rack spacing has reduced the entrainment rate for larger-bodied diadromous fish species at Orono. Observations of adult American eel, American shad and river herring entrained through the Orono turbine units were limited to a single radio-tagged eel during the 2016 telemetry study. Turbine entrainment survival rates ranged from 67 to 100% for Atlantic salmon smolts at Orono Powerhouses A and B during the five years of field evaluation.

Table 3–1. Summary of downstream passage route utilization and resulting route-specific estimates of passage survival for diadromous fish species previously conducted by Black Bear at the Milford hydroelectric project.

Reference No.	Study Year	Species	Life Stage	n	Downstream Passage Route*						Reported Route-Specific Survival Rate					
					Turbine	DSB1[a]	DSB2[a]	Low-Level DSB	Spill	Waste	Turbine	DSB1	DSB2	Low-Level DSB	Spill	Waste
3	2016	American eel	Adult	46	0%	0%	4%	46%	50%	n/a	n/a	n/a	100.0%	95.2%	91.3%	n/a
7	2017	American shad	Adult	90	0%	0%	17%	n/a	1%	58%	n/a	n/a	33.3%	n/a	100.0%	100.0%
8	2018	American shad	Adult	121	0%	54%	22%	n/a	2%	7%	n/a	97.0%	77.0%	n/a	50.0%	100.0%
1	2014	Atlantic salmon	Smolt	80	44%	21%		n/a	35%	n/a	88.6%	100.0%		n/a	96.4%	n/a
2	2015	Atlantic salmon	Smolt	95	70%	2%	5%	n/a	8%	n/a	95.5%	100.0%	100.0%	n/a	100.0%	n/a
4	2016	Atlantic salmon	Smolt	234	9%	1%	3%	n/a	59%	21%	83.2%	100.0%	100.0%	n/a	95.8%	100.0%
5	2017	Atlantic salmon	Smolt	267	9%	2%	1%	n/a	76%	9%	98.1%	100.0%	100.0%	n/a	100.0%	100.0%
6	2018	Atlantic salmon	Smolt	178	6%	1%	3%	n/a	74%	11%	90.0%	100.0%	100.0%	n/a	100.0%	99.8%
8	2018	River herring	Adult	109	6%	75%	11%	n/a	0%	0%	100.0%	93.0%	58.0%	n/a	n/a	n/a

*Note: Downstream route utilization percentages may not sum to 100 as only values for fish which passed downstream via known routes are presented (i.e., does not include unknown or "no pass" fish)

a: DSB1 = Bay #2 bypass located on river side of Milford powerhouse. DSB2 = Bay #7 bypass located towards center of Milford powerhouse.

Table 3–2. Summary of downstream passage route utilization and resulting route-specific estimates of passage survival for diadromous fish species previously conducted by Black Bear at the Stillwater hydroelectric project.

					Downstream Passage Route*							Reported Route-Specific Survival Rate						
Reference No.	Study Year	Species	Life Stage	n	Turbine A	DSB A	Low-Level DSB-A	Turbine B	DSB B	Low-Level DSB-B	Spill	Turbine A	DSB A	Low-Level DSB-A	Turbine B	DSB B	Low-Level DSB-B	Spill
3	2016	American eel	Adult	50	12%	40%	2%	0%	14%	12%	20%	50.0%	100.0%	100.0%	n/a	100.0%	100.0%	100.0%
7	2017	American shad	Adult	48	2%	4%	n/a	0%	90%	n/a	0%	100.0%	100.0%	n/a	n/a	100.0%	n/a	n/a
8	2018	American shad	Adult	19	0%	16%	n/a	0%	68%	n/a	0%	n/a	66.7%	n/a	n/a	100.0%	n/a	n/a
1	2014	Atlantic salmon	Smolt	69	10%	7%	n/a	0%	12%	n/a	71%	85.7%	100.0%	n/a	n/a	100.0%	n/a	100.0%
2	2015	Atlantic salmon	Smolt	106	22%	8%	n/a	5%	33%	n/a	21%	78.3%	87.5%	n/a	60.0%	80.0%	n/a	86.4%
4	2016	Atlantic salmon	Smolt	162	1%	10%	n/a	9%	11%	n/a	69%	100.0%	94.5%	n/a	100.0%	89.8%	n/a	95.6%
5	2017	Atlantic salmon	Smolt	178	4%	1%	n/a	1%	9%	n/a	83%	57.1%	100.0%	n/a	100.0%	100.0%	n/a	100.0%
6	2018	Atlantic salmon	Smolt	164	2%	4%	n/a	0%	6%	n/a	86%	75.0%	85.7%	n/a	n/a	100.0%	n/a	100.0%
8	2018	River herring	Adult	93	19%	41%	n/a	1%	33%	n/a	0%	100.0%	100.0%	n/a	0.0%	100.0%	n/a	n/a

*Note: Downstream route utilization percentages may not sum to 100 as only values for fish which passed downstream via known routes are presented (i.e., does not include unknown or "no pass" fish)

Table 3–3. Summary of downstream passage route utilization and resulting route-specific estimates of passage survival for diadromous fish species previously conducted by Black Bear at the Orono hydroelectric project.

Reference No.	Study Year	Species	Life Stage	n	Downstream Passage Route*					Reported Route-Specific Survival Rate				
					Turbine A	Turbine B	DSB	Low-Level DSB	Spill	Turbine A	Turbine B	DSB	Low-Level DSB	Spill
3	2016	American eel	Adult	45	0%	2%	47%	16%	36%	n/a	100.0%	100.0%	100%	100.0%
7	2017	American shad	Adult	94	0%	0%	93%	n/a	0%	n/a	n/a	89.7%	n/a	n/a
8	2018	American shad	Adult	18	0%	0%	89%	n/a	0%	n/a	n/a	100.0%	n/a	n/a
1	2014	Atlantic salmon	Smolt	71	11%	14%	38%	n/a	37%	75.0%	80.0%	96.3%	n/a	96.2%
2	2015	Atlantic salmon	Smolt	83	25%	17%	35%	n/a	21%	85.7%	78.6%	96.6%	n/a	94.1%
4	2016	Atlantic salmon	Smolt	134	2%	17%	31%	n/a	48%	66.0%	74.5%	100.0%	n/a	100.0%
5	2017	Atlantic salmon	Smolt	162	3%	4%	12%	n/a	77%	100.0%	100.0%	100.0%	n/a	100.0%
6	2018	Atlantic salmon	Smolt	139	9%	2%	24%	n/a	63%	76.9%	66.7%	100.0%	n/a	100.0%
8	2018	River herring	Adult	135	0%	0%	76%	n/a	20%	n/a	n/a	90.0%	n/a	100.0%

*Note: Downstream route utilization percentages may not sum to 100 as only values for fish which passed downstream via known routes are presented (i.e., does not include unknown or "no pass" fish)

4 Juvenile Alosine TBSA Blade Strike Probabilities

The Turbine Blade Strike Analysis (TBSA) desktop tool developed by the U.S. Fish and Wildlife Service, Region 5 Fish Passage Engineering Group (Towler and Pica 2018) was utilized to estimate the probability of a turbine strike for juvenile alosines at each of the 20 turbine units at Milford (n = 6), Stillwater (n = 7) and Orono (n = 7). Individual model runs were conducted for each unique set of turbine parameters. For each turbine model run, the discharge was held constant and assumed the site-specific maximum capacity for each turbine (see Tables 2-2 through 2-4). The TBSA model runs for each Project turbine were conducted on a standardized set of 1,000 “fish” with a mean body length of 3.5 inches (standard deviation = 1.0 inches). All other model parameters (i.e., runner size, rpm, head, number of blades, etc.) were fixed based on the individual turbine.

For each run, the TBSA model created a normally distributed population of fish described by the user-defined fish number, mean length, and standard deviation of length that were routed through hazards at a hydroelectric project (in this case, a specific set of turbine parameters). Monte Carlo simulations were performed to determine the percentage of individuals subjected to turbine blade strike calculated using methods outlined in Franke et al. (1997). All TBSA model simulations were performed using a correlation factor of 0.2, which is the recommended conservative value (Towler and Pica 2018).

A total of five separate TBSA model runs were conducted for each unique set of turbine parameters at Milford, Stillwater, and Orono, and the resulting strike and passage percentages are provided in Tables 4-1 through 4-3. To provide a generalized comparison among the TBSA results specific to project turbine units, model output was converted to a qualitative ranking. Estimates in excess of 85% were classified as “High” survival potential, “Moderate” for estimates between 85-70%, and “Low” for estimates less than 70%.

4.1 Milford

Of the six turbine units in operation at Milford, Units 1 and 2 are vertical propeller units, Unit 3 is a fixed blade propeller unit, and Units 4, 5 and 6 are Kaplan units. When examined by turbine type, the percentage of 3.5 inch (S.D.±1.0 inches) fish expected to avoid contact during passage was estimated at 96.0% for the vertical propeller units, 97.0% for the fixed blade propeller unit, and 97.5% for the Kaplan units. Conversely it would be expected to see 4.0%, 3.0%, and 2.5% of juvenile alosine-sized fish make physical contact with the Milford turbine units during passage for Units 1 or 2; 3; or 4, 5, or 6, respectively. Survival rates estimated for juvenile alosine-sized fish for the turbine units in operation at Milford are all classified as "high".

Table 4–1. TBSA estimated blade strike and turbine passage percentages for 3.5 inch (S.D.±1.0 in.) sized fish under maximum generation conditions at Milford.

	Milford Turbine Units					
	1 or 2		3		4, 5, or 6	
Trial No.	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass
1	4.5	95.5	3.0	97.0	2.0	98.0
2	4.6	95.4	2.9	97.1	2.4	97.6
3	4.4	95.6	2.8	97.2	2.3	97.7
4	3.9	96.1	3.0	97.0	2.8	97.2
5	2.8	97.2	3.1	96.9	3.0	97.0
Mean	4.0	96.0	3.0	97.0	2.5	97.5
Qualitative Survival Rating	High		High		High	

4.2 Stillwater

Stillwater Powerhouse A contains four Francis units. Francis Unit 4 differs slightly from Units 1 through 3 with a higher rotational speed and maximum capacity (cfs). Survival rates through each of the four units in Powerhouse A are classified as moderate with the percentage of 3.5 inch (S.D.±1.0 inches) fish expected to avoid contact during passage estimated at 82.7% for Francis units 1, 2, and 3, and at 80.8% for Unit 4 with its slightly faster rotational speed.

Of the three units in operation at Stillwater Powerhouse B, Unit 1 is a Kaplan and Units 2 and 3 are vertical propeller type turbines. When examined by turbine type, the percentage of 3.5 inch (S.D.±1.0 inches) fish expected to avoid contact during passage was estimated at 94.6% for the vertical propeller units and 95.0% for the Kaplan unit. Survival rates estimated for juvenile alosine-sized fish for the turbine units in operation at Stillwater Powerhouse B are all classified as "high".

Table 4–2. TBSA estimated blade strike and turbine passage percentages for 3.5 inch (S.D.±1.0 in.) sized fish under maximum generation conditions at Stillwater Powerhouses A and B.

Trial No.	A1, A2, A3		A4		B1		B2 or B3	
	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass
1	18.1	81.9	20.8	79.2	4.7	95.3	4.2	95.8
2	18.2	81.8	17.6	82.4	5.2	94.8	7.1	92.9
3	13.9	86.1	18.9	81.1	6.4	93.6	4.7	95.3
4	15.8	84.2	21.9	78.1	5.0	95.0	6.3	93.7
5	20.3	79.7	16.8	83.2	3.6	96.4	4.7	95.3
Mean	17.3	82.7	19.2	80.8	5.0	95.0	5.4	94.6
Qualitative Survival Rating	Moderate		Moderate		High		High	

4.3 Orono

Orono Powerhouse A contains a total of four similar Francis units. The rotational speed among the four Francis units vary slightly, but all are within the range from 212-225 rpm. Orono Francis Units 1 and 2 are slightly smaller and have a lower maximum capacity (370 cfs) than that of Francis Units 3 and 4. Survival rates through each of the four Francis units in Powerhouse A are classified as moderate, with the percentage of 3.5 inch (S.D.±1.0 inches) fish expected to avoid contact during passage ranging from 76.2% to 79.8%.

Of the three units in operation at Orono Powerhouse B, Unit 1 is a Kaplan and Units 2 and 3 are vertical propeller type turbines. When examined by turbine type, the percentage of 3.5 inch (S.D.±1.0 inches) fish expected to avoid contact during passage was estimated at 95.1% for the vertical propeller units and 95.8% for the Kaplan unit. Survival rates estimated for juvenile alosine sized fish for the turbine units in operation at Orono Powerhouse B are all classified as “high”.

Table 4–3. TBSA estimated blade strike and turbine passage percentages for 3.5 inch (S.D.±1.0 in.) sized fish under maximum generation conditions at Orono Powerhouses A and B.

	Orono Turbine Units											
	A1		A2		A3		A4		B1		B2 or B3	
Trial No.	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass
1	23.6	76.4	23.9	76.1	20.8	79.2	20.4	79.6	5.3	94.7	4.4	95.6
2	24.3	75.7	22.8	77.2	21.7	78.3	22.6	77.4	2.9	97.1	5.9	94.1
3	24.0	76.0	18.6	81.4	22.6	77.4	17.4	82.6	3.6	96.4	4.6	95.4
4	21.5	78.5	21.8	78.2	17.4	82.6	23.1	76.9	5.7	94.3	4.4	95.6
5	25.4	74.6	24.6	75.4	20.1	79.9	17.3	82.7	3.7	96.3	5.1	94.9
Mean	23.8	76.2	22.3	77.7	20.5	79.5	20.2	79.8	4.2	95.8	4.9	95.1
Qualitative Survival Rating	Moderate		Moderate		Moderate		Moderate		High		High	

5 Juvenile Alosine Whole Station Survival Estimates

The TBSA desktop tool was used to estimate whole station survival for juvenile alosines at Milford, Stillwater and Orono. Each project-specific model required input of available downstream passage routes and an estimate of their proportional usage. The proportional distribution of juvenile alosine passage among downstream passage routes was evaluated at each of the three Projects using radio telemetry during October 2020 (Normandeau 2020c). The observed route selection probabilities for each Project were imported into a project-specific, multi-route TBSA model to evaluate the predicted whole-station survival for a population of 1,000 3.5 inch (S.D.±1.0 inches) fish. For non-turbine routes (e.g., downstream bypass or spill), an estimate of passage mortality was required and was based on previously conducted empirical studies at each Project. The non-turbine route estimates were generated as averages for comparable species (herring, shad) or body sizes (smolts) for studies with a route-specific sample size of 10 or more individuals. Turbine-specific parameters were incorporated as previously described above in Section 4. Model inputs and the resulting estimate for each Project are provided in Sections 5.1 (Milford), 5.2 (Stillwater), and 5.3 (Orono). The TBSA model provides an estimate of the initial mortality associated with blade strike. It does not account for potential injuries or mortality associated with other potential factors including shear or barotrauma. As such these estimates should be interpreted as minimum estimates of mortality at each project.

5.1 Milford

The route selection probabilities and estimated non-turbine route mortality values used in the Milford whole-station TBSA model are presented in Table 5-1. The dominant downstream passage routes used during the 2020 radio telemetry assessment were turbine Units 3-6 (77% of fish which passed Milford Dam) followed by the riverside downstream bypass (21% of fish which passed the dam). Mortality rates for individuals passing downstream via the bypass facility or on spill were estimated using available empirical data previously collected at Milford (see Table 3-1). A downstream passage mortality rate for fish using the bypass facility was estimated at 0.033 and was calculated as the average for adult shad (2018), adult herring (2018), and Atlantic salmon smolts (2014) previously documented using the Bay #2 entrance (corresponding to Bay #2 bypass usage observations for radio-tagged juvenile alosines during the 2020 field evaluation). A downstream passage mortality rate for fish passing Milford Dam via spill was estimated at 0.02 and was calculated as the average from four years of Atlantic salmon smolt evaluations (2014, 2016-2018). Design parameters for Units 1 and 6 were selected as representative for fish utilizing the “new” vertical propeller and the “old” Kaplan style units at Milford.

Figure 5-1 presents the October flow duration curve for inflow at Milford Dam based on the 1969-2018 time series. Quartile values of exceedance for inflow at Milford are 4,018 cfs (75%), 4,976 cfs (50%) and 7,861 cfs (25%). Mean daily inflow at Milford on release dates during the 2020 radio telemetry downstream passage route evaluation ranged between 3,367 and 7,293 cfs. The route selection probabilities adopted from the 2020 field study and used as part of the

Milford TBSA model appear representative of river flows between the 25th and 75th percentiles for the month of October. Table 5-2 provides a summary of the five model runs performed to evaluate the whole-station passage for a population of 1,000 3.5 inch (S.D.±1.0 inches) fish. Whole-station survival at Milford Dam for juvenile alosine-sized fish is estimated at 97.2%. Passage failures were attributed to fish passing downstream via Units 3-6 (2.1%) and via the downstream bypass facility/spill (0.7%).

Table 5–1. Route selection probabilities and non-turbine route mortality estimates used to inform the TBSA model for estimation of whole station survival of 3.5 inch (S.D.±1.0 inches) fish at Milford.

Route	Route Selection Probability[1]	Estimated Mortality[2]
Spill	2.0%	2.0
DS Bypass	21.4%	3.3
Units 1-2	0.0%	-
Units 3-6	76.5%	-

1 - Taken from Normandeau 2020c
2 - Estimated from previously conducted empirical studies

Table 5–2. TBSA estimated whole station survival (% strike, % bypass fail, and % pass) for 3.5 inch (S.D.±1.0 in.) sized fish at Milford.

Trial No.	Milford Whole Station Survival		
	% Strike	% Bypass Fail	% Pass
1	2.0	0.4	97.6
2	2.0	0.5	97.5
3	2.0	1.0	97.0
4	2.0	0.6	97.4
5	2.4	1.2	96.4
Mean	2.1	0.7	97.2

5.2 Stillwater

The route selection probabilities and estimated non-turbine route mortality values used in the Stillwater whole-station TBSA model are presented in Table 5-3. The dominant downstream passage routes used during the 2020 radio telemetry assessment at Stillwater were the Powerhouse A turbine units (47% of fish which passed the Project) followed by the Powerhouse B downstream bypass (37% of fish which passed the Project). Mortality rates for individuals passing downstream via the bypass facilities at Powerhouses A and B or on spill were estimated using available empirical data previously collected at the Project (see Table 3-2). The downstream passage mortality rate at the Powerhouse A bypass (2.8%) was calculated as the average rate for adult herring (2018) and Atlantic salmon smolts (2016). Suitable numbers of individuals utilized the Powerhouse B downstream bypass during the 2017/2018 adult shad studies, 2015-2018 Atlantic salmon smolts studies, and the 2019 adult herring study. Results from the 2015 and 2016 Atlantic salmon smolt studies were not considered in this analysis, because those two studies occurred prior to the structural modifications made at Stillwater bypass B prior to the 2017 passage season to enhance passage survival through that facility. Passage survival through the Stillwater bypass B has been estimated at 100% for all studies conducted since those modifications were made. A downstream passage mortality rate of 3.6% was estimated for fish passing Stillwater via spill and was based on five years of Atlantic salmon smolts studies (2014-2018). Design parameters for Unit 1 were selected as representative for fish utilizing the turbine units in either Powerhouse A or Powerhouse B at Stillwater.

Figure 5-2 presents the October flow duration curve for the Stillwater Branch based on the 1969-2018 time series. Quartile values of exceedance for inflow are 2,520 cfs (75%), 3,318 cfs (50%) and 4,922 cfs (25%). Mean daily inflow at Stillwater on release dates during the 2020 radio telemetry downstream passage route evaluation ranged between 687 and 3,740 cfs. The route selection probabilities adopted from the 2020 field study and used as part of the Stillwater TBSA model appear representative of Stillwater Branch flows between the 25th and 75th percentiles for the month of October. Table 5-4 provides a summary of the five model runs performed to evaluate the whole-station passage for a population of 1,000 3.5 inch (S.D.±1.0 inches) fish at Stillwater, and the whole-station survival for juvenile alosine-sized fish was estimated at 91.4%. Passage failures were attributed to fish passing downstream via the turbines (8.4%) and the downstream bypass facilities (0.1%). As described in Section 4.2, passage survival is expected to be lower through the Francis units in Stillwater Powerhouse A than in the Kaplan and vertical propeller units in Stillwater Powerhouse B.

Table 5–3. Route selection probabilities and non-turbine route mortality estimates used to inform the TBSA model for estimation of whole station survival of 3.5 inch (S.D.±1.0 inches) fish at Stillwater.

Route	Route Selection Probability[1]	Estimated Mortality[2]
Powerhouse A	46.8%	-
Powerhouse B	6.4%	-
Bypass A	9.6%	2.8
Bypass B	37.2%	0.0
Spill	0.0%	3.6

1 - Taken from Normandeau 2020c
2 - Estimated from previously conducted empirical studies

Table 5–4. TBSA estimated whole station survival (% strike, % bypass fail, and % pass) for 3.5 inch (S.D.±1.0 in.) sized fish at Stillwater.

Trial No.	Stillwater Whole Station Survival		
	% Strike	% Bypass Fail	% Pass
1	6.3	0.0	93.7
2	8.1	0.3	91.6
3	9.3	0.0	90.7
4	7.2	0.4	92.4
5	11.3	0.0	88.7
Mean	8.4	0.1	91.4

5.3 Orono

Table 5-5 presents the route selection probabilities and estimated non-turbine route mortality values used in the Orono whole-station TBSA model. Radio-tagged juvenile alosines passing downstream of Orono during the 2020 field evaluation most frequently utilized the downstream bypass (67% of fish which passed the Project), Powerhouse B turbine units (24% of fish which passed the Project), and spill (8% of fish which passed the Project). Mortality rates for individuals utilizing the downstream bypass and spill were estimated at 3.4% and 1.6%, respectively. The downstream bypass mortality rate was estimated as the average of results from the 2017/2018 adult shad, 2014-2018 Atlantic salmon smolt, and the 2018 adult river herring studies (Table 3-3). The 2014-2018 Atlantic salmon smolt and the 2018 adult river herring studies were used to estimate downstream passage via spill at Orono. Design parameters for Unit 1 were selected as representative for fish utilizing the turbine units in either Powerhouse A or Powerhouse B at Orono.

Similar to observations at Stillwater, the route selection probabilities adopted from the 2020 field study and used as part of the Orono TBSA model appear representative of Stillwater Branch flows between the 25th and 75th percentiles for the month of October. Table 5-6 provides a summary of the five model runs performed to evaluate the whole-station passage for a population of 1,000 3.5 inch (S.D.±1.0 inches) fish at Orono. The whole-station survival for juvenile alosine-sized fish at the Orono Project was estimated at 96.4%. Passage failures were attributed to fish passing downstream via the turbines (1.1%) and the downstream bypass facilities (2.5%).

Table 5–5. Route selection probabilities and non-turbine route mortality estimates used to inform the TBSA model for estimation of whole station survival of 3.5 inch (S.D.±1.0 inches) fish at Orono.

Route	Route Selection Probability[1]	Estimated Mortality[2]
Powerhouse A	0.7%	-
Powerhouse B	24.3%	-
Bypass	66.9%	3.4
Spill	8.1%	1.6

1 - Taken from Normandeau 2020c

2 - Estimated from previously conducted empirical studies

Table 5–6. TBSA estimated whole station survival (% strike, % bypass fail, and % pass) for 3.5 inch (S.D.±1.0 in.) sized fish at Orono.

Trial No.	Orono Whole Station Survival		
	% Strike	% Bypass Fail	% Pass
1	0.3	1.9	97.8
2	1.5	2.7	95.8
3	1.1	2.7	96.2
4	0.9	2.8	96.3
5	1.7	2.3	96.0
Mean	1.1	2.5	96.4

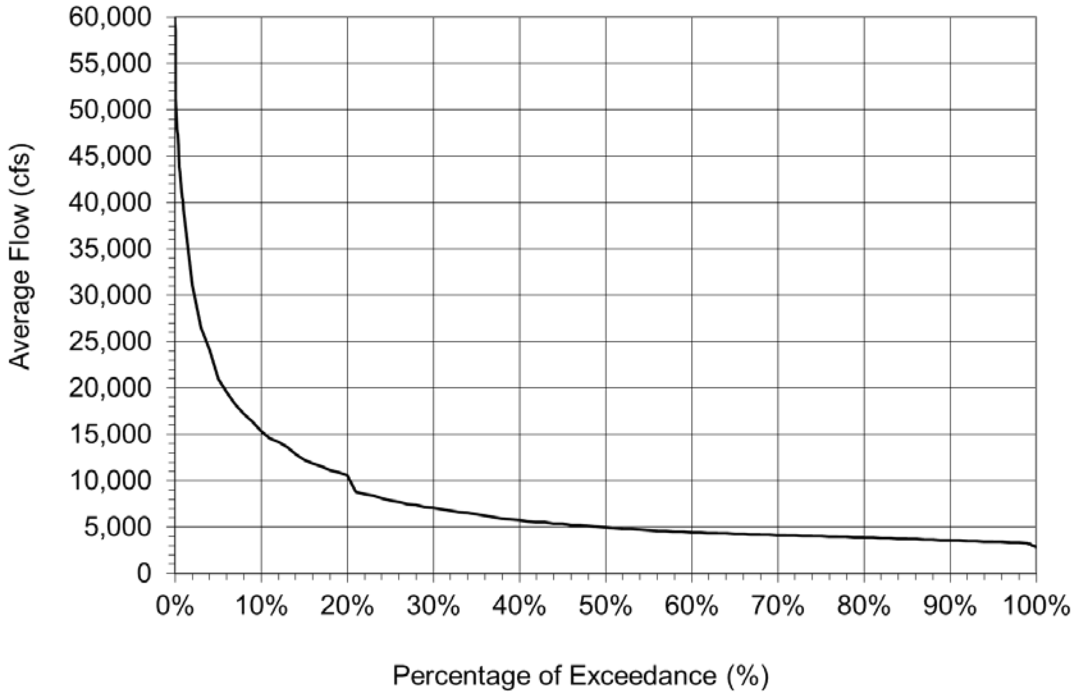

Figure 5–1. October flow duration curve for the Penobscot River at Milford (1969-2018).

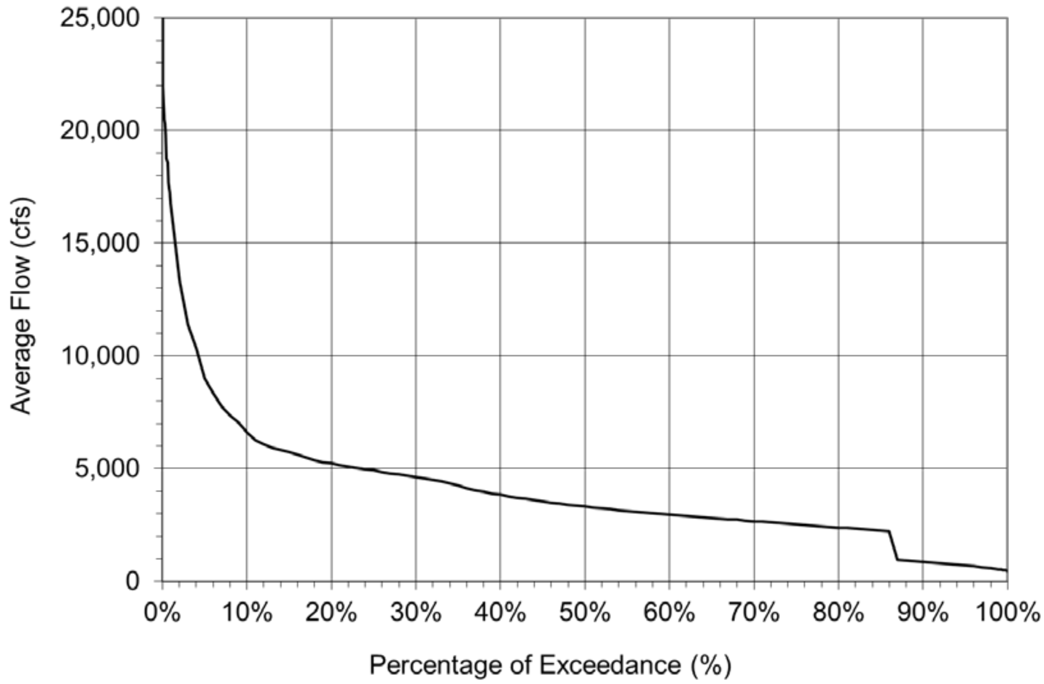

Figure 5–2. October flow duration curve for the Stillwater Branch of the Penobscot River (1969-2018).

6 Summary

During October 2020, Black Bear conducted a radio telemetry evaluation of juvenile alosines for the purposes of (1) evaluating the residence duration from arrival until downstream passage, and (2) determining the proportional downstream passage route selection at the Milford, Stillwater and Orono Projects. The methodologies and full results from that evaluation were described in a related study report (Normandeau 2020c). Although the 2020 telemetry evaluation at Milford, Stillwater and Orono was successful in providing meaningful findings with regards to downstream passage route selection at those hydroelectric projects, the question of post-passage survival at these Projects was not addressed as part of that effort. Uncertainty around the rate of transmitter retention by juvenile alosines during downstream passage as well as the relatively fragile nature of the juvenile life stage has the potential to bias passage survival estimates due to lost or shed transmitters. The intent of this desktop study was to integrate available station and empirical fish passage data to gain an understanding of downstream passage survival for juvenile alosines at each of the three Lower Penobscot Projects. The publicly-available Turbine Blade Strike Analysis (TBSA) desktop tool developed by the USFWS Fish Passage Engineering Group provided the platform for generating these estimates.

Model input was obtained from:

- Black Bear operations to describe the physical parameters for each of the 20 individual turbine units at the three Projects;
- Previously-conducted empirical studies to evaluate downstream passage and related rates of survival for diadromous fish species; and
- Passage route selection probabilities recorded for radio-tagged juvenile alosines at each of the three Projects.

Downstream passage survival for juvenile alosines was estimated at 97.2% for Milford, 91.4% for Stillwater, and 96.4% for Orono. Downstream passage of radio-tagged juvenile alosines at Milford Dam occurred primarily via the "old" turbines (i.e., Units 3, 4, 5, and 6), as well as via the downstream bypass facilities. Each of the four "old" units at Milford are axial-flow style turbines[2]. When compared to the two "new" axial-style turbines at Milford (i.e., Units 1 and 2) and those in the new "B" powerhouses at Stillwater and Orono, Units 3-6 at Milford are relatively large (9.1 foot vs. 5.6 foot runner diameter), have a larger capacity (1,370-1,420 cfs vs. 550-694 cfs), and rotate at a lower speed (120 rpm vs. 257-300 rpm). All of these characteristics are of known benefit to successful downstream passage of fish. When examined independently, estimates of survival for Milford Units 3-6 were relatively high, ranging from 97.0-97.5%. It should be noted that although slightly smaller and with faster rotational speed the axial-style turbines at Milford (Units 1 and 2) and the new "B" powerhouses at Stillwater and Orono still exhibited a high rate of predicted survival for juvenile alosines (range = 94.6-96.0%). The full set of axial-style turbines modeled during this exercise demonstrated higher

[2] Axial flow units include Kaplan and propeller style turbines.

passage survival than the Francis style units present in the old “A” powerhouses at Stillwater and Orono, a trend that is well documented by turbine passage survival studies conducted at other hydroelectric project locations (Pracheil et al. 2016).

Downstream passage survival is expected to be high for juvenile alosines using the downstream bypass facilities at Milford based on previous studies (range 93.0% - 100%; average = 96.7%). The high proportional contribution to the overall passage of juvenile alosines via these two routes contributed to the high estimated passage survival for Milford Dam as a whole. Downstream passage via spill at Milford was not observed for a significant number of juvenile alosines, likely due to the high proportion of river flow passing via the powerhouse during the 2020 field study. However, downstream passage of juvenile alosines via spill at Milford is expected to be high based on previously conducted downstream studies for adult alosines and salmon smolts.

Estimated passage survival was lower at Stillwater (91.4%) than was observed at either Milford or Orono. The likely reason for this is the high route selection probability for radio-tagged juvenile alosines utilizing the Francis-style units in Powerhouse A (47% of all tagged fish passing the Project). The majority of mortality (99% of the estimated 8.5% overall) was attributed to turbine strikes. When examined independently, the predicted blade strike probability is nearly 15% higher for juvenile herring-sized fish passing downstream via the Powerhouse A Francis style turbines than the axial-flow style turbines in Stillwater Powerhouse B. When examined by powerhouse, downstream passage of radio-tagged juvenile alosines was nearly equal between Powerhouse A and Powerhouse B. However, the proportional use of the downstream bypass facility was greater at Powerhouse B than at Powerhouse A, which resulted in a higher proportion of fish exposed to the Francis units. Downstream passage survival estimates for the two bypass facilities, as well as spill at Stillwater, are high (96.4-100%) when empirical results from other diadromous species are considered.

Similar to Stillwater, Orono is characterized by two powerhouse structures. Powerhouse A contains four Francis style turbines and Powerhouse B contains three axial-flow style turbines. Orono has a single downstream bypass facility located adjacent to the shared intake rack structure for the two powerhouses. Similar to observations at Stillwater, when examined independently, the predicted blade strike probability is nearly 15% higher for juvenile herring-sized fish passing downstream via the Powerhouse A Francis style turbines than the axial-flow style turbines in Powerhouse B. However, the proportional use of Francis units at Orono was very low (only 0.7% of all tagged fish passing the Project), and the use of the downstream bypass facility was relatively high (67% of all tagged fish passing the Project). Similar to the downstream bypass facilities at Milford and Stillwater, the Orono downstream bypass survival estimate, calculated from passage of other diadromous fish species, was high (96.6%). The high relative use of the Orono bypass facility and low rate of passage through Powerhouse A contributed to the high survival estimate for Orono.

The whole station survival rates estimated here for Milford, Stillwater and Orono are based on the proportional use among passage routes observed under the set of river conditions present during the 2020 radio telemetry study. That study was conducted over a range of flows which corresponded roughly with those expected to be exceeded during October between 75% and 25% of the time. Estimated survival rates should be expected to vary as downstream passage patterns shift for flow conditions with higher or lower exceedance rates. Flows conditions lower than those observed during the 2020 field evaluation would likely result in reduced generation and prioritization of most efficient units. Flow conditions in excess of those observed during the 2020 field evaluation would likely result in an increase in turbine generation as well as increased spill flows when river levels exceed station capacity.

7 References

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Pracheil, B.M., C.R. DeRolph, M.P. Schramm, and M.S. Bevelhimer. 2016. A fish-eye view of riverine hydropower systems: the current understanding of the biological response to turbine passage. Reviews in Fish Biology and Fisheries 26: 153-167.

Towler, B. and J. Pica. 2018. TBSA Model: A desktop tool for estimating mortality of fish entrained at hydroelectric turbines. Background, data requirements & how to run simulations.

Appendix A. Summary of questions and topics discussed at the January 27, 2021 resource agency and PIN study discussion meeting.

The following questions were posed during the January 27, 2021 resource agency and PIN study discussion meeting. Responses provided on that date are summarized here and where appropriate, additional information has been provided

Question 1: *Section 4.0 of the draft report presents qualitative rankings to provide a general categorization for TBSA results. Estimates in excess of 85% were classified as "High" survival potential, "Moderate" for estimates between 85-70%, and "Low" for estimates less than 70%. How were those categories defined? Are these values specific to alosines?*

Response 1: Winchell et al. (2000[3]) provided a summary of an EPRI (1997) database that was developed to draw together the existing data on fish entrainment and turbine passage survival in a consistent and objective format designed to facilitate the examination of trends based on project design, geographical location, and other site characteristics. Normandeau staff previously developed these general classifications based on information summarized by Winchell et al. (2000) and originally prepared by EPRI, and they have been used to help provide general characterizations of passage estimates to aid in comparisons among passage routes at a specific project. These classifications are not based on a quantitative assessment or a species, but rather they are to provide the reader with generalized categories of survival. The Franke et al. (1997[4]) blade strike equations (foundation of the TBSA model) are not species-oriented, but rather are driven by body size. For a standard "fish", you tend to see increasing mortality as body size increases.

Question 2: *The draft report considered juvenile alosines of mean length = 3.5 inches (SD ±1.0 inches). Is this range representative of fish studied in the accompanying telemetry study or of out-migrating Penobscot River juvenile alosines in general?*

Response 2:
Each TBSA model run in the draft report was established for an out-migrating population with an average length of 3.5 inches and a standard deviation of 1.0 inches. The TBSA provided model outputs consisting of a full listing of every fish considered within a simulation, and it provides values for body length for each member of the modeled population. To better understand the distribution of juvenile alosine body lengths considered in this study, the length frequency distribution of the modeled population of fish for a single simulation was plotted (note: the model evaluating Milford Units 1/2 was randomly selected). Figure A-1 below

[3] Winchell, F., S. Amaral, and D. Dixon. 2000. Hydroelectric turbine entrainment and survival database: An alternative to field studies. Hydrovision 2000: New Realities, New Responses

[4] Franke, G. F., D. R. Webb, R. K. Fisher, D. Mathur, P. N. Hopping, P. A. March, M. R. Headrick, I. T. Laczo, Y. Ventikos, and F. Sotiropoulos. 1997. Development of environmentally advanced hydropower turbine system design concepts. Voith Hydro, Inc. Report No. 2677-0141. Prepared for the U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho

provides the length frequency distribution for that model run and demonstrates a normal distribution with a mean = 3.5 inches and a standard deviation of 1.0 inches. The 68-95-99.7 "empirical rule" in statistics is used to define the percentage of values that lie within a band around the mean of normally distributed data. Specifically, 68.27%, 95.45%, and 99.73% of values within a sample lie within one, two, or three standard deviations of the mean. Application of that rule to the population parameters selected for this report results in a range of body lengths from 0.6 to 6.6 inches. The population parameters utilized in the draft report are representative of the range of lengths expected to be encountered for juvenile alosines exiting the Penobscot River. The seaward migration of young generally occurs from mid-July through early November at a size range of 1.3-6.0 inches, depending upon the availability of feed in the lakes, the total number of young produced in a particular watershed, and the length of time they remain in the freshwater environment (https://www.maine.gov/dmr/science-research/searun/alewife.html).

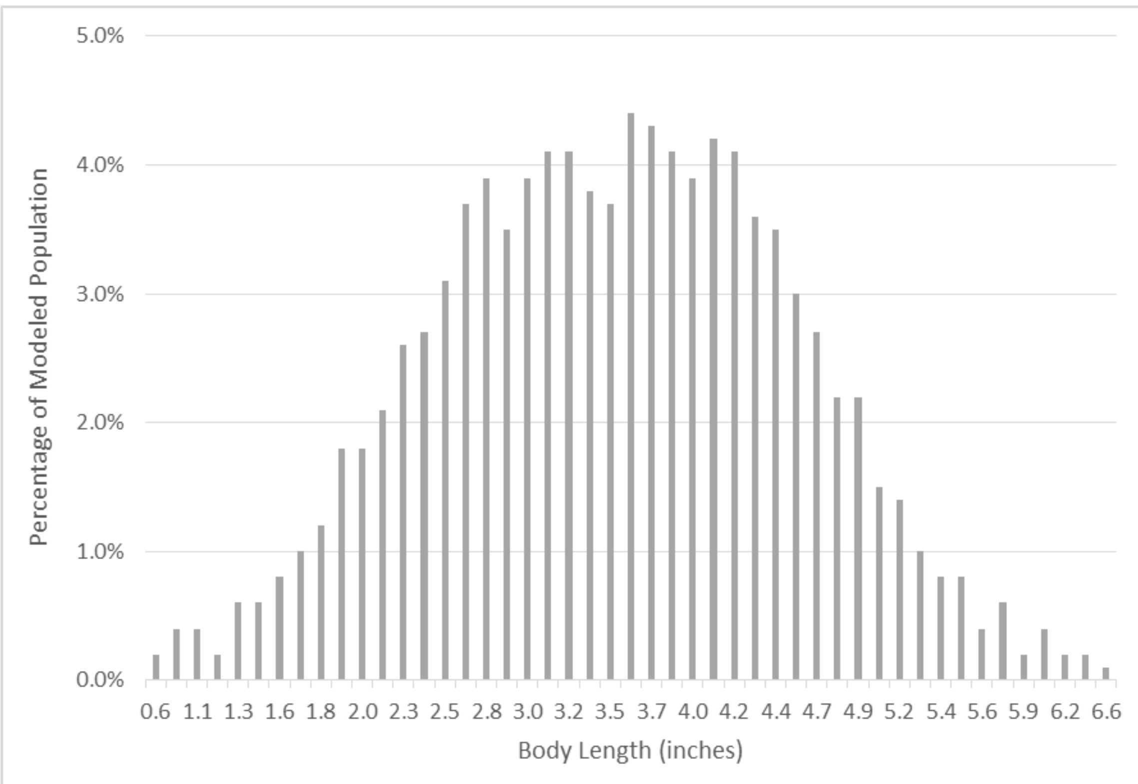

Figure A-1. Example length frequency distribution for the modeled population of juvenile alosines considered during desktop assessment of passage survival.

Question 3: *Any sense on the error bounds around the estimates provided by the desktop TBSA? Previous desktop and empirical studies at Ellsworth differed significantly.*

Response 3:
TBSA incorporates the turbine blade strike equations originally developed by the Idaho National Engineering Laboratory (Franke et al. 1997) and allows users to input site-specific information

to inform a Monte Carlo simulation that probabilistically models turbine and non-turbine route fish passage mortality. A standardized output is generated for each simulated run (see Figure A-2 below) and provides a summary of the user defined route selection probabilities, turbine parameters, non-turbine route mortality rates, fish population parameters, and the resulting estimates of strike probability, bypass failure rate, and passage rate. In addition, the body size, route usage, and strike probability for each individual are included. There is not an apparent estimate of variance provided around an individual model estimate. As part of this analysis, a total of five model runs were conducted for each turbine or project evaluated. The full set of estimates for each condition is provided in the report and provides the reader with an idea of the variability among estimates.

Normandeau previously conducted a single-project review to compare the similarity between desktop and empirical estimates of turbine passage as part of the FERC relicensing process for the Pejepscot Project on the Androscoggin River in Maine[5]. Table A-1 below provides the TBSA-empirical comparison for diadromous fish species from that report. The TBSA tended to produce passage estimates higher than that observed during empirical studies for adult-sized river herring and shad, and comparable estimates to those observed during empirical studies for body lengths equivalent to Atlantic salmon smolts.

Table A-1. Survival (%) of target species from radio telemetry studies at Pejepscot and from TBSA desktop analysis.

Species	Life Stage	From Pejepscot Telemetry studies (2015 - 2019)			Based on TBSA or multiple regression	
		# of fish	Size range (in)	Survival (%)	Size Range (in)	Survival (%)
American Shad	Adult	11	14 to 23	82%	14 to 23	91.3% to 95.6%
Atlantic Salmon	Juvenile	55/60	6 to 9	92.7% to 100%	6 to 9	96.8% to 97.6%
River Herring	Adult	48	11 to 13	88%	11 to 13	95.5% to 95.6%

Question 4: *Does the TBSA provide an estimate of latent mortality?*

Response 4: The TBSA model produces an estimate of the probability of blade strike for a fish of a given size passing through a user-defined turbine. This estimate should be considered as equivalent to an initial or immediate estimate of turbine passage.

Question 5: *Have latent estimates of passage survival been examined elsewhere for juvenile alosines, possibly via HI-Z turbine tag testing?*

Response 5: Yes, latent estimates are available from some previously conducted HI-Z tests. In some cases, survival of control fish during the latent holding period was poor resulting in only

[5] FERC Accession Number: 20200413-5208

an estimate of initial survival. A full listing of HI-Z studies for juvenile alosines conducted by Normandeau is provided in Table A-2 below.

Question 6: *Can Brookfield provide a description of the current unit prioritization strategy employed at Milford, Stillwater and Orono?*

Response 6: Milford Station is simultaneously operated by automated equipment and Black Bear Operations staff to generate power while maintaining compliance with license conditions (run of river operations with stable headpond and minimum flows). The various turbine-generator units of the powerhouse are turned on or off over the wide range of flows from the minimum hydraulic capacity of 500 cfs to the maximum hydraulic capacity of the Project (6,730 cfs). In order to maximize attraction to the upstream fish passage facility, Unit #6 (the discharge closest to the fish lift entrance) is operated first on and last off from May 15 to November 15; depending on river flows (when river flows are less than the hydraulic capacity of the entire station), units are sequenced on/off from #6 to #1. Alternatively, from April 1st to May 15th and from November 15th to December 31st each year, in order to maximize attraction to the downstream fish bypass facilities, the units are sequenced in reverse order, i.e., Unit 1 is operated first on and last off.[6]

The Orono Project powerhouses are operated by automated equipment and Black Bear Operations staff simultaneously to generate power while maintaining compliance with license conditions (run of river operations with stable headpond and minimum bypass reach flows). The various turbine-generator units of both powerhouses are on or off over the wide range of flows from the minimum hydraulic capacity of Powerhouse A (100 cfs) to the maximum hydraulic capacity of the Project (3,822 cfs). Under normal operations, the fully regulated turbine generator unit of Powerhouse B (175 cfs minimum capacity) is operated as first on and last off.[7] In consultation with the resource agencies, Orono Powerhouse A is prioritized during the two-week peak smolt passage window each spring based on empirical smolt study survival results that demonstrated higher whole station survival of smolts at Powerhouse A.[8]

The Stillwater Project Powerhouse A is manually operated, while Powerhouse B is operated by automated equipment and Black Bear Operations staff simultaneously to generate power while maintaining compliance with license conditions (run of river operations with stable headpond and minimum bypass reach flows). The various turbine-generator units of both powerhouses will be on or off over the wide range of flows from the minimum hydraulic capacity of Powerhouse A (100 cfs) to the maximum hydraulic capacity of the Project (3,458 cfs). Under

[6] 2011 Milford Fish Passage Operations and Maintenance Plan

[7] 2013 Orono Operations and Flow Monitoring Plan

[8] Brookfield Renewable. March 27, 2017. Atlantic Salmon Species Protection Plan - 2016 Annual Report for Project Nos. 2710, 2712, 2534, 2600, and 2666 (Orono, Stillwater, Milford, West Enfield, and Medway Hydroelectric Projects)

normal operations, the fully regulated turbine generator unit of Powerhouse B (160 cfs minimum capacity), which is closest to the downstream fish passage bypass entrance, is operated as first on and last off.[9] In consultation with the resource agencies, beginning in 2021 Stillwater Powerhouse B will be prioritized during the peak downstream fish passage season for alosines (June through October) within existing operating constraints, based on empirical study results that demonstrated higher use of the Stillwater Powerhouse B downstream fish passage facility and higher whole station survival than at Powerhouse A.

[9] 2013 Stillwater Operations and Flow Monitoring Plan

Obiex Hydroelectric Project, FERC Project No. 00000 ARCHIVED RUN .N1000-L4-S98 11/30/2020

Enter brief project description here. dtrested

Release 200316

ROUTE SELECTION				TURBINE DATA													BYPASS
					D	N	B	Q	Q_{OPT}/Q	H	ω	ζ	λ	D_1	D_2	η	P_B
Route Name	Route Selection Prob.	Prob. Lower Bound	Calc. Type	Route Type	Runner Dia. (ft)	Blades (#)	Runner Height (ft)	Turbine Discharge (cfs)	Discharge at Opt. Eff. (%)	Net. Head (ft)	Speed (rpm)	Swirl Coeff. (-)	Correlation Coeff. (-)	Runner Dia. at Inlet (ft)	Runner Dia. at Disch. (ft)	Turbine Eff. (-)	Estimated Mortality (-)
M_U1-2	0.000	0.000	3	propeller	5.60	4		550	90.0%	18.0	257.0		0.20			0.80	
M_U3-6	0.765	0.000	2	Kaplan	9.10	4		1,420	85.0%	20.0	120.0		0.20			0.90	
M_DSB	0.214	0.765	0	bypass													0.03
M_Spill	0.020	0.979	0	bypass													0.02

	MODEL SIMULATION INPUT PARAMETERS	
n_f	1,000	Number of fish
μ	3.5	Mean length (inches)
σ	1.0	SD in length (inches)

	BLADE STRIKE SIMULATION RESULTS	
Turbine Strikes:	20 of 1000 fish	2.0%
Bypass Failures:	4 of 1000 fish	0.4%
Passed:	976 of 1000 fish	97.6%

Fish ID (#)	Fish Length (in)	Fish Length (ft)	Route Seed (-)	Route Selection (#)	Calc. Type (-)	Route Name (-)	$E_{\omega d}$ (-)	$Q_{\omega d}$ (-)	β (rad)	α_t or α_a (rad)	λ (-)	Mortality Seed (-)	Strike Prob. (-)	Individual Results (-)	(-1, 0, 1)
1	5.96	0.50	0.615	2	2	M_U3-6	0.049201523	0.149952705	----	0.554	0.2	0.901	0.041	pass	✓
2	3.94	0.33	0.267	2	2	M_U3-6	0.049201523	0.149952705	----	0.554	0.2	0.527	0.027	pass	✓

Figure A-2. Example output log from a TBSA model simulation.

Table A-2. Summary of previously conducted HI-Z turbine tag studies focused on downstream passage of juvenile alosines.

Station	State	Study Year	River	Species	Average size (mm)	Turbine Type	No. of blades	Runner speed (rpm)	Runner diameter (in)	Discharge (cfs)	Project Head (ft)	1 h survival	1 h SE	48 h survival	48 h SE
Columbia	SC	1998	Broad/Congaree	Blueback Herring	141	H-Francis	14	164	64	800	28	0.936		0.881	0.073
Conowingo	MD	2011	Susquehanna	American Shad	119	Francis	13	81.8	203	5,080	89	0.899	0.034	0.899	0.034
Conowingo	MD	1993	Susquehanna	American Shad	125	Mixed Flow	6	120	225	8,000	90	0.949	0.043	0.929	0.045
Crescent	NY	1991	Mohawk	Blueback herring	91	Kaplan	5	144	108	1,520	27	0.960	0.0408	0.960	0.0408
Hadley Falls (Holyoke)	MA	1991	Connecticut	American Shad	82	Kaplan	5	128	170	4,200	52	0.973	0.0821		
Hadley Falls (Holyoke)	MA	1991	Connecticut	American Shad	82	Kaplan	5	128	170	1,550	52	1.000	0.0561		
Hadley Falls (Holyoke)	MA	1991	Connecticut	American Shad	82	Propeller	5	150	156	4,200	52	0.891	0.0617		
Holtwood	PA	1991	Susquehanna	American Shad	125	Francis (single runner)	16	94.7	164	3,500	51	0.894	0.05	0.78 (24-h)	0.0847
Holtwood	PA	1991	Susquehanna	American Shad	125	Francis (double runner)	17	102.8	112	3,500	51	0.835	0.0525	0.68 (24-h)	0.0684
Holtwood	PA	1997	Susquehanna	American Shad	119	Francis (single runner)	13	94.7	164	3,000	51	0.905	0.116		
Safe Harbor	PA	1990	Susquehanna	American Shad	118	Mixed Flow	7	76.6	240	9,200	55	0.960	0.015	0.830	0.071
Safe Harbor	PA	1990	Susquehanna	American Shad	118	Mixed Flow	7	76.6	240	9,200	55	0.980	0.010	0.980	0.010
Safe Harbor	PA	1990	Susquehanna	American Shad	118	Kaplan	5	109.1	220	8,300	55	0.980	0.010	0.980	0.010
Stevens Creek	SC	1993	Savannah	Blueback Herring	203	Francis	14	75	135	1,000	28	0.953	0.0163	0.943	0.0209
Turners Falls (Cabot Station)	MA	2015	Connecticut	American Shad	96	Francis	13	97.3	136	2,304	60	0.952	0.020		
Turners Falls (Station No. 1)	MA	2015	Connecticut	American Shad	96	Francis	13	200	54	651	44	0.766	0.048		
Turners Falls (Station No. 1)	MA	2015	Connecticut	American Shad	96	Francis	13&15	257&200	39&55	591	44	0.678	0.050		
Vernon	VT/NH	1995	Connecticut	American Shad	92	Francis	15	74	156	1,834	34	0.947	0.022	0.946	0.031
Vernon	VT/NH	2015	Connecticut	American Shad	98	Francis	13	133	62.5	1,000	35	0.917	0.055		
Vernon	VT/NH	2015	Connecticut	American Shad	104	Kaplan	5	144	122	1,200	35	0.952	0.047		
York Haven	PA	2000	Susquehanna	American Shad	114	Francis	18	84	78	850	23	0.771	0.0676	0.771	
York Haven	PA	2000	Susquehanna	American Shad	118	Kaplan	4	200	93	1100	21	0.927	0.064	0.927	

Appendix B. Correspondence related to the distribution and comment on the draft desktop assessment of juvenile alosine passage survival study report.

From: Bernier, Kevin [mailto:Kevin.Bernier@brookfieldrenewable.com]
Sent: Thursday, December 10, 2020 10:41 AM
To: Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Harold Peterson <harold.peterson@bia.gov>; Marchelle M Foster <marchelle.foster@bia.gov>; Antonio Bentivoglio <antonio_bentivoglio@fws.gov>; Kenneth J Hogan <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Bryan Sojkowski <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Julianne Rosset (julianne_rosset@fws.gov) <julianne_rosset@fws.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: External: Lower Penobscot juvenile alosine draft study reports

Please find attached for your review two draft reports prepared by Normandeau Associates covering juvenile alosine downstream studies conducted this fall at the Milford, Stillwater, and Orono Projects. As you probably recall, these studies resulted from our discussions last winter, whereby the general consensus was to focus on downstream-migrating juvenile alosines in 2020 (after a successful pilot study had been conducted at the West Enfield Project in 2019), followed by evaluations of upstream alosine passage in 2021. FERC had previously provided direction requesting that the studies address data gaps on upstream-migrating adult alosines and downstream-migrating juvenile alosines at these Projects.

Please provide any comments **by January 11, 2021**; I will also be distributing a draft report in the near future on this fall's downstream eel study at the Medway Project. A Teams Meeting will likely then be scheduled in early January to review these reports and answer any questions. In the meantime, please feel free to contact me with any questions.

Kevin Bernier
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www.brookfieldrenewable.com

From: Sferra, Christopher [mailto:Christopher.Sferra@maine.gov]
Sent: Friday, December 11, 2020 4:55 PM
To: Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; Clark, Casey <Casey.Clark@maine.gov>; Simpson, Mitch <Mitch.Simpson@maine.gov>; Dan McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; harold.peterson@bia.gov; marchelle.foster@bia.gov; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Kenneth J Hogan <kenneth_hogan@fws.gov>; anna_harris@fws.gov; jeff.murphy <jeff.murphy@noaa.gov>; donald.dow@noaa.gov; Sojkowski, Bryan <bryan_sojkowski@fws.gov>; Valliere, Jason <Jason.Valliere@maine.gov>; Dunham, Kevin <Kevin.Dunham@maine.gov>; Perry, John <John.Perry@maine.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>
Subject: RE: Lower Penobscot juvenile alosine draft study reports

Hello all,

MDEP has reviewed the juvenile alosine draft study reports for the Milford, Orono and Stillwater Projects and has no comments on the reports at this time. The Department will defer to comments provided by the state and federal resource agencies. Thanks and have a good weekend.

Christopher Sferra (he/him)
Environmental Specialist III, Hydropower Unit
Bureau of Land Resources
Maine Department of Environmental Protection
Cell: (207) 446 - 1619
www.maine.gov/dep

Brookfield
Renewable

December 28, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Stillwater Project (FERC No. 2712); Orono Project (FERC No. 2710); Milford Project (FERC No. 2534); Time Extension Request for 2020 Diadromous Fish Passage Report

Dear Secretary Bose:

On behalf of the licensees for the Projects listed below, Brookfield Renewable (Brookfield) is submitting this time extension request for filing the 2020 Diadromous Fish Passage Report for the following hydroelectric projects located on the Penobscot River in Maine:

- **Milford Project (FERC No. 2534),** licensed to Black Bear Hydro Partners, LLC (Black Bear)
- **Orono Project (FERC No. 2710),** licensed to Black Bear; Black Bear SO, LLC; and Black Bear Development Holdings, LLC
- **Stillwater Project (FERC No. 2712),** licensed to Black Bear; Black Bear SO, LLC; and Black Bear Development Holdings, LLC

Pursuant to Commission Orders "*Amending License and Revising Annual Charges*" for the Orono and Stillwater Projects (both dated September 14, 2012) and "*Approving Fish Passage Design Drawings Under Articles 407 and 408*" for the Milford Project (dated October 9, 2012), the licensees constructed and installed upstream and downstream fish passage systems at the Milford, Stillwater (downstream only), and Orono Projects in 2013 and 2014 to facilitate the passage of diadromous fish species on the Penobscot River. To evaluate the performance of the new fish passage facilities at passing alosines (collectively American shad, blueback herring, and sea run alewives) and American eels (also required by the 2012 Commission Orders), the licensees have performed monitoring studies at these Projects since 2014.

In reply to the 2019 Diadromous Fish Passage Report filed by the licensees on January 13, 2020, the Commission noted (in a letter dated March 6, 2020) that the 2020 Diadromous Fish Passage Study Plans were due for Commission review by April 15, 2020. The Commission further requested that the 2020 Diadromous Fish Passage Report be filed by January 15, 2021. Following agency consultation, Brookfield, again on behalf of the licensees, submitted two 2020 Study Plans to the Commission on April 15, 2020 for these Projects, entitled "*Study Plan for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization*" and "*Study Plan for the Desktop Assessment of Juvenile Alosine Project Passage Survival*". Together, and as requested by the resource agencies[1] and Penobscot Indian Nation (PIN), these two studies will allow whole station survival estimates of juvenile alosines to be generated for each Project.

[1] Maine Department of Environmental Protection (MDEP); Maine Department of Marine Resources (MDMR); Maine Department of Inland Fisheries and Wildlife (MDIFW); United States Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS); Bureau of Indian Affairs

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Fax: 207.723.3948

Brookfield
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Both of these studies were successfully completed in the fall of 2020, and draft reports were distributed for 30-day review to resource agencies and PIN on December 10, 2020. In reply, the resource agencies and PIN have unanimously requested an additional 30 days for review (see attached e-mails). **Therefore, the licensees respectfully request a one-month time extension from the Commission for filing the 2020 Diadromous Fish Passage Report, or to February 15, 2021.**

Please feel free to contact me by e-mail at Kevin.Bernier@brookfieldrenewable.com or by phone at (207) 951-5006 if you have any questions or comments.

Sincerely,

Kevin Bernier

Kevin Bernier
Senior Compliance Specialist

Attachments

cc: S. Ledwin, M. Simpson, C. Clark, G. Wippelhauser, J. Valliere; MDMR
D. McCaw, J. Banks; PIN
H. Peterson; BIA
B. Sojkowski, J. Rosset, K. Hogan, A. Bentivoglio; USFWS
J. Murphy, D. Dow; NMFS
J. Perry, K. Dunham, K. Gallant; MDIFW
K. Howatt, C. Sferra; MDEP
H. Frank; FERC
S. Michaud, N. Stevens, B. Brochu, J. Cole, R. Dill, K. Maloney, L. Macomber; Brookfield
D. Trested, Normandeau

Brookfield Files: HSSE 4a/Stillwater/01; HSSE 4a/Orono/01; HSSE 4a/Milford/01

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From: Bernier, Kevin
To: Gail Wippelhauser; Casey.Clark@maine.gov; Mitch Simpson; Daniel McCaw; John.Banks@penobscotnation.org; Harold Peterson; Marchelle M Foster; Antonio Bentivoglio; Kenneth J Hogan; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Bryan Sojkowski; Kathy Howatt; Christopher Sferra; Jason Valliere; Kevin Dunham; John Perry; Julianne Rosset (julianne_rosset@fws.gov); Gallant, Kevin; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov)
Cc: Maloney, Kelly; Brochu, Robert; Cole, James; Drew Trested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: Lower Penobscot juvenile alosine draft study reports
Date: Thursday, December 10, 2020 10:39:00 AM
Attachments: 20201210 Draft Penobscot TBSA Report.pdf
20201210 Draft Penobscot Juv Passage Report.pdf
image001.jpg

Please find attached for your review two draft reports prepared by Normandeau Associates covering juvenile alosine downstream studies conducted this fall at the Milford, Stillwater, and Orono Projects. As you probably recall, these studies resulted from our discussions last winter, whereby the general consensus was to focus on downstream-migrating juvenile alosines in 2020 (after a successful pilot study had been conducted at the West Enfield Project in 2019), followed by evaluations of upstream alosine passage in 2021. FERC had previously provided direction requesting that the studies address data gaps on upstream-migrating adult alosines and downstream-migrating juvenile alosines at these Projects.

Please provide any comments **by January 11, 2021**; I will also be distributing a draft report in the near future on this fall's downstream eel study at the Medway Project. A Teams Meeting will likely then be scheduled in early January to review these reports and answer any questions. In the meantime, please feel free to contact me with any questions.

Kevin Bernier
Senior Compliance Specialist

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kevin.bernier@brookfieldrenewable.com
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From: Bernier, Kevin
To: Clark, Casey; jeff.murphy
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 12:58:00 PM

Black Bear's current deadline for filing the final juvenile alosine study reports with FERC is January 15, 2021. Thus, we would need to get a 30-day time extension from FERC in order provide the additional time for review requested by USFWS, NMFS, and MDMR. Since the push from the resource agencies and PIN in recent years has been for earlier deadlines for finalizing these diadromous fish passage reports, Black Bear is requesting that the other consulting agencies (MDIFW; MDEP; BIA) and PIN weigh in before we make the time extension request to FERC. Thank you.

Kevin Bernier
Senior Compliance Specialist

Brookfield Renewable
C 207 951 5006

From: Clark, Casey
To: jeff.murphy; Bernier, Kevin
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 12:13:30 PM

Hello Kevin,

DMR also supports additional time to review the study reports. And I would like to participate in the early January meeting that USFWS referenced. Can you please share details for the meeting.

-Casey

Casey Clark
Resource Management Coordinator
Maine Department of Marine Resources
Office: (207) 624-6594 (currently forwarding)
Cell: (207) 350-9791
Email: casey.clark@maine.gov
www.maine.gov/dmr/

From: Jeff Murphy - NOAA Federal
To: Bernier, Kevin
Cc: Gail Wippelhauser; Casey.Clark@maine.gov; Mitch Simpson; Rosset, Julianne; Daniel McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow@noaa.gov; Sojkowski, Bryan; Kathy Howatt; Christopher Sferra; Jason Valliere; Kevin Dunham; John Perry; Gallant, Kevin; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov); Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 11:56:34 AM

Hello Kevin - NMFS supports receiving additional time to review the study reports.
Thank you, Jeff.

From: Peterson, Harold S
To: Bernier, Kevin
Cc: Dan McCaw; Mokhtarzadeh, Christina; Frozena, Jennifer L
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 2:17:50 PM

Good afternoon,

After speaking with Penobscot Nation about this request BIA is in support of additional time to review these reports.

Sincerely,
-Harold Peterson

cc: Dan McCaw, PIN
cc: Christina Mokhtarzadeh, BIA
cc: Jennifer Frozena, DOI SOL

From: Rosset, Julianne
To: Bernier, Kevin; Gail Wippelhauser; Casey.Clark@maine.gov; Mitch Simpson; Daniel McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Sojkowski, Bryan; Kathy Howatt; Christopher Sferra; Jason Valliere; Kevin Dunham; John Perry; Gallant, Kevin; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov)
Cc: Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 11:47:22 AM

Hi Kevin,

Thank you for the additional TBSA model information.

Can we please have an additional 30 days to provide comments on the Lower Penobscot juvenile alosine draft study reports? That would be a deadline for comment of Wednesday February 10, 2021. We'd like some time to digest the information that will be presented at the Teams meeting in early January before providing our comments to Brookfield.

Thank you for considering this request.

Kind regards,
Julianne

Julianne Rosset

USFWS Fish and Wildlife Biologist

Migratory Fish/Hydropower

306 Hatchery Road, East Orland, ME 04431

603-309-4842 (cell)

fws.gov/mainefieldoffice/|facebook.com/usfwsnortheast/

From: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Sent: Wednesday, December 16, 2020 8:46 AM
To: Rosset, Julianne <julianne_rosset@fws.gov>; Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov <Casey.Clark@maine.gov>; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org <John.Banks@penobscotnation.org>; Peterson, Harold S <Harold.Peterson@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov <Jeff.Murphy@noaa.Gov>; donald.dow@noaa.gov <donald.dow@noaa.gov>; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>;

Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; dtrested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Julianne – welcome to Maine, and I look forward to working with you. The attached folder contains the archived output files for each TBSA model run included in the draft lower Penobscot juvenile alosine report. As you can see, the file names identify the specific unit(s)/project analyzed; note that the files with just a station name are for the whole station estimates at each location. The outputs include the full set of turbine, route selection, and fish population parameters that were used. Please let us know if there are any additional questions.

Thank you, Kevin Bernier

From: Rosset, Julianne <julianne_rosset@fws.gov>
Sent: Wednesday, December 16, 2020 8:00 AM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; Marchelle M Foster <marchelle.foster@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; dtrested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>

Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hello Kevin,

My name is Julianne Rosset and I am one of the new USFWS Fish and Wildlife Biologists based out of the Maine Field Office in East Orland.

Thank you for providing the 2020 downstream juvenile alosine study results for the Lower Penobscot. After a cursory review, we noticed the TBSA model inputs were not provided. Could Brookfield please provide the parameters utilized within the TBSA model? This will allow the natural resource agencies to clearly understand which turbine units were analyzed and what went into estimating the reported project-survival values.

Thank you,
Julianne

Julianne Rosset

USFWS Fish and Wildlife Biologist

Migratory Fish/Hydropower

306 Hatchery Road, East Orland, ME 04431

603-309-4842 (cell)

fws.gov/mainefieldoffice/|facebook.com/usfwsnortheast/

From: Dan McCaw
To: Bernier, Kevin; Clark, Casey; jeff.murphy
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; John Banks; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Monday, December 21, 2020 2:13:54 PM

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ATTENTION: Ce courriel provient d'une source externe, ne cliquez pas sur les liens et n'ouvrez pas les pièces jointes, à moins que vous en reconnaissiez la source. Veuillez nous aviser ici de tout courriel suspect.

Hello Kevin,

The Penobscot Nation has supported earlier deadlines in the past for the submission of study reports. That effort has been to enable the incorporation of the study results into the development of studies for the next season. The PiN still believes this to be important.

However, we are in a unique position where the FERC coordinator position for USFWS has been recently filled after many months being vacant. If our partners at USFWS, MDMR, and NOAA need additional time in the middle of a global pandemic and a personnel change to review these important studies, the Penobscot Nation will support them. As these studies tie into the quest to establish evaluation criteria for fish passage at all three lower Penobscot projects, it it imperative that adequate time is given to complete the needed consultation.

Thank you for reaching out. Please let me know if you have any questions.

Dan McCaw

From: Howatt, Kathy
To: Bernier, Kevin
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; jeff.murphy; Clark, Casey; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Perry, John; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: Lower Penobscot juvenile alosine draft study reports
Date: Tuesday, December 22, 2020 7:39:47 AM

Good morning Kevin,

The Department supports the resource agencies request for an extension of time to review and comment on the draft Lower Penobscot Juvenile Alosine Study Reports. We have the great pleasure of welcoming Julianne Rosset to the USFWS team and should provide her sufficient time to understand the projects' fish passage facilities as well as to review the report and develop comments. Further, year-end reports and other commitments at this time of year will make a few extra days for our own review welcome. Thank you for considering this request.

Kathy

Kathy Davis Howatt
Hydropower Coordinator, Bureau of Land Resources
Maine Department of Environmental Protection
Phone: 207-446-2642
www.maine.gov/dep

From: Perry, John
To: Bernier, Kevin
Cc: Wippelhauser, Gail; Simpson, Mitch; Rosset, Julianne; Dan McCaw; John.Banks@penobscotnation.org; Peterson, Harold S; Bentivoglio, Antonio; Hogan, Kenneth J; donald.dow; Sojkowski, Bryan; Howatt, Kathy; Sferra, Christopher; Valliere, Jason; Dunham, Kevin; Gallant, Kevin; Ledwin, Sean M; Maloney, Kelly; Brochu, Robert; Cole, James; dtrested; Clark, Casey; jeff.murphy; Stevens, Nate; Michaud, Steve; Macomber, Lance; Osborne, Michael; Mapletoft, Thomas; Kessel, Miranda
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports
Date: Tuesday, December 22, 2020 9:38:24 AM
Attachments: image002.png

Hi Kevin,

MDIFW supports the request for an extension of time to review and comment on the Study Reports.

Thank you,

John

John Perry
Environmental Review Coordinator
Maine Department of Inland Fisheries and Wildlife
284 State Street, 41 SHS
Augusta, Maine 04333-0041
Tel (207) 287-5254; Cell (207) 446-5145
Fax (207) 287-6395
www.mefishwildlife.com

Correspondence to and from this office is considered a public record and may be subject to a request under the Maine Freedom of Access Act. Information that you wish to keep confidential should not be included in email correspondence.

From: Bernier, Kevin [mailto:Kevin.Bernier@brookfieldrenewable.com]
Sent: Monday, January 11, 2021 12:11 PM
To: sean.m.ledwin@maine.gov; mitch.simpson@maine.gov; Casey Clark (casey.clark@maine.gov) <casey.clark@maine.gov>; Gail.Wippelhauser@maine.gov; Jason.Valliere@maine.gov; 'dan.mccaw@penobscotnation.org' <dan.mccaw@penobscotnation.org>; john.banks@penobscotnation.org; harold.peterson@bia.gov; 'bryan_sojkowski@fws.gov' <bryan_sojkowski@fws.gov>; Julianne_Rosset@fws.gov; kenneth_hogan@fws.gov; 'antonio_bentivoglio@fws.gov' <antonio_bentivoglio@fws.gov>; Jeff Murphy - NOAA Federal <jeff.murphy@noaa.gov>; Donald Dow <Donald.Dow@noaa.gov>; John Perry (john.perry@maine.gov) <john.perry@maine.gov>; kevin.dunham@maine.gov; Kevin.Gallant@maine.gov; Kathy Howatt (Kathy.howatt@maine.gov) (Kathy.howatt@maine.gov) <Kathy.howatt@maine.gov>; Christopher Sferra <christopher.sferra@maine.gov>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Dill, Richard <Richard.Dill@brookfieldrenewable.com>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>
Subject: RE: FERC Filing: EOT Request Lower Penobscot Juv Alosine Reports

FERC has approved our time extension request for submittal of the 2020 lower Penobscot diadromous fish passage report (see attached), so the new deadline for the resource agencies and PIN to provide comments on the two draft juvenile alosine downstream study reports (distributed on December 10th) is **February 10, 2021.**

Please let me know if you have any questions.

Kevin Bernier
Senior Compliance Specialist

Brookfield Renewable
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kevin.bernier@brookfieldrenewable.com
www.brookfieldrenewable.com

FEDERAL ENERGY REGULATORY COMMISSION
Washington, D. C. 20426

OFFICE OF ENERGY PROJECTS

Project No. 2534-100--Maine
Milford Hydroelectric Project
Black Bear Hydro Partners, LLC

Project No. 2710-070--Maine
Orono Hydroelectric Project

Project No. 2712-086--Maine
Stillwater Hydroelectric Project
Black Bear Hydro Partners, LLC;
Black Bear SO, LLC; and Black Bear
Development Holdings, LLC

January 11, 2021

VIA FERC Service

Kelly Maloney
License Compliance Manager
Black Bear Hydro Partners, LLC
150 Main Street
Lewiston, ME 04240

Subject: Extension of Time for 2020 Diadromous Fish Passage Report.

Dear Ms. Maloney:

This letter is in response to your 30-day extension of time request, filed December 28, 2020, for your 2020 Diadromous Fish Passage Report. By letter dated March 6, 2020, Commission staff requested you to file your 2020 report by January 15, 2021. You state that your 2020 study plans, titled "Study Plan for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization" and "Study Plan for the Desktop Assessment of Juvenile Alosine Project Passage Survival" were both completed in the fall of 2020. You provided draft reports to the resource agencies and the Penobscot Indian Nation (PIN) on December 10, 2020. The U.S. Fish and Wildlife Service, due to new personnel, requested additional time to review the report, and the other agencies and the PIN agreed to the extension. You are requesting a one-month extension to file your report until February 15, 2021.

Document Accession #: 20210111-3025 Filed Date: 01/11/2021

Your request is reasonable and will provide the resource agencies and the PIN needed time to review and provide comments on the report. Your request is approved. Please file your 2020 Diadromous Fish Passage Report with the Commission by February 15, 2021.

Thank you for your cooperation. If you have any questions regarding this matter, please contact me at (202) 502-8171.

Sincerely,

Andrea Claros

Andrea Claros
Aquatic Resources Branch
Division of Hydropower Administration
and Compliance

From: Rosset, Julianne [mailto:julianne_rosset@fws.gov]
Sent: Wednesday, December 16, 2020 8:00 AM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; Marchelle M Foster <marchelle.foster@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hello Kevin,

My name is Julianne Rosset and I am one of the new USFWS Fish and Wildlife Biologists based out of the Maine Field Office in East Orland.

Thank you for providing the 2020 downstream juvenile alosine study results for the Lower Penobscot. After a cursory review, we noticed the TBSA model inputs were not provided. Could Brookfield please provide the parameters utilized within the TBSA model? This will allow the natural resource agencies to clearly understand which turbine units were analyzed and what went into estimating the reported project-survival values.

Thank you.
Julianne

Julianne Rosset
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From: Rosset, Julianne [mailto:julianne_rosset@fws.gov]
Sent: Wednesday, January 6, 2021 3:36 PM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hi Kevin -

Something that isn't clear to me from the data provided is what turbines were modeled at each Project - all of them? Perhaps that's something we can discuss on the call later this month if the answer isn't straightforward. Also, I saw that an EOT request was filed by Brookfield - should the agencies assume the new due date for our comments on the draft lower Penobscot juvenile alosine report will be February 10th?

Thanks so much.
Julianne

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From: Rosset, Julianne [mailto:julianne_rosset@fws.gov]
Sent: Wednesday, February 10, 2021 12:38 PM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Gail Wippelhauser <Gail.Wippelhauser@maine.gov>; Casey.Clark <Casey.Clark@maine.gov>; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; jeff.murphy@noaa.gov; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.Howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <John.Perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Greetings -

This is the United States Fish and Wildlife Service's (Service) response to the Milford (FERC No. 2534), Stillwater (FERC No. 2712), and Orono (FERC No. 2710) Hydroelectric Project's *Study Report for the Desktop Assessment of Juvenile Alosine Project Survival* and the *Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization* (collectively, Reports) which were both distributed to the resource agencies by Brookfield Renewable (Brookfield) on December 10, 2020. We reviewed the Reports, attended the January 27, 2021 virtual meeting, and have the following comments.

<u>Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization</u>

The Service recommends Brookfield update the passage route utilization report to include the following information:

- At Milford, it was reported that 63% of fish utilized the turbine units as a route of passage but 18% of the fish that approached Milford never passed. Therefore, it should be reported that out of the fish that passed the Milford dam, 77% passed through the units. This also increases the percentage of fish that utilized the downstream bypass from 18% to 21% (these values were reported correctly within the desktop assessment report).
- The Service recommends Brookfield include a table showing project effects associated with impoundment losses versus losses in the natural reach. For example, 18% of fish were lost in the Milford impoundment while fish that passed the Milford dam and moved roughly 1.5 miles downstream saw a loss of only 5%. Please provide a comparison of residence duration and project residence time for fish that passed multiple sites versus a single project (i.e. provide the median project residence time for fish that passed Milford, Stillwater, and Orono, as well as for fish that passed Stillwater and Orono versus fish that just passed Orono, or Stillwater, or Milford). This assessment will aid in the resource agencies understanding of whether or not a cumulative effect to downstream juvenile migration is apparent.
- Please include a map to indicate the locations where fish were released above the Milford, Stillwater, and Orono projects.

<u>Study Report for the Desktop Assessment of Juvenile Alosine Project Passage Survival</u>

Juvenile alosine passage occurred primarily via the turbine units at Milford (63%), while only 18% used the existing downstream bypass facility (specifically the surface bypass on the river side of the powerhouse). At Stillwater, 48% of the released juvenile alosines passed via the turbine units, while only 42% used the existing downstream bypass facility. At Orono, 25% of the released juvenile alosines passed via the turbines while 60% used the existing downstream bypass.

The Service notes, as discussed at the January 27, 2021 meeting, the desktop assessment does not account for injury, latent mortality, or cumulative mortality of alosine species; rather the desktop assessment is an estimate of immediate survival.

Thank you for this opportunity to comment. The Service looks forward to working with Brookfield to develop the 2021 Diadromous Fish Passage Study Plan in a timely manner so that studies can be performed in the 2021 fish passage season.

Kind regards,
Julianne

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From: Jeff Murphy - NOAA Federal [mailto:jeff.murphy@noaa.gov]
Sent: Wednesday, February 10, 2021 3:48 PM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Cc: Rosset, Julianne <julianne_rosset@fws.gov>; Gail Wippelhauser <Gail.Wippelhauser@maine.gov>; Casey.Clark <Casey.Clark@maine.gov>; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.Howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <John.Perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Hello Kevin - Thanks for seeking NMFS' comments on the draft Study Report for the Desktop Assessment of Juvenile Alosine Project Survival and the draft Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization. We concur with USFWS' comments submitted earlier today and offer several additional comments.

- The juvenile alosine route utilization study at Milford, Orono, and Stillwater was well conducted and we support the report's findings. As indicated in the report, turbine passage is by far the most utilized route of downstream passage for juvenile alosines at the Milford Project (77%). Downstream passage via turbines was also a significant route of passage for juvenile herring at Stillwater (48%) and Orono (25%). Based upon these results, we can conclude that the 1" trashracks installed at each project are not highly effective in preventing turbine passage of small fish (<150 mm).
- As noted by the USFWS, the desktop assessment of juvenile alosine survival at Milford, Orono, and Stillwarer does not account for injury, latent mortality, or cumulative mortality of alosine species. These factors in addition to immediate mortality of downstream migrating alosines must be quantified through actual field studies in order for the resource agencies to assess the impacts of operating the projects on our restoration goals for the Penobscot River. Otherwise, the best available information that we presently have demonstrates that turbine passage at the projects is the most dangerous route of passage presently available for downstream migrants and must be minimized through project operation or structural changes.
- We appreciate your willingness to work with us to meet our goals of safe, timely, and effective passage for downstream migrants at your lower projects in the Penobscot River. Based upon our call today, I understand that we will have further opportunities to identify additional downstream assessments at the projects and/or mitigation measures going forward.

Please don't hesitate to contact me with any questions concerning these comments. Thank you, Jeff.

From: Clark, Casey [mailto:Casey.Clark@maine.gov]
Sent: Wednesday, February 10, 2021 5:40 PM
To: jeff.murphy <jeff.murphy@noaa.gov>; Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Cc: Rosset, Julianne <julianne_rosset@fws.gov>; Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; Simpson, Mitch <Mitch.Simpson@maine.gov>; Dan McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; donald.dow <Donald.Dow@noaa.gov>; Sojkowski, Bryan <bryan_sojkowski@fws.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>; Sferra, Christopher <Christopher.Sferra@maine.gov>; Valliere, Jason <Jason.Valliere@maine.gov>; Dunham, Kevin <Kevin.Dunham@maine.gov>; Perry, John <John.Perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>
Subject: RE: [EXTERNAL] Lower Penobscot juvenile alosine draft study reports

Dear Kevin:
I have reviewed the Draft Study Report for the Draft Study Report for the 2020 Evaluation of Downstream Juvenile Alosine Passage Route Utilization and the Desktop Assessment of Juvenile Alosine Project Survival (collectively, Reports) for the Milford (FERC No. 2534), Stillwater (FERC No. 2712), and Orono (FERC No. 2710) Hydroelectric Projects for the Department of Marine Resources. Thank you for the opportunity to comment on these draft study reports. I also concur with the comments of USFWS and NOAA earlier today.

<u>Route of passage Study comments:</u>
We request that you include a written description of each of the release locations and include GPS coordinates for each. In addition, we request that you include a map or diagram that clearly labels the release locations and the routes of passage for each project. Finally, we also request that you include a table or written description of distance from release location to each route of passage location. As some routes of passage are a wide area, as opposed to a narrow point, we request that you mark the minimum and maximum distance from the release location to the edges of these routes of passage.

In section 4.4-4.6, you report route of passage for study fish that were released above Stillwater and passed Stillwater, fish that were released above Orono and passed Orono, and fish that were released above Milford and passed Milford. We request that you also report on all results for fish that were released above Stillwater in regards to their detections at the Orono project including but not limited to the following metrics:

- approach time from Stillwater to Orono,
- project residence time,
- downstream passage route selection for both Stillwater and Orono,
- percent success of passage at Orono for all fish that successfully passed Stillwater,
- detections downstream of Orono
- and any other metrics that you can report

We also request that you perform an appropriate statistical test of significant difference (E.g. T-test) to compare the results for the fish that were released above Orono in regards to their passage of Orono and the fish that were released above Stillwater in regards to their passage of Orono. Please report the method and results of these tests.

The size of the juvenile alosines captured for this study (total length 113-144mm) was limited due to the constraints of the tagging method. That size constraint did not allow the study to include smaller juvenile alosines (40mm-100mm) that migrate past the three projects in the lower Penobscot. As a 40mm alosine does not have the same swimming ability of larger fish, we have to assume that route of passage would differ for this smaller size class. We request that you include a statement in the study report to describe bias in the study results due to the size constraint of the study fish.

Juvenile alosines (age zero alewife, blueback herring, and American Shad) have been documented by NOAA in the Penobscot estuary. In brief, juvenile alosines are present in the Penobscot Estuary starting in July (30-40mm fish) and are seen through the end of sampling in September (>120mm fish). Data from other rivers indicate that juveniles reach total lengths in excess of 150mm in late fall. Data from the work is available in following publication:
Justin R. Stevens, Rory Saunders and William Duffy. (2019). Evidence of Life Cycle Diversity of River Herring in the Penobscot River Estuary, Maine USA.

TBSA Model comments:
In Section 5, the report states, "the observed route selection probabilities for each Project were imported into a project-specific, multi-route TBSA model to evaluate the predicted whole-station survival for a population of 1,000 3.5 inch (S.D.±1.0 inches) fish." However the TBSA model only estimates immediate mortality associated with blade strike. We request that you include the following statement to more accurately describe the context of the results of this study. "This study is an estimation of immediate mortality from turbine strike and does not estimate other potential sources of immediate mortality (E.g. barotrauma, shear force) nor does it estimate injury, latent mortality, or indirect impacts to fish such as predation. As such the results of this study can only be interpreted as minimum estimates of mortality at each project."

Passage selection is the most important aspect of downstream passage survival. While the TBSA model estimates blade strike mortality, the impact of pressure and shear-force is much greater than turbine strike, especially on smaller fish such as juvenile alosines.

The study states, "When at full capacity (i.e., 6,730 cfs) and at normal pond elevation, the calculated intake velocity at Milford is 1.5 ft/sec." For the entirety of the modeling exercise, Milford was assumed to be at "normal pond & full generation" the intake velocity was assumed to be 1.5 ft/sec. However, Milford was not at full capacity for 3 out of the 5 release groups (3037; 4050; 7796; 6220; and 6892 cfs respectively for each release group as reported in table 4-1 of the route of passage study) and Milford was not at full generation as reported in section 4.1 of the route of passage study. We request that you correct the language in the last paragraph of Section 6 to more accurately describe flow and generation conditions.

The study also states, "Flows conditions lower than those observed during the 2020 field evaluation would likely result in reduced generation and prioritization of most efficient units." We request that you include a description of the "most efficient units" for each project and a summary of how they are prioritized.

In Section 5-2 and 5-3 you include results for fish that passed the Stillwater and Orono projects, separately. We request that you include results for fish that were released above Stillwater, passed Stillwater, and subsequently passed Orono. We request that you report these results separate from results already reported. We also request that you perform an appropriate statistical test of significant difference (E.g. T-test) to compare the results for the fish that were released above Orono in regards to their passage of Orono and the fish that were released above Stillwater in regards to their passage of Orono. Please report the method and results of these tests.

Regards,
Casey

Casey Clark
Resource Management Coordinator
Maine Department of Marine Resources
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Written comments on the draft desktop assessment of juvenile alosine passage survival study report were provided by MDMR, USFWS, MDEP and NMFS. Questions or requests related to the technical draft report are reproduced here along with the associated responses.

Question 1: *Could Brookfield please provide the parameters utilized within the TBSA model? This will allow the natural resource agencies to clearly understand which turbine units were analyzed and what went into estimating the reported project-survival values.*

Response 1: The licensees provided a zip folder containing all archived model runs from the TBSA reporting effort to the resource agencies and the PIN on December 16, 2020.

Question 2: *Something that isn't clear to me from the data provided is what turbines were modeled at each Project - all of them?*

Response 2: Yes, Section 4.0 of the report contains estimates of turbine passage survival for all turbines at each Project. Where specific turbine parameters were identical for one or more turbines at a Project, a single estimate was prepared and considered representative of the group.

Question 3: *In Section 5, the report states, "the observed route selection probabilities for each Project were imported into a project-specific, multi-route TBSA model to evaluate the predicted whole-station survival for a population of 1,000 3.5 inch (S.D.±1.0 inches) fish." However the TBSA model only estimates immediate mortality associated with blade strike. We request that you include the following statement to more accurately describe the context of the results of this study. "This study is an estimation of immediate mortality from turbine strike and does not estimate other potential sources of immediate mortality (E.g. barotrauma, shear force) nor does it estimate injury, latent mortality, or indirect impacts to fish such as predation. As such the results of this study can only be interpreted as minimum estimates of mortality at each project."*

Response 3: A statement has been added to Section 5.0 of the report.

Question 4: *The study states, "When at full capacity (i.e., 6,730 cfs) and at normal pond elevation, the calculated intake velocity at Milford is 1.5 ft/sec." For the entirety of the modeling exercise, Milford was assumed to be at "normal pond & full generation" and the intake velocity was assumed to be 1.5 ft/sec. However, Milford was not at full capacity for 3 out of the 5 release groups (3037; 4050; 7796; 6220; and 6892 cfs respectively for each release group as reported in table 4-1 of the route of passage study), and Milford was not at full generation as reported in section 4.1 of the route of passage study. We request that you correct the language in the last paragraph of Section 6 to more accurately describe flow and generation conditions.*

Response 4: Clarification has been added to the last paragraph of Section 6.

Question 5: *The study also states, "Flow conditions lower than those observed during the 2020 field evaluation would likely result in reduced generation and prioritization of most efficient units." We request that you include a description of the "most efficient units" for each project and a summary of how they are prioritized.*

Response 5: Pursuant to the O&M plans for each Project, the units are prioritized for fish passage efficiency. Please see the response to Question 6 in Appendix A.

Question 6: *In Section 5-2 and 5-3 you include results for fish that passed the Stillwater and Orono projects, separately. We request that you include results for fish that were released above Stillwater, passed Stillwater, and subsequently passed Orono. We request that you report these results separate from results already reported.*

Response 6: The Orono whole station survival model presented in Section 5.3 of the draft report was rerun to assess route selection information for radio-tagged juvenile alosines originally released upstream of Stillwater. The TBSA model inputs are provided in Table B-1 below, and the output is summarized in Table B-2. The mean estimate of whole station survival for those individuals based on five simulations was 96.4%. Although the route selection probabilities varied, the mean estimate of whole station survival at Orono based on tagged fish released upstream of Stillwater Dam did not.

Table B-1. Route selection probabilities and non-turbine route mortality estimates used to inform the TBSA model for estimation of whole station survival of 3.5 inch (S.D.±1.0 inches) fish originally released upstream of Stillwater at Orono.

Route	Route Selection Probability[1]	Estimated Mortality[2]
Powerhouse A	0%	-
Powerhouse B	32.8%	-
Bypass	54.7%	3.4
Spill	12.5%	1.6

1 - Taken from Normandeau 2020c
2 - Estimated from previously conducted empirical studies

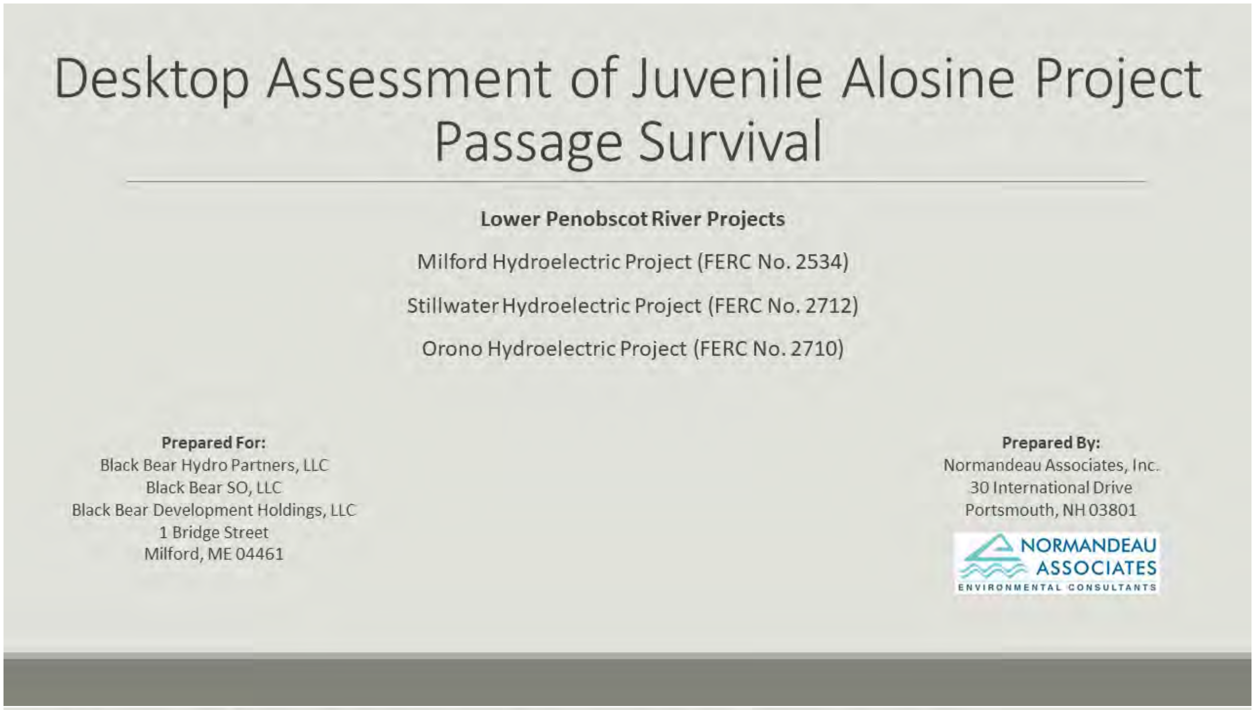
Table B-2. TBSA estimated whole station survival (% strike, % bypass fail, and % pass) for 3.5 inch (S.D.±1.0 in.) sized fish originally released upstream of Stillwater at Orono.

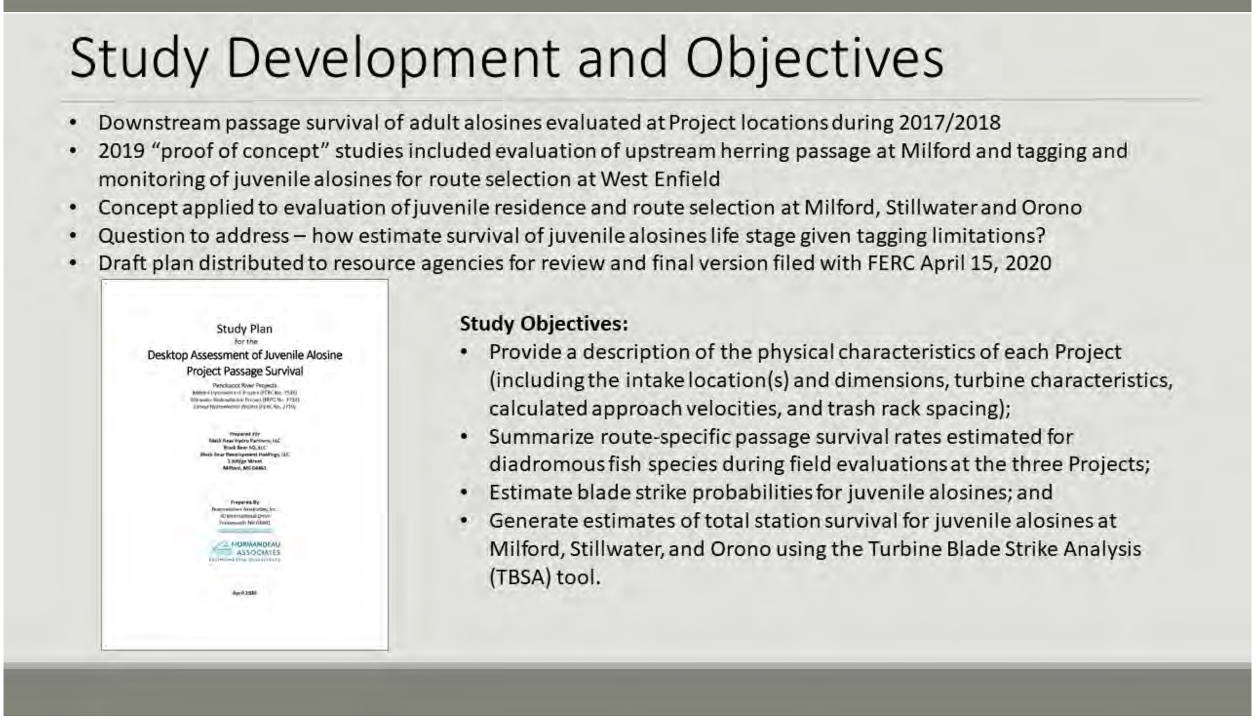
Trial No.	Orono Whole Station Survival		
	% Strike	% Bypass Fail	% Pass
1	1.2	2.4	96.4
2	1.4	2.1	96.5
3	1.0	1.6	97.4
4	1.6	2.6	95.8
5	1.7	2.5	95.8
Mean	1.4	2.2	96.4

Question 7: *We also request that you perform an appropriate statistical test of significant difference (E.g. T-test) to compare the results for the fish that were released above Orono in regards to their passage of Orono and the fish that were released above Stillwater in regards to their passage of Orono. Please report the method and results of these tests.*

Response 7: A two sample t-test was conducted to compare Stillwater and Orono-released fish for statistical significance. Residence duration and downstream transit times were not found to be statistically significant between groups ($p = 0.88$ and $p = 0.30$, respectively). To compare route selection between groups, a chi-squared test for categorical variables was conducted. Route selection was found to differ significantly between the two groups ($p < 0.01$).

Appendix C. PowerPoint presentation slides from the January 27, 2021 resource agency and PIN study discussion meeting.





Project Descriptions

Milford:

- Downstream bypass facility with 2 surface entrances and 1 submerged entrance
- Single powerhouse with six generating turbines (propeller or Kaplan style units)
- One-inch rack spacing
- Intake velocity (at normal pond & full generation) = 1.5 fps
- Spill via waste gate, inflatable bladder sections

Orono:

- Two powerhouses
  - A has four Francis style units
  - B has three propeller or Kaplan style units
- Downstream bypass facility with surface and lower entrances
- One-inch rack spacing
- Intake velocity (at normal pond & full generation) = 1.5-1.6 fps
- Spill via overflow of flashboard sections

Stillwater:

- Two powerhouses
  - A has four Francis style units
  - B has three propeller or Kaplan style units
- Downstream bypass facilities with surface and lower entrances at both powerhouse A and B
- One-inch rack spacing
- Intake velocity (at normal pond & full generation) = 1.1-1.3 fps
- Spill via overflow of flashboard sections

Project Facility	Milford	Stillwater A	Stillwater B	Orono A	Orono B
Normal headpond elevation (ft)	101.7	94.65	94.65	73	73
Intake rack position	Full Depth	Full Depth	Full Depth	Full Depth	Full Depth
Intake rack width (ft)	177.4	69.6	84.0	70.0	94.8
Intake rack height (ft)	24.5	19.4	19.1	15.1	15.1
Intake rack area (ft²)	4346	1350	1604	1057	1431
Intake rack clear spacing (in)	1.0	1.0	1.0	1.0	1.0
Calculated approach velocity ft/sec	1.5	1.3	1.1	1.6	1.5

Project Descriptions

	Milford					
Turbine ID	1	2	3	4	5	6
Turbine Type	Vertical Propeller	Vertical Propeller	Fixed Blade Propeller	Kaplan	Kaplan	Kaplan
Number of Blades	4	4	4	4	4	4
Runner Diameter (ft)	5.6	5.6	9.1	9.1	9.1	9.1
Head (ft)	18	18	20	20	20	20
Rotational Speed (rpm)	257	257	120	120	120	120
Max Discharge (cfs)	550	550	1370	1420	1420	1420

	Stillwater A				Stillwater B		
Turbine ID	1	2	3	4	1	2	3
Turbine Type	Francis	Francis	Francis	Francis	Kaplan	Vertical Propeller	Vertical Propeller
Number of Blades	14	14	14	14	4	4	4
Runner Diameter (ft)	3.5	3.5	3.5	3.5	5.6	5.6	5.6
Runner Diameter at Inlet (ft)	2.5	2.5	2.5	2.5	n/a	n/a	n/a
Runner Diameter at Discharge (ft)	3.5	3.5	3.5	3.5	n/a	n/a	n/a
Runner Height (ft)	2.6	2.6	2.6	2.6	n/a	n/a	n/a
Head (ft)	19	19	19	19	18.75	18.75	18.75
Rotational Speed (rpm)	150	150	150	180	300	300	300
Max Discharge (cfs)	380	380	380	560	586	586	586

	Orono A				Orono B		
Turbine ID	1	2	3	4	1	2	3
Turbine Type	Francis	Francis	Francis	Francis	Kaplan	Vertical Propeller	Vertical Propeller
Number of Blades	14	14	14	14	4	4	4
Runner Diameter (ft)	2.8	2.8	3.6	3.6	5.6	5.6	5.6
Runner Diameter at Inlet (ft)	1.6	1.6	2.6	2.6	n/a	n/a	n/a
Runner Diameter at Discharge (ft)	2.8	2.8	3.6	3.6	n/a	n/a	n/a
Runner Height (ft)	2.6	2.6	2.6	2.6	n/a	n/a	n/a
Head (ft)	25	25	25	25	26.5	26.5	26.5
Rotational Speed (rpm)	225	220	225	212	300	300	300
Max Discharge (cfs)	370	370	500	500	694	694	694

Key Parameters:

- Turbine type
- No. blades
- Runner diameter
- Rotational speed
- Capacity (cfs)

Existing Empirical Data

- TBSA report provides summary tables of previously conducted downstream passage studies for diadromous species at Milford, Stillwater and Orono
- Studies conducted since 2015 and included salmon, shad, herring and eels
- Summary tables developed to provide proportional distribution among potential passage routes and the associated survival estimates for fish using those routes
- Observations of bypass survival were required for incorporation into models for estimation of juvenile alosines survival

Blade Strike Probabilities

- Utilized USFWS TBSA desktop tool to look at blade strike probability at each turbine type at Milford, Stillwater and Orono
  - Grouped units at a Project where physical parameters were the same
- Discharge was held constant and was run at an assumed maximum capacity value for each turbine
- Used a standardized "population" of juvenile sized fish (mean length = 3.5 inches with SD = 1.0 inches)
- Utilized most conservative correlation value (i.e., 0.2)
- Assigned a qualitative survival ranking of High (>85%), Moderate (85-70%) or Low (<70%)

Blade Strike Probabilities - Milford

Milford Turbine Units						
	1 or 2		3		4, 5, or 6	
Trial No.	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass
1	4.5	95.5	3.0	97.0	2.0	98.0
2	4.6	95.4	2.9	97.1	2.4	97.6
3	4.4	95.6	2.8	97.2	2.3	97.7
4	3.9	96.1	3.0	97.0	2.8	97.2
5	2.8	97.2	3.1	96.9	3.0	97.0
Mean	4.0	96.0	3.0	97.0	2.5	97.5
Qualitative Survival Rating	High		High		High	

Milford:

- Vertical propeller (1/2), fixed blade (3), and Kaplan (4/5/6) units
- Expected blade strike rates ranged from 2.5-4.0%
- Passage survival rated as "High" for all units (96-97.5%)

Blade Strike Probabilities - Stillwater

	A1, A2, A3		A4		B1		B2 or B3	
Trial No.	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass
1	18.1	81.9	20.8	79.2	4.7	95.3	4.2	95.8
2	18.2	81.8	17.6	82.4	5.2	94.8	7.1	92.9
3	13.9	86.1	18.9	81.1	6.4	93.6	4.7	95.3
4	15.8	84.2	21.9	78.1	5.0	95.0	6.3	93.7
5	20.3	79.7	16.8	83.2	3.6	96.4	4.7	95.3
Mean	17.3	82.7	19.2	80.8	5.0	95.0	5.4	94.6
Qualitative Survival Rating	Moderate		Moderate		High		High	

Stillwater:

- Powerhouse A – Francis turbines
- Passage survival rated as "Moderate" for Powerhouse A turbines (80.8-82.7%)
- Powerhouse B – Kaplan (1) and vertical propeller (2/3)
- Passage survival rated as "High" for Powerhouse B turbines (94.6-95.0%)

Blade Strike Probabilities - Orono

Orono Turbine Units												
	A1		A2		A3		A4		B1		B2 or B3	
Trial No.	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass	% Strike	% Pass
1	23.6	76.4	23.9	76.1	20.8	79.2	20.4	79.6	5.3	94.7	4.4	95.6
2	24.3	75.7	22.8	77.2	21.7	78.3	22.6	77.4	2.9	97.1	5.9	94.1
3	24.0	76.0	18.6	81.4	22.6	77.4	17.4	82.6	3.6	96.4	4.6	95.4
4	21.5	78.5	21.8	78.2	17.4	82.6	23.1	76.9	5.7	94.3	4.4	95.6
5	25.4	74.6	24.6	75.4	20.1	79.9	17.3	82.7	3.7	96.3	5.1	94.9
Mean	23.8	76.2	22.3	77.7	20.5	79.5	20.2	79.8	4.2	95.8	4.9	95.1
Qualitative Survival Rating	Moderate		Moderate		Moderate		Moderate		High		High	

Orono:

- Powerhouse A – Francis turbines
- Passage survival rated as "Moderate" for Powerhouse A turbines (76.2-79.5%)
- Powerhouse B – Kaplan (1) and vertical propeller (2/3)
- Passage survival rated as "High" for Powerhouse B turbines (95.1-95.8%)

Total Station Estimates

- Utilized USFWS TBSA desktop tool to develop a Project-specific multi-route total station survival estimate for juvenile alosines at Milford, Stillwater and Orono
- Proportional passage route data obtained from 2020 field studies
- Empirical study results used to inform passage survival rates for bypass and spill
    - generated from previous studies of salmonids or alosines with a route usage sample size of 10 or more individuals
- Relied on turbine estimates for survival based on project-specific parameter set

Total Station Estimates - Milford

Empirical inputs:

Route	Route Selection Probability[1]	Estimated Mortality[2]
Spill	2.0%	2.0
DS Bypass	21.4%	3.3
Units 1-2	0.0%	*
Units 3-6	76.5%	*

* Generated in TBSA based on station parameters

TBSA Output:

Trial No.	Milford Whole Station Survival % Strike	% Bypass Fail	% Pass
1	2.0	0.4	97.6
2	2.0	0.5	97.5
3	2.0	1.0	97.0
4	2.0	0.6	97.4
5	2.4	1.2	96.4
Mean	2.1	0.7	97.2

Milford:

- Estimated passage success = 97.2%
- Estimated loss due to strike = 2.1%
- Estimated loss to spill/bypass = 0.7%

Total Station Estimates - Stillwater

Empirical inputs:

Route	Route Selection Probability[1]	Estimated Mortality[2]
Powerhouse A	46.8%	*
Powerhouse B	6.4%	*
Bypass A	9.6%	2.8
Bypass B	37.2%	0.0
Spill	0.0%	3.6

* Generated in TBSA based on station parameters

TBSA Output:

Trial No.	Stillwater Whole Station Survival % Strike	% Bypass Fail	% Pass
1	6.3	0.0	93.7
2	8.1	0.3	91.6
3	9.3	0.0	90.7
4	7.2	0.4	92.4
5	11.3	0.0	88.7
Mean	8.4	0.1	91.4

Stillwater:

- Estimated passage success = 91.4%
- Estimated loss due to strike = 8.4%
- Estimated loss to spill/bypass = 0.1%

Total Station Estimates - Orono

Empirical inputs:

Route	Route Selection Probability[1]	Estimated Mortality[1]
Powerhouse A	0.7%	*
Powerhouse B	24.3%	*
Bypass	66.9%	3.4
Spill	8.1%	1.6

* Generated in TBSA based on station parameters

TBSA Output:

Trial No.	Orono Whole Station Survival		
	% Strike	% Bypass Fail	% Pass
1	0.3	1.9	97.8
2	1.5	2.7	95.8
3	1.1	2.7	96.2
4	0.9	2.8	96.3
5	1.7	2.3	96.0
Mean	1.1	2.5	96.4

Orono:

- Estimated passage success = 96.4%
- Estimated loss due to strike = 1.1%
- Estimated loss to spill/bypass = 2.5%

Summary

- Desktop evaluation conducted to build on findings from telemetry assessment of passage route utilization – generate estimates of passage survival which are not attainable from field evaluation due to uncertainty of tag retention
- Milford (97.2%) driven by observed usage of downstream bypass facility and the "old" turbines 3, 4, 5 and 6
  - TBSA rates for those units classified as "High" (97-97.5%)
  - Mean downstream bypass survival from previous diadromous studies = 96.7%
- Stillwater (91.4%) driven by observed usage of powerhouse A and downstream bypass facility at powerhouse B
  - TBSA rates for the Francis style units in powerhouse A classified as "moderate" (80.8-82.7%)
  - Survival for powerhouse B bypass facility at 100% for studies since modifications conducted following 2016 smolt study
- Orono (96.4%) driven by high relative use of downstream bypass and powerhouse B
  - TBSA rates for powerhouse B units classified as "High" (95.1-95.8%)
  - Mean downstream bypass survival from previous diadromous studies = 96.6%
- 2020 routing study characterized usage during a range of flows representative of October conditions between 75 and 25% of the time
  - Lower flow conditions would result in less generation and prioritization of most efficient units
  - Higher flow conditions would result in more generation and subsequent spill flows once capacity is reached

FERC Points: Delay
Operational Conditions
Effectiveness Criteria

Project	Study Year	Study Dates	Species	Life Stage	Analysis Type	Passage Direction	Passage Survival/Success		Residence Duration				General River Conditions	General Operational Conditions	Unique Operational Conditions	Key Agency Comments Related to Study Findings	Consultant
							Estimate	Confidence Interval	Minimum	Median	Maximum	Fate					
Milford	2020	Oct 13- Nov 15	**River Herring**	Juvenile	Quantitative	**Downstream**	97.2%	-	P25 = 1.5hr	1.8 hr	P75=3.2hr	Passed downstream	Penobscot Flows 3,000-20,500 cfs during study period.	River flow below station capacity for R1 & R2, and above station capacity R3, R4, R5.Downstream bypass (bays 2 and 7, low level) passing >300 cfs combined. Units 5/6 on entire duration, Units 1/2 for R3, R4, R5. Per flow O&M plan spill flow passed first through waste gate and then via obermyer	Radio telemetry passage route study combined with turbine blade strike analysis desk top study to produce survival estimate. 63% through Units 3-6, 18% via Bay 2 DS Passage.		Normandeau
Milford	2015	May 27 - August	**River Herring**	Adult	Quantitative	**Upstream**	16.7%	**estimated from 1 of 6 tagged RH which approached dam and passed US*	-	-	-	Passed Upstream	Not reported	Not reported		Seasonal tagging of timing likely a factor in poor study results	Kleinschmidt
Milford	2019	May 8 - June 30	**Alewife**	Adult	Quantitative	**Upstream**	65.1%	95% CI = 56.9-73.8%	0.5 hr 0.4 hr	19.2 d 6.0 d	25.3 hr 20.1 hr	Did not pass upstream Passed upstream	Penobscot flows 5,760-38,900 cfs (mean = 18.3 kcfs during study period)	River flow in excess of station capacity during May and first third of June; fish lift entrance flow = 190-210 cfs, entrance velocity = 4-6 ft/s, depth over entrance gate = >3.0 ft, hopper velocity = 1-1.5 ft/s		Findings suggested potential defficiency with internal lift effectiveness (i.e., rate of passage from entrance to hopper and hopper to upper flume). Indicated potential collection of additional data in future.	Normandeau
Milford	2017	June 13-Aug 15	**American Shad**	Adult	Quantitative	**Downstream**	76.6%	75% CI = 71.1-82.2%	0.3 hr	1.6 d	25.3 d	Passed downstream	Penobscot flows 2,960-15,500 cfs (mean = 6,750 cfs). Mean flow trended downward June to August (8,200 - 3,700 cfs)	River flow periodically in excess of station capacity; outflow at project via turbines, downstream bypasses (~500 cfs), and upstream fishway (~200 cfs); periodic spill via sluice gate or Obermeyer due to fish passage ops or curtailments. Headpond operated ~1ft below normal June 20-Aug 3 and ~3.5 ft below normal after Aug 3 for spillway breach repair operation.		The estimated survival and forebay residence duration for adult shad at Milford suggested additional measures may be necessary to help protect outmigrants.	Normandeau
Milford	2018	June-July	**American Shad**	Adult	Quantitative	**Downstream**	86.2%	75% CI = 82.4-89.9%	0.6 hr	1.1 d	23.5 d	Passed downstream	Penobscot flows 3,350-8,870 cfs (mean = 5,530 cfs during study period)	River flow rarely in excess of station capacity; outflow at project via turbines, downstream bypasses (~500 cfs), and upstream fishway (~200 cfs); periodic spill via sluice gate or Obermeyer due to fish passage ops or curtailments.	"Shad Windows" installed in outer grizzley rack upstream of powerhouse intake/downstream bypass entrances	Findings indicated a potentail issue during downstream passage through the downstream bypass in Bay #7. Following this evaluation the Licensee dewatered the DSB and repaired a damaged section of the exit pipe.	Normandeau
Milford	2018	June-July	**Alewife**	Adult	Quantitative	**Downstream**	86.1%	75% CI = 82.1-89.7%	0.6 hr	0.6 d	11.8 d	Passed downstream	Penobscot flows 3,350-8,870 cfs (mean = 5,530 cfs during study period)	River flow rarely in excess of station capacity; outflow at project via turbines, downstream bypasses (~500 cfs), and upstream fishway (~200 cfs); periodic spill via sluice gate or Obermeyer due to fish passage ops or curtailments.	"Shad Windows" installed in outer grizzley rack upstream of powerhouse intake/downstream bypass entrances	Findings indicated a potentail issue during downstream passage through the downstream bypass in Bay #7. Following this evaluation the Licensee dewatered the DSB and repaired a damaged section of the exit pipe.	Normandeau
Milford	2016	September-October	**American Eel**	Adult	Quantitative	**Downstream**	90.0%	-	0.1 hr	1.2 d	23.9 d	Passed downstream	Penobscot flows 2,520-5-960 cfs (mean = 4,042 cfs).	"Normal" operations for river conditions.	Although river flow low, spill was available at Milford for all but 16 days of the study period	Possible mortality issue associated with ledges downstream of spillway; passage delay a concern	HDR
Stillwater	2020	Oct 13- Nov 15	**River Herring**	Juvenile	Quantitative	**Downstream**	91.4%	-	P25 = 0.5hr	1.1 hr	P75=6.9hr	Passed downstream	Penobscot Flows 3,000-20,500 cfs during study period.	River flow below station capacity for R1 & R2, and above station capacity R3, R4, R5.Downstream bypass (SWA and SWB) passing 70 cfs each. Spill flows passed over spillway flashboards. SWA turbines offline for R1/R2. SWB Unit 1 prioritized according to Flow O&M plan.	Radio telemetry passage route study combined with turbine blade strike analysis desk top study to produce survival estimate		Normandeau
Stillwater	2017	June 13-Aug 15	**American Shad**	Adult	Quantitative	**Downstream**	95.8%	75% CI = 91.7-97.9%	0.4 hr	4.7 d	17.2 d	Passed downstream	Penobscot flows 2,960-15,500 cfs (mean = 6,750 cfs). Mean flow trended downward June to August (8,200 - 3,700 cfs)	River flow less than combined Powerhouse A/B capacity for most of study period; generation at Powerhouse A/B for most of period; Downstream bypasses A/B open and passing ~70 cfs; flashboards in place; spill flow limited to overtopping and leakage.		Forebay residence prior to downstream passage was relatively long at Stillwater.	Normandeau
Stillwater	2018	June-July	**American Shad**	Adult	Quantitative	**Downstream**	94.7% *	**estimated from 18 of 19 tagged shad which approached dam*	0.2 hr	0.3 d	5.9 d	Passed downstream	Penobscot flows 3,350-8,870 cfs (mean = 5,530 cfs during study period)	River flow less than combined Powerhouse A/B capacity for most of study period; generation at Powerhouse A/B for most of period; Downstream bypasses A/B open and passing ~70 cfs; flashboards in place; spill flow limited to overtopping and leakage.			Normandeau
Stillwater	2018	June-July	**Alewife**	Adult	Quantitative	**Downstream**	94.6%	75% CI = 92.4-97.8%	0.1 hr	0.4 d	10.8 d	Passed downstream	Penobscot flows 3,350-8,870 cfs (mean = 5,530 cfs during study period)	River flow less than combined Powerhouse A/B capacity for most of study period; generation at Powerhouse A/B for most of period; Downstream bypasses A/B open and passing ~70 cfs; flashboards in place; spill flow limited to overtopping and leakage.			Normandeau

Project	Study Year	Study Dates	Species	Life Stage	Analysis Type	Passage Direction	Passage Survival/Success		Residence Duration				General River Conditions	General Operational Conditions	Unique Operational Conditions	Key Agency Comments Related to Study Findings	Consultant
							Estimate	Confidence Interval	Minimum	Median	Maximum	Fate					
Stillwater	2016	September-October	**American Eel**	Adult	Quantitative	**Downstream**	92.0%	-	0.1 hr	1.8 hr	48.6 d	Passed downstream	Penobscot flows 2,520-5-960 cfs (mean = 4,042 cfs).	"Normal" operations for river conditions.	Although river flow low, spill was available at Stillwater for all but 10 days of the study period	22% of eels passed Stillwater via Powerhouse A and half died during passage. Exising one inch rack spacing was not successful and Licensee should inspect racks to gaps or bends which allowed eels to enter; passage delay a concern.	HDR
Orono	2015	May 27 - August	**River Herring**	Adult	Quantitative	**Upstream**	0.0%	**estimated from 0 of 8 tagged RH which approached dam*	-	-	-	Passed Upstream	Not reported	Not reported		Seasonal tagging of timing likely a factor in poor study results	Kleinschmidt
Orono	2020	Oct 13- Nov 15	**River Herring**	Juvenile	Quantitative	**Downstream**	96.4%	-	P25 = 0.3hr	0.5 hr	P75=0.8hr	Passed downstream	Penobscot Flows 3,000-20,500 cfs during study period.	River flow below station capacity for R1 & R2, and above station capacity R3, R4, R5.Downstream bypass operated at 200 cfs. Spill flows passed over spillway flashboards. ORA turbines offline for R1/R2/R3. ORB Unit 1 prioritized according to Flow O&M plan.	Radio telemetry passage route study combined with turbine blade strike analysis desk top study to produce survival estimate		Normandeau
Orono	2017	June 13-Aug 15	**American Shad**	Adult	Quantitative	**Downstream**	87.0%	75% CI = 82.4-91.2%	0.3 hr	1.6 d	15.0 d	Passed downstream	Penobscot flows 2,960-15,500 cfs (mean = 6,750 cfs). Mean flow trended downward June to August (8,200 - 3,700 cfs)	River flow less than combined Powerhouse A/B capacity for most of period; generation at Powerhouse A/B during study; Downstream bypass open (~150 cfs); flashboards in place; spill flow limited to overtopping or leakage.			Normandeau
Orono	2018	June-July	**American Shad**	Adult	Quantitative	**Downstream**	94.4% *	**estimated from 17 of 18 tagged shad which approached dam*	0.2 hr	8.1 hr	2.0 d	Passed downstream	Penobscot flows 3,350-8,870 cfs (mean = 5,530 cfs during study period)	River flow less than combined Powerhouse A/B capacity for most of period; generation primarily at Powerhouse B during study; Downstream bypass open (~150 cfs); spill present through missing flashboards prior to June 19.			Normandeau
Orono	2018	June-July	**Alewife**	Adult	Quantitative	**Downstream**	97.8%	75% CI = 96.0-98.8%	0.1 hr	2.1 hr	3.6 d	Passed downstream	Penobscot flows 3,350-8,870 cfs (mean = 5,530 cfs during study period)	River flow less than combined Powerhouse A/B capacity for most of period; generation primarily at Powerhouse B during study; Downstream bypass open (~150 cfs); spill present through missing flashboards prior to June 19.			Normandeau
Orono	2016	September-October	**American Eel**	Adult	Quantitative	**Downstream**	98.0%	-	0.1 hr	1.6 hr	20.8 d	Passed downstream	Penobscot flows 2,520-5-960 cfs (mean = 4,042 cfs).	"Normal" operations for river conditions.	Although river flow low, spill was available at Orono for all but 10 days of the study period	Possible mortality issue associated with ledges downstream of spillway; passage delay a concern	HDR
							92%	88.0-96.0	P25: 6.1hr	7.4 hr	P75: 29.1 hr	Passed downstream					
Medway	2020	Oct 15 - Nov 15	**American Eel**	Adult	Quantitative	**Downstream**	68%	60.0-76.0%	12 eels adjusted to mortality due to transit time			Passed downstream	WB Pen flows 2,000 - 4,000 cfs. No spill during the study. Limited rain events >0.25" Oct 16-17, Nov 1-3 & Nov 15	"Normal" operations for river conditions. DS bypass open ~15 cfs (7fps, 3' depth as measured 2.5 ft in front of bellmouth)			Normandeau

FERC Points: **Delay**
Operational Conditions
Effectiveness Criteria

Study Year	Study Dates	Species	Life Stage	Project	General Study Objective	General Findings	Consultant
2015	July to mid-October	**river herring**	**Juvenile**	**-**	Tank-based retention ans survival study of externally tagged juvenile alosines	Late July event: externally radio-tagged n=10 fish (size range 30-60mm) with 0% retention/survival at 36 hours; Mid-October event: externally tagged (radio or PIT) n=29 fish (size range 73-95mm) with 81% mortality at 24 hours.	Kleinschmidt
2015	August 30 - October 17	**American Eel**	**Adult**	**Stillwater**	UW camera observations of low-level downstream eel way at Powerhouse B	Video monitoring for a seven week period from first week of September through mid October. Observed 36 eels - passage events occurred weeks of September 13 (n = 4), September 20 (n = 1) and September 27 (n = 31).	Kleinschmidt
2014	August 27 - October 23	**Alosines**	**Juvenile & Post-spawn Adult**	**Milford, Stillwater, Orono**	Video monitoring of DS bypasses to evaluate use; visual observations for presence of juveniles in vicintiy of Projects; determine availability for future studies.	Resulted in observation of schools of thousands of juvenile alosines at Milford, Stillwater A, and Orono downstream bypasses; smaller schools observed at Stillwater B.	Kleinschmidt
2014	September-early October	**American Eel**	**Adult**	**Stillwater Branch & main stem Penobscot**	Efish and net surveys to assess availability of outmigrant silver eels for future testing	Stillwater Branch efish yielded 10 silver eels in 3 hours of effort and one was captured in a trap net; main stem Penobscot efish yielded 26 silver eels in 14 hours of effort	Kleinschmidt
2014	June 5-September 16	**American Eel**	**Juvenile**	**Milford**	Operation of eel fishway and trap; Three August nighttime visual surveys	Collected 370 eels in trap (90% between July 31 and August 14); sizes ranged from 3.3-11.8 inches; Nighttime surveys recorded 30-100 eels per trip from dam face, pools just DS of dam and bedrock ledge near fishway	Kleinschmidt
2014	June 23 - August 14	**American Eel**	**Juvenile**	**Stillwater & Orono**	Weekly nighttime visual surveys to determine if and where juvenile eels may be congregating downstream	Stillwater - surveys indicated greatest densities at or near the small island in middle of the river channel; Orono - majority of observations along the non-overflow section.	Kleinschmidt

Study Year	Species	Life Stage	Project	River	Passage Direction	Passage Survival/Success		Residence Duration		
						Estimate	Confidence Interval	Minimum	Median	Maximum
2015	**Alewife**	Adult	**Lockwood**	Kennebec	**Downstream**	85.0%	75% CI = 69.0-100.0%	0.1 hr	10.7 hr	8.3 d
2016	**Alewife**	Adult	**Hydro Kennebec**	Kennebec	**Downstream**	100.0%	75% CI = 98.4-100.0%	2.9 hr	3.3 d	20.4 d
2018	**Alewife**	Adult	**West Enfield**	Penobscot	**Downstream**	93.7%	75% CI = 90.9-96.7%	1.9 hr	0.7 d	20.9 d
2019	**Alewife**	Adult	**Pejepscot**	Androscoggin	**Downstream**	80.9%	75% CI = 76.3-85.7%	0.1 hr	0.9 hr	8.9 d
2015	**Alosines**	Juvenile	**Vernon**	Connecticut	**Downstream**	-	-	0.1 hr	0.7 hr	9.8 d
2015	**Alosines**	Juvenile	**Garvins Falls**	Merrimack	**Downstream**	-	-	0.1 hr	0.8 hr	1.3 d
2019	**Alosines**	Juvenile	**Pejepscot**	Androscoggin	**Downstream**	-	-	0.1 hr	0.5 hr	18.2 hr
2019	**Alosines**	Juvenile	**West Enfield**	Penobscot	**Downstream**	-	-	0.2 hr	0.6 hr	1.4 d
2015	**American Eel**	Adult	**Wilder**	Connecticut	**Downstream**	-	-	0.1 hr	0.2 hr	16.7 d
2015	**American Eel**	Adult	**Bellows Falls**	Connecticut	**Downstream**	-	-	0.1 hr	0.2 hr	12.8 d
2015	**American Eel**	Adult	**Vernon**	Connecticut	**Downstream**	-	-	0.1 hr	0.2 hr	34.8 d
2018	**American Eel**	Adult	**Garvins Falls**	Merrimack	**Downstream**	70.1%	75% CI = 62.9-76.4%	0.1 hr	0.2 hr	13.2 d
2018	**American Eel**	Adult	**Hooksett**	Merrimack	**Downstream**	90.5%	75% CI = 83.8-94.6%	0.1 hr	0.1 hr	7.0 hr
2018	**American Eel**	Adult	**Amoskeag**	Merrimack	**Downstream**	84.1%	75% CI = 76.0-89.9%	0.1 hr	0.6 hr	8.5 d
2018	**American Eel**	Adult	**Lowell**	Merrimack	**Downstream**	84.2%	75% CI = 74.1-90.3%	0.1 hr	0.3 hr	20.2 hr
2018	**American Eel**	Adult	**Lawrence**	Merrimack	**Downstream**	88.9%	75% CI = 79.8-94.2%	-	-	-
2019	**American Eel**	Adult	**Garvins Falls**	Merrimack	**Downstream**	88.3%	75% CI = 82.7-92.3%	0.1 hr	1.6 hr	10.7 d
2019	**American Eel**	Adult	**Hooksett**	Merrimack	**Downstream**	90.6%	75% CI = 84.8-94.3%	0.1 hr	0.2 hr	16.1 d
2019	**American Eel**	Adult	**Amoskeag**	Merrimack	**Downstream**	91.7%	75% CI = 85.8-95.3%	0.1 hr	1.5 hr	18.7 d
2019	**American Eel**	Adult	**Pejepscot**	Androscoggin	**Downstream**	90.0%	75% CI = 86.0-94.0%	0.1 hr	2.1 hr	19.4 d
2015	**American Shad**	Adult	**Vernon**	Connecticut	**Downstream**	-	-	0.1 hr	11.9 hr	21.6 d
2016	**American Shad**	Adult	**Vernon**	Connecticut	**Downstream**	-	-	0.1 hr	11.6 hr	17.8 d
2018	**American Shad**	Adult	**West Enfield**	Penobscot	**Downstream**	88.0%	75% CI = 84.4-91.9%	7.2 hr	3.9 d	31.1 d
2019	**American Shad**	Adult	**Pejepscot**	Androscoggin	**Downstream**	51.4%	75% CI = 41.6-61.1%	2.7 hr	5.3 d	10.4 d

Study Year	Species	Life Stage	Project	River	Passage Direction	Structure	Passage Survival/Success		Residence Duration		
							Estimate	Confidence Interval	Minimum	Median	Maximum
2010	**American Shad**	Adult	**Conowingo (East Lift)**	Susquehanna	**Upstream**	Lift	44.9%	±10.4%	-	-	-
2012	**American Shad**	Adult	**Conowingo (East Lift)**	Susquehanna	**Upstream**	Lift	25.8%	±10.6%	-	-	-
2015	**American Shad**	Adult	**Conowingo (East Lift)**	Susquehanna	**Upstream**	Lift	21.6%	±9.5%	-	-	-
2015	**American Shad**	Adult	**Lockwood**	Kennebec	**Upstream**	Lift	0.0%	-	-	-	-
2019	**American Shad**	Adult	**Pejepscot**	Androscoggin	**Upstream**	Lift	0.0%	-	0.1 hr	9.1 hr	42.5 d
2019	**Alewife**	Adult	**Pejepscot**	Androscoggin	**Upstream**	Lift	19.8%	14.8-24.9%	0.1 hr	2.7 d	17.1 d
2018	**American Shad**	Adult	**Holtwood**	Susquehanna	**Upstream**	Lift	4.2%	-	-	-	-
2019	**American Shad**	Adult	**Holtwood**	Susquehanna	**Upstream**	Lift	6.5%	-	-	-	-

						Passage Survival/Success		Residence Duration		
Study Year	Species	Life Stage	Project	River	Passage Direction	Estimate	Confidence Interval	Minimum	Median	Maximum
Adult Alewife - Downstream Passage										
2019	Alewife	Adult	Pejepscot	Androscoggin	Downstream	80.9%	75% CI = 76.3-85.7%	0.1 hr	0.9 hr	8.9 d
2015	Alewife	Adult	Lockwood	Kennebec	Downstream	85.0%	75% CI = 69.0-100.0%	0.1 hr	10.7 hr	8.3 d
2018	**Alewife**	**Adult**	**Milford**	**Penobscot**	**Downstream**	**86.1%**	**75% CI = 82.1-89.7%**	**0.6 hr**	**0.6 d**	**11.8 d**
2018	Alewife	Adult	West Enfield	Penobscot	Downstream	93.7%	75% CI = 90.9-96.7%	1.9 hr	0.7 d	20.9 d
2018	**Alewife**	**Adult**	**Stillwater**	**Penobscot**	**Downstream**	**94.6%**	**75% CI = 92.4-97.8%**	**0.1 hr**	**0.4 d**	**10.8 d**
2018	**Alewife**	**Adult**	**Orono**	**Penobscot**	**Downstream**	**97.8%**	**75% CI = 96.0-98.8%**	**0.1 hr**	**2.1 hr**	**3.6 d**
2016	Alewife	Adult	Hydro Kennebec	Kennebec	Downstream	100.0%	75% CI = 98.4-100.0%	2.9 hr	3.3 d	20.4 d
Juvenile Alewife - Downstream Passage								**P25**	**Median**	**P75**
2020	**Alewife**	**Juv**	**Milford**	**Penobscot**	**Downstream**	**97.2%**	**-**	**1.5 hr**	**1.8 hr**	**3.2 hr**
2020	**Alewife**	**Juv**	**Stillwater**	**Penobscot**	**Downstream**	**91.4%**	**-**	**0.5 hr**	**1.1 hr**	**6.9 hr**
2020	**Alewife**	**Juv**	**Orono**	**Penobscot**	**Downstream**	**96.4%**	**-**	**0.5 hr**	**0.6 hr**	**1.3 hr**
Adult American Shad - Downstream Passage								**Minimum**	**Median**	**Maximum**
2019	American Shad	Adult	Pejepscot	Androscoggin	Downstream	51.4%	75% CI = 41.6-61.1%	2.7 hr	5.3 d	10.4 d
2017	**American Shad**	**Adult**	**Milford**	**Penobscot**	**Downstream**	**76.6%**	**75% CI = 71.1-82.2%**	**0.3 hr**	**1.6 d**	**25.3 d**
2018	**American Shad**	**Adult**	**Milford**	**Penobscot**	**Downstream**	**86.2%**	**75% CI = 82.4-89.9%**	**0.6 hr**	**1.1 d**	**23.5 d**
2017	**American Shad**	**Adult**	**Orono**	**Penobscot**	**Downstream**	**87.0%**	**75% CI = 82.4-91.2%**	**0.3 hr**	**1.6 d**	**15.0 d**
2018	American Shad	Adult	West Enfield	Penobscot	Downstream	88.0%	75% CI = 84.4-91.9%	7.2 hr	3.9 d	31.1 d
2018	**American Shad**	**Adult**	**Orono**	**Penobscot**	**Downstream**	**94.4%**	***estimated from 17 of 18 tagged shad which approached dam**	**0.2 hr**	**8.1 hr**	**2.0 d**
2018	**American Shad**	**Adult**	**Stillwater**	**Penobscot**	**Downstream**	**94.7%**	***estimated from 18 of 19 tagged shad which approached dam**	**0.2 hr**	**0.3 d**	**5.9 d**
2017	**American Shad**	**Adult**	**Stillwater**	**Penobscot**	**Downstream**	**95.8%**	**75% CI = 91.7-97.9%**	**0.4 hr**	**4.7 d**	**17.2 d**
2015	American Shad	Adult	Vernon	Connecticut	Downstream	-	-	0.1 hr	11.9 hr	21.6 d
2016	American Shad	Adult	Vernon	Connecticut	Downstream	-	-	0.1 hr	11.6 hr	17.8 d
Adult American Eel - Downstream Passage								**Minimum**	**Median**	**Maximum**
2018	American Eel	Adult	Garvins Falls	Merrimack	Downstream	70.1%	75% CI = 62.9-76.4%	0.1 hr	0.2 hr	13.2 d
2017	American Eel	Adult	West Enfield	Penobscot	Downstream	84.0%	-	0.3 hr	2.0 hr	31.9 d
2018	American Eel	Adult	Amoskeag	Merrimack	Downstream	84.1%	75% CI = 76.0-89.9%	0.1 hr	0.6 hr	8.5 d
2018	American Eel	Adult	Lowell	Merrimack	Downstream	84.2%	75% CI = 74.1-90.3%	0.1 hr	0.3 hr	20.2 hr
2019	American Eel	Adult	Garvins Falls	Merrimack	Downstream	88.3%	75% CI = 82.7-92.3%	0.1 hr	1.6 hr	10.7 d
2018	American Eel	Adult	Lawrence	Merrimack	Downstream	88.9%	75% CI = 79.8-94.2%	-	-	-
2019	American Eel	Adult	Pejepscot	Androscoggin	Downstream	90.0%	75% CI = 86.0-94.0%	0.1 hr	2.1 hr	19.4 d
2016	**American Eel**	**Adult**	**Milford**	**Penobscot**	**Downstream**	**90.0%**	**-**	**0.1 hr**	**1.2 d**	**23.9 d**
2018	American Eel	Adult	Hooksett	Merrimack	Downstream	90.5%	75% CI = 83.8-94.6%	0.1 hr	0.1 hr	7.0 hr
2019	American Eel	Adult	Hooksett	Merrimack	Downstream	90.6%	75% CI = 84.8-94.3%	0.1 hr	0.2 hr	16.1 d
2019	American Eel	Adult	Amoskeag	Merrimack	Downstream	91.7%	75% CI = 85.8-95.3%	0.1 hr	1.5 hr	18.7 d
2016	**American Eel**	**Adult**	**Stillwater**	**Penobscot**	**Downstream**	**92.0%**	**-**	**0.1 hr**	**1.8 hr**	**48.6 d**
2016	**American Eel**	**Adult**	**Orono**	**Penobscot**	**Downstream**	**98.0%**	**-**	**0.1 hr**	**1.6 hr**	**20.8 d**
2015	American Eel	Adult	Wilder	Connecticut	Downstream	-	-	0.1 hr	0.2 hr	16.7 d
2015	American Eel	Adult	Bellows Falls	Connecticut	Downstream	-	-	0.1 hr	0.2 hr	12.8 d
2015	American Eel	Adult	Vernon	Connecticut	Downstream	-	-	0.1 hr	0.2 hr	34.8 d
2019	American Eel	Adult	Lowell	Merrimack	Downstream	75.5%	(75% CI = 71.4%-79.6%)	0.2	0.4	16.4 d
								P25	**Median**	**P75**
						92%	**75% CI = 88.0 - 96.0%**	**6.1 hr**	**7.4 hr**	**29.1 hr**
2020	**American Eel**	**Adult**	**Medway**	**WB Penobscot**	**Downstream**	**68%**	**75% CI = 60.0 - 76.0%**	**12 eels adjusted to mortality due to transit time**		

Study Year	Species	Life Stage	Project	River	Passage Direction	Passage Survival/Success	
						Estimate	**Confidence Interval**
Adult American Shad - Upstream Passage							
2010	American Shad	Adult	Conowingo (East Lift)	Susquehanna	Upstream	44.9%	±10.4%
2012	American Shad	Adult	Conowingo (East Lift)	Susquehanna	Upstream	25.8%	±10.6%
2015	American Shad	Adult	Conowingo (East Lift)	Susquehanna	Upstream	21.6%	±9.5%
2015	American Shad	Adult	Lockwood	Kennebec	Upstream	0.0%	-
2019	American Shad	Adult	Pejepscot	Androscoggin	Upstream	0.0%	-
2018	American Shad	Adult	Holtwood	Susquehanna	Upstream	4.2%	-
2019	American Shad	Adult	Holtwood	Susquehanna	Upstream	6.5%	-
2020	American Shad	Adult	Lowell (lift)	Merrimack	Upstream	30.4%	(75% CI = 22.1-39.5%)
Adult Alewife - Upstream Passage							
2019	Alewife	Adult	Pejepscot	Androscoggin	Upstream	19.8%	75% CI = 14.8-24.9%
2019	**Alewife**	**Adult**	**Milford**	**Penobscot**	**Upstream**	**65.1%**	**95% CI = 56.9-73.8%**
2020	Alewife	Adult	Lowell (lift)	Merrimack	Upstream	43.9%	75% CI = 39.3-51.4%
2020	Alewife	Adult	Lowell (ladder)	Merrimack	Upstream	75.6%	75% CI = 69.2-82.2%
2020	Alewife	Adult	Mine Falls (lift)	Nashua	Upstream	56.5%	75% CI =49.2-63.6%

Consultation Regarding FERC's March 6, 2020 Response Letter to Black Bear Hydro Partners, LLC's (Black Bear's) Eel and Alosine Passage Studies conducted at the Milford, Orono, Stillwater Projects
June 3, 2020 at 12:30 pm

Meeting Location: Conference Call

A.) National Marine Fisheries Service (NMFS): Jeff Murphy, Don Dow
B.) U.S. Fish and Wildlife Service: Ken Hogan, Bryan Sojkowski
C.) Maine Dept. of Marine Resources: Gail Wippelhauser, Casey Clark
D.) Maine Dept. of Environmental Protection: Chris Sferra
E.) Penobscot Indian Nation (PIN): Dan McCaw
F.) Bureau of Indian Affairs: Harold Peterson
G.) Brookfield Renewable: Kelly Maloney, Kevin Bernier, Richard Dill, James Cole
H.) Environmental Consultant: Drew Trested, Normandeau Associates

Introductions and Background:
The conference call began with introductions and a quick review of the key points of FERC's March 6, 2020 letter.

> *"Based on our review of data collected at the projects, we have identified some frequent issues that arise in the stakeholder comments which may require further explanation, additional review or data analysis, or future study. These are: (1) migratory delay; (2) operational conditions; and (3) development of passage performance standards (effectiveness criteria). Due to the common themes in these comments and because they frequently arise, we conclude that they require further action to maintain compliance with your project license and to benefit fishery resources at the project."*

A summary of both qualitative and quantitative alosine and eel passage studies conducted at the Milford, Orono and Stillwater Projects (following completion of new fish passages at these Projects in 2013 and 2014) was distributed prior to the meeting. Information provided in the summary tables included: river conditions during the studies, general and unique operational conditions, passage success estimates, and residence duration. Significant agency comments submitted for each study were also summarized and included in the table.

The information provided in the study summary was presented and discussed. It was noted that initial quantitative studies attempted in 2015 for upstream migrating adult alosines were unsuccessful due to significant fall back of study fish after tagging/release, and that a pilot juvenile river herring tagging study failed due to almost 100% mortality of the fish post handling, including the control (untagged) juvenile herring. For comparison, results for passage studies conducted by Normandeau Associates at other hydroelectric projects in New England for similar species, life stages, and directions were included in the summary. Generally, the methodologies for these studies were comparable to those used at the Milford, Stillwater and Orono Projects. There were questions about other recent passage studies conducted at Conowingo Dam and Holyoke Dam. The Conowingo study used fish that were captured at the dam, then tagged and released back downstream of the project. However, the group was unsure about the Holyoke study, as it was not conducted by Normandeau. Black Bear indicated that these studies could be incorporated into the summary.

Group Discussion of FERC Requests:

1. Migratory Delay

> *"Based on your completed telemetry studies, recorded observations of fish behavior, and project-specific information, you may already have the data available to inform reasonable operational and/or structural modifications to ensure timely up- and downstream passage at the projects. Therefore, you should continue to consult with the stakeholders to determine whether there are potential project or environmental factors that may be contributing to migratory delay, and what additional structural or operational modifications must be enacted to minimize delay."*

There was a suggestion that residence duration times upstream and downstream of the Projects include only passage times between the 5th and 95th percentiles, in order to exclude the outliers that drive the extreme minimum and maximum duration times. A request was also made to look at the distribution of residence times between the median and maximum passage times. Finally, there was a request to develop study-specific frequency distributions for blocks of residence time (i.e., 24 hours), focusing first on the downstream passage studies.

> **Task:** Add an upstream residence time tab to the study summary with data presented in tabular format to allow review of values across Projects/species.

Black Bear emphasized that the residence times for some of these species, life-stages, and migratory directions should be considered in the context of their migration stage (e.g. pre-spawn, post-spawn), as some study fish were tagged and released while they were actively migrating upstream (e.g. pre-spawn shad were tagged for the purpose of studying their subsequent post-spawn downstream migration through the Projects). As an example, the median downstream passage time for adult American shad at Stillwater was close to 5 days in 2017, but median passage in 2018[1] was much shorter at 0.3 days. In 2017, shad were collected at the Milford Project during their upstream migration (i.e., pre-spawn), and then released above the Project dams. The resulting residence times of these 2017 study shad above Stillwater and Orono Dams during their post-spawn downstream migration to the ocean were likely overestimated due to upstream and downstream forays of the fish prior to spawning (since they had limited or no options for moving upstream into the main stem of the Penobscot River). Conversely, the 2018 study fish that were monitored moving downstream through the Stillwater Branch of the Penobscot River were more representative of active outmigrants, as those fish had been stocked in the main stem of the river upstream of the Stillwater Branch, had likely already spawned, and were actively outmigrating to the ocean.

Similarly, adult eels are known to respond to environmental cues (increasing flows; precipitation; decreasing river temperature) which stimulate downstream migration behaviors, the absence of which may influence their migration timing and motivation, and thus their residence times in the vicinity of the Projects. The two early releases for the 2016 downstream eel studies were made during periods of very low flows and warm river temperature (September 2 and September 27), which likely affected the migratory urge of those study animals. (The late summer/fall of 2016 was a drought period, with the first significant rainfall not occurring until ~October 21).

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[1] 18 radio tagged adult American shad released upriver to study passage specifically at the Milford and West Enfield Projects were observed passing downstream through the Stillwater and Orono projects.

There was discussion of the importance of residence times in the Penobscot shad model first developed by Stich et al. (2019), as the model emphasizes upstream and downstream passage in the context of 24 and 48 hour residence times in the vicinity of the Projects. There was further clarification that, while numerous combinations of passage effectiveness under the 24 and 48 hour residence time scenarios were analyzed, ultimately the model considered shad returns to a river reach significantly upstream in the Penobscot drainage (above Weldon Dam) to achieve recovery goals. Black Bear highlighted the challenge(s) of discerning between a residence time goal based on biology against the practical application of study methods that may be skewing the results. The agencies and PIN support use of the Stich model as a backdrop for the alosine studies on the lower Penobscot River (see #3 below), but stated that keeping fish out of the turbines is the ultimate goal, regardless of the nuances of the studies.

2. Operational Conditions

"Your recent reports under the Atlantic Salmon Species Protection Plan describe how you manipulate specific spill conditions, prioritize stations, or pass inflows in order to improve passage conditions for Atlantic salmon smolts, indicating that you should be able to develop similar conditions or evaluations for alosines and eels. As the diadromous fish passage study results are expected to inform recommendations for structural or operational changes at the projects, you should review your years of passage data and operations information and consult with the stakeholders to determine whether you have sufficient evidence to refine operational conditions to improve passage. Alternatively, it may be necessary to develop additional studies to specifically evaluate passage under different operational conditions."

Note: Potential operational changes were not discussed during this meeting.

3. Fish Passage Standards

"In your 2019 report, you referenced the dam passage performance standard model for the Penobscot River in describing your river herring passage results, where approximately 58 percent of the river herring passed upstream within 24 hours and 79 percent within 48 hours of arrival at the Milford Project. Specifically, you noted that the model estimates the effects of dam passage and migratory delay on management goals for shad (i.e., abundance, spatial distribution of spawning adults, and proportion of repeat spawners in space and time), and highlighted a finding in the model that upstream passage efficiencies of 0.60 or greater with passage occurring within 48 hours are needed in order to meet interim recovery targets for shad.

Though the model provides a tool to relate proposed performance standards directly to management objectives, your 2019 report does not indicate whether you will pursue use of this model to establish effectiveness criteria, and the stakeholders don't provide specific comments. You should therefore reconvene with the stakeholders on the matter now that the model is published to discuss the potential for passage criteria. You should also consider a re-examination of your completed radio telemetry studies with adult alosines (conducted 2017-2019) as the model may inform the understanding of those results with regard to management objectives, and/or determining what additional information is needed."

There was discussion of the Stich et al. (2019) "*Dam Passage Performance Standard Model for American Shad*" developed specifically for the Penobscot River, taking into consideration the results of Black Bear's passage studies to date at the three Project dams. Important conclusions of the Stich model were that rivers without dams have a large suite of age classes of shad, while rivers with multiple dams may result in culling repeat spawners, and that downstream passage inadequacies have a greater potential to impede shad population recovery than upstream passage inefficiencies. Stich et al. concludes that hydro project targets of 85% shad survival for downstream passage and 60% efficiency for upstream shad passage should increase the shad population upward toward management goals. Black Bear's most recent shad downstream passage data indicate greater than 85% downstream passage survival for each of the lower Penobscot Projects. Using the 2019 Milford upstream study for adult river herring as a proxy (which showed an upstream passage efficiency of 65%), the 60% upstream passage efficiency standard for shad would also be met, thus indicating that Black Bear's study results are consistent with the model's targets.

It was noted that downstream shad passage at the Milford Project improved to over 85% in the second study year after "shad windows" were installed in the outer trash racks. Also, passage survival at both the Stillwater and Orono Projects was greater than 85% in both study years, while residence duration times were much shorter for the post-spawn study shad that passed these Projects in 2018. There was a question if the 85% downstream survival target for alosines in Stich et al. was for both juveniles and post spawn adults. The assumption was yes, but the agencies will ask Dan Stich to clarify. Black Bear has scheduled downstream passage studies of juvenile alosines in 2020 at the lower Penobscot Projects (using both radio telemetry to determine passage routes and a desktop model to estimate survival) that will provide additional useful information.

There were questions/discussion related to studies/results at other hydro facilities in the Northeast that might help inform passage standards for the three lower Penobscot Projects. Although shad and river herring would generally be expected to have similar passage success, NMFS questioned if the species have been studied together at any sites. Black Bear responded that downstream passage studies of both species were conducted simultaneously at the three lower Penobscot Projects in 2018. Normandeau also indicated that it is currently conducting upstream and downstream evaluations for both river herring and American shad at the Lowell Project, but to date the Pejepscot Project on the Androscoggin River is the only other site where both alosine species have been studied simultaneously (upstream and downstream).

It was noted that projects on the Susquehanna River have performance standards for American shad. Specifically, the Conowingo Project has an upstream passage criteria of 85% for shad which enter the tailwater. At Holtwood Dam, the upstream shad passage standard of 85% has not been achieved, possibly due to overwhelming numbers of gizzard shad. It was also noted that a working group on the Connecticut River is developing shad passage performance standards using the Stich model specifically for the Holyoke, Turners Falls, and Vernon Projects.

There was a question about whether Dan Stich could populate the model with the actual data collected from the Penobscot to see if shad restoration goals are achievable; it was pointed out that the model is available as a shareware, and other organizations have been coordinating with Stich on its use.

> **Task:** NMFS to reach out to Dan Stich/Joe Zydlewski regarding utility/availability to participate in the next meeting to discuss the model.
>
> **Task:** Black Bear to distribute the 2016 downstream eel passage study report prior to the next meeting.

The discussion then moved to eel passage. Black Bear's 2016 downstream eel study results were: Milford - 90% survival, Stillwater - 92% survival, and Orono - 98% survival, with no eels contacted passing through the turbines except at Stillwater A Station (where gaps in the 1-inch trash racks were discovered). The University of Maine (UM) has conducted downstream eel studies (using acoustic tags) for the 2016-2019 period that mirror Black Bear's results. UM presented the downstream eel passage results to the agency ad hoc fish passage working group earlier this year. The presentation slides were shared amongst the group during this meeting. There was agreement that the full study reports should be distributed for review. Since the Black Bear and UM study methodologies were different, it is difficult to compare how survival is estimated and defined without fully understanding the studies. There was a suggestion that studies of downstream passage for adult eels need further clarification as to how passage success is defined, including how far downstream of the Projects the receivers are located, and transit time should be a consideration (i.e. establish a reasonable amount of time it should take for a migrating eel to reach a downstream receiver, and then comparatively review how long it took study eels to reach the receiver to determine if there is any indication of eel mortality or injury). Black Bear indicated that its 2020 downstream eel passage studies at the upstream Medway Project will include a dead eel drift component, which will inform this suggestion. In addition, "Hi-Z" balloon tag studies of eels scheduled for 2020 to support the relicensing of the upstream West Enfield Project will also be informative.

In closing this conference call, Black Bear noted that there is no set timeline for reporting back to FERC on the consultation progress; however, Black Bear would like to provide an update to FERC on the status of these issues before the end of the year. The agencies and PIN emphasized that downstream passage should be the priority moving forward, as indicated by the Stich et al. modeling. Regarding upstream passage, there was a suggestion to table upstream shad studies for now due to the challenges associated with studying upstream passage of this species. Black Bear agreed noting that its upstream passage efficiency results for river herring at the Milford Project exceed the Stich model's 60% passage efficiency target for shad. PIN stated that it is supportive of developing performance standards for eels and alosines. Black Bear replied that it would prefer not to propose passage standards; if the agencies have an idea of what definitive performance standards should be beyond those that Stich et al. suggests, then they should make proposals. The agencies agreed, and indicated that they would be discussing this prior to the next meeting and may make proposals for the performance standards, as well as potential operational and structural modifications.

Tasks for next meeting:

- Doodle Poll for August meeting via Microsoft Teams.
- Distribution of the residence time to passage for alosines and eels at all sites.
    - 24 hrs
    - 48 hrs
    - 95% passed in X amount of time
- Review of the Stich Model… perhaps invite Dan Stich or Joe Zydlewski to discuss
- Review of 2016 eel study to determine how far downstream receivers were located and if dead or injured eels may have been detected.
    - Distribute 2016 eel report for review.
    - Question the University of Maine about their eel study/survival results and downstream receiver locations.

Meeting Notes

Consultation meeting regarding FERC's March 6, 2020 Response to Black Bear Hydro Partners, LLC's (Black Bear's) Eel and Alosine Passage Studies conducted at the Milford, Orono, Stillwater Projects

Date/Time: September 9, 2020 at 12:30 pm

Meeting Location: Microsoft Teams Meeting

Materials distributed prior to the meeting via e-mail:

1.) Meeting agenda
2.) Black Bear's draft June 3rd consultation meeting notes
3.) Updated summary tables of Lower Penobscot Passage Residence Time Results
4.) Penobscot River American Shad Restoration Model paper (Stich et al. 2019)
5.) Black Bear's 2016 Downstream Eel Passage Study – Final Report

Meeting Participants

A.) National Marine Fisheries Service (NMFS): Jeff Murphy, Don Dow
B.) U.S. Fish and Wildlife Service (USFWS): Bryan Sojkowski, Ken Hogan
C.) Maine Dept. of Marine Resources (MDMR): Mitch Simpson, Casey Clark
D.) Penobscot Indian Nation (PIN): Dan McCaw
E.) Bureau of Indian Affairs (BIA): Harold Peterson, Marchelle Foster
F.) Brookfield Renewable (BR): Kelly Maloney, Kevin Bernier, Bob Brochu, Richard Dill
G.) Normandeau Associations (NAI): Drew Trested
H.) University of Maine (UM): Joe Zydlewski

1.) Introductions and Background

A roll call of those participating in the meeting was conducted. Richard (BR) gave a brief background of the reason for this consultation meeting. FERC, in its March 6, 2020 letter, had requested that Black Bear consult with the resource agencies and PIN regarding the results of eel and alosine passage studies conducted at Black Bear's hydroelectric projects in the lower Penobscot River since 2014 to address three ongoing issues, specifically:

"Based on our review of data collected at the projects, we have identified some frequent issues that arise in the stakeholder comments which may require further explanation, additional review or data analysis, or future study. These are: (1) migratory delay; (2) operational conditions; and (3) development of passage performance standards (effectiveness criteria). Due to the common themes in these comments and because they frequently arise, we conclude that they require further action to maintain compliance with your project license and to benefit fishery resources at the project."

2.) June 3rd Draft Meeting Notes

Black Bear offered the opportunity for comment on the draft notes from the June 3rd meeting, which were distributed to the agencies and PIN on August 6th, 2020, and then again on September 9th. No correspondence or written comments related to those draft meeting notes have been received, and no questions or comments related to the notes were expressed during this meeting.

3.) Addressing Tasks from June 3rd Meeting

- Update fish passage residence time summary tables - Drew (NAI) reviewed the updated distribution of the residence times to passage for species at all three Projects. As requested, the residence times prior to passage for each species were parsed into quartiles as well as 5th and 95th percentiles. Also, as requested, eel downstream passage results from the 2016 downstream studies were included in the summary information. It was pointed out that the residence times included in the summaries were only for those fish that successfully passed the Projects. It was also emphasized that the river herring and shad used in the downstream passage studies were in pre-spawn condition when tagged/released, and therefore they may not have been representative of the behavior of post-spawn outmigrating fish. For example, the small number of radio-tagged shad observed passing Stillwater and Orono in 2018 were more likely post-spawn fish (those fish had been tagged and released further upstream to study other Projects), and therefore they were motivated post-spawn outmigrants. The 2018 study fish had a lower residence time prior to passage than the 2017 study fish. It was suggested that the residence times for 2018 shad and alewife released above the West Enfield Project be analyzed when they passed downstream at the Milford Project.

  Task: Analyze passage data (residence times) for the shad released in 2018 upstream of West Enfield that passed downstream at Milford, and for alewife that were released upstream of West Enfield that passed both the Milford Project and the Projects on the Stillwater Branch (Stillwater and Orono).

- Review of the Penobscot River Shad Restoration Model (Stich et al. 2019) - Joe Zydlewski (UM and USGS) presented key aspects of the model and answered questions. The model provides shad recovery probabilities under various scenarios by modeling individual fish and their probability of passing upstream, reproducing, and passing back downstream. To do this, the model geographically separates the river using the dams and in context with their upstream and downstream passage effectiveness (i.e., the percentages of fish successfully passing the dams are used as input criteria).

  In reply to a question on whether data for various species and life stages could be plugged into the model, Joe said that this is probably not the right way to use it. However, the model can be used to see how passage at a specific dam affects restoration probabilities, using upstream and downstream passage success as inputs, including for juveniles. Joe added that downstream passage success drives the model's recovery probability outputs more than upstream passage, demonstrating the importance of successfully getting fish out of the river and to the ocean. Joe also said that the model can be used to evaluate fish recovery goals, but he cautioned against model results that are based on too many assumptions. However, Joe said that specific scenarios/conditions could easily be run using the model, such as what happens to the recovery probability if passage efficiency increases by 10% at a dam.

  Joe presented Figure 9 from the Stich et al 2019 shad restoration model, which shows heat graphs of shad recovery probabilities based on dam passage survival and residence times. Richard pointed out that, based on Figure 9, Black Bear's studies have demonstrated passage results that should lead to an increasing shad population and successful shad restoration (67% upstream passage effectiveness for river herring at Milford, and generally about 85% downstream passage effectiveness). Joe cautioned that the model assumes fish passage delays of 24 or 48 hours, which were sometimes shown to be exceeded by Black Bear's studies.

Jeff (NMFS) stated that the resource agencies and PIN have discussed the need for performance standards that, based on the model, would lead to recovery of shad and river herring. In addition, FERC is recommending in their March 6, 2020 letter that passage standards for alosines be discussed for the Penobscot dams. Joe said that the model would be useful for determining what performance standards are needed, but management goals first need to be defined. Casey (MDMR) pointed out that a management plan has already been defined with the input of many stakeholders. He agreed that performance standards are needed that make shad and river herring restoration on the Penobscot achievable, and that the model would be a good tool to develop the standards.

Richard asked if Black Bear's existing fish passage data could be used in the model to determine how many shad and river herring could be restored under current conditions. Joe replied yes, but he felt that sensitivity analyses (looking a range of fish passage efficiencies) would be useful; one could then change parameters (such as a dam's upstream or downstream fish passage success) one at a time to see what effect they have on future fish populations. Drew asked if the time for passage parameter could be varied as part of the sensitivity analyses. Joe replied yes, and you could then back-calculate the time necessary for fish to pass in order to meet restoration goals. Joe added that although there is set-up time for each scenario, the scenarios could then be run all at once. He also mentioned that the same criteria were used for adults and juveniles in the model, but they could be separated out with different criteria entered.

Richard asked how the model is affected by an individual fish that doesn't pass a dam or takes longer than the time (48 hour) criteria. Joe said that each fish has a probability of passing the dam and for migrating up and down the river kilometer by kilometer. If an upstream-migrating fish does not pass a dam, the model assumes that they will still spawn in the habitat below the dam with an assigned density-dependent function based on the quality of that habitat. Richard felt that motivation of shad to passively move upstream will be an issue with the model. Casey replied that this should be a moot point over time, as shad will eventually occupy the habitat. Kelly (BR) replied that this motivation issue makes it difficult for Black Bear to study shad and demonstrate that a performance standard is being met. Joe agreed, and said that UM has only had a few study shad that moved upstream to Milford after tagging and release. However, he again pointed out that downstream passage is the more important criteria and easier to study.

Richard expressed concern with having black and white performance standards for alosines similar to Atlantic salmon due to this motivation issue; he also pointed out that a smolt is considered dead in the existing smolt performance standards if it doesn't pass with 24 hours, even though that is likely not the case. Dan (PIN) agreed that a smolt that takes over 24 hours to pass might survive, but delayed mortalities due to injury are not adequately considered in the smolt performance standards. Dan also agreed that motivation is an issue for studying upstream alosine passage, but downstream passage is more important and we need to focus on protecting fish as they migrate to the ocean. Jeff agreed.

Richard questioned if the interactions of variables/assumptions in the model are too complex to provide definitive answers with regard to passage standards. Joe said that the model outputs are not that complex, but the model does use a lot of assumptions with regard to the inputs. Casey stated the model is exactly what the agencies need to help them determine what is needed to reach their Phase 1 restoration target of ~633K adult shad returning annually, as identified in the State of Maine's 2009 Penobscot Operational Plan for Diadromous Fish (POP). Richard pointed out that the POP determined that based on the results of two independent 50-

year recolonization models that were developed in support of refining shad population goals for the POP, that the target population of 633K shad could not be reached in the 50 year time frame through natural recolonization. One model indicated that achieving the target population of 633K shad through natural recolonization would required either a very high rate of increase for a prolonged period or a very large starting population of shad. Because neither of these natural recolonization scenarios were considered likely, the alternative of jump starting the shad restoration by hatchery supplementation of shad fry was included as a strategy. The POP's measures/strategies called for the annual supplemental stocking of nearly 12 million hatchery shad fry, and to continue stocking efforts annually for the entire 50-year period, or until 633K adult shad return annually for 5 years. Joe indicated that he is open to using the model to assess various scenarios.

- <u>Review of the Milford/Orono/Stillwater 2016 eel study report</u> – The 2016 eel study report was distributed to the agencies and PIN prior to the meeting. Casey asked about delayed eel mortalities after dam passage. Joe confirmed that the survival results from UM's downstream eel passage studies at West Enfield and Milford were based on detections far enough downstream of the dams to ensure that drifting dead eels were not being detected. Kevin (BR) indicated that the upcoming downstream eel passage studies at the Medway Project will provide information on delayed eel mortalities, as it will contain a dead eel drift component.

4.) Continue discussion of FERC's March 6, 2020 Letter - Key Issues

a. Passage Delay
b. Potential Modification to Project Operations or Structures
c. Passage standards for eel/alosines

Dan (PIN) asked about next steps, recognizing that downstream passage is the most critical issue to focus on. PIN believes that more work needs to be done to identify issues, and then operational and structural changes will need to be considered and implemented to meet fish passage standards. PIN believes that FERC is requiring that operational and structural changes be made. Richard replied that Black Bear's downstream passage study results to date appear to meet the criteria used in the shad model that demonstrate achievement of restoration goals. Although Black Bear is still studying downstream alosine passage at the lower Penobscot facilities (with juvenile alosine studies scheduled for this fall), Black Bear is not convinced that operational and structural changes are currently necessary. Richard pointed out that FERC has requested that Black Bear continue to consult with the agencies and PIN to resolve ongoing issues. However, it has not been determined if additional measures need to be implemented.

Casey disagreed that structural and operational changes are not advised per page 7 of FERC's letter. Casey added that FERC is suggesting that the same successful approach being used for Atlantic salmon smolts be used for eels and alosines. Kelly felt that FERC is looking for a stepwise approach for eels and alosines, and that FERC has requested that Black Bear review the collected fish passage data and consult with the agencies and PIN on the delay, potential operational measures, and performance standard issues to determine if additional changes are warranted. Kevin pointed out that a number of changes have already been made that have resulted in improved fish passage.

Dan stated that the next steps should include a review of the 2009 POP to determine what performance standards are needed and where gaps in fish passage knowledge still exist. He felt that the shad model could be a valuable tool for developing the standards, and for focusing future study efforts. Richard pointed out that the 2009 POP was based on lofty stocking goals for shad, and not on the current natural recolonization approach. Dan agreed that the intricacies of the plan should be looked into, and asked if there were other management plans that should be guiding these discussions.

5.) Meeting wrap up – Next step

It was agreed that another meeting should be convened after the fall passage studies (juvenile river herring passage route study and turbine blade strike analysis at Orono/Stillwater/Milford) to further review passage data and continue joint efforts to resolve the issues, especially with regard to downstream passage. In the meantime, the agencies and PIN will review the 2009 POP to determine if the measures and strategies listed should be updated given 11 years has passed (e.g., new information is available, and the shad stocking initiative was never implemented). Based on the new information, the agencies and PIN will work to update eel and alosine management goals and objectives for the Penobscot River for incorporation into Black Bear's efforts to satisfy diadromous fish passage requirements at the Milford, Orono, and Stillwater Projects.

Attachment B

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February 15, 2021

Medway Project
FERC No. 2666

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Electronically Filed

RE: Medway Project (FERC No. 2666), Article 405;
2020 Evaluation of Downstream Passage Effectiveness for Adult American Eel

Dear Secretary Bose:

Black Bear Hydro Partners, LLC (Black Bear), an affiliate of Brookfield Renewable (Brookfield) and licensee for the Medway Project (FERC No. 2666) on the West Branch of the Penobscot River in Maine, is filing this final study report: *Evaluation of Downstream Passage Effectiveness for Adult American Eel at the Medway Project,* which was conducted in the fall of 2020. This study was required pursuant to Article 405 of the Medway Project license (issued on March 29, 1999) and the Commission's October 6, 2020 approval of the study plan for this evaluation.

In an April 18, 2019 update to the Commission, Black Bear proposed to cumulatively study downstream eel passage at the Medway Project in conjunction with an evaluation of adult eel passage at the Mattaceunk Project, which is located about 7 miles downriver on the mainstem of the Penobscot River. In its September 26, 2019 reply, the Commission agreed that there is substantial logic for a comprehensive, multi-project study, as it may require fewer eels, reveal larger-scale migration patterns, and necessitate fewer resources. However, the Commission also agreed with the Penobscot Indian Nation (PIN) that downstream eel passage evaluations at the Medway Project should resume, stating both that it could not anticipate when a license would be granted for the Mattaceunk Project (which would trigger downstream eel passage study requirements), and that the requirements of the Medway Project are not contingent on those at Mattaceunk, or vice versa. Thus, the Commission stated that the Medway Project requirements must stand independently and be fulfilled, and that Black Bear should anticipate resuming the downstream eel study at the Medway Project in the fall of 2020.

Accordingly, Black Bear then consulted with the resource agencies[1] and PIN to develop the "*Study Plan for the Evaluation of Downstream Passage Effectiveness for Adult American Eel* at *the Medway Project"* for the fall of 2020, which was submitted to the Commission on June 15, 2020. The Commission approved the study plan on October 6, 2020, with the condition that the study would need to be repeated in fall of 2021 if less than the 38 study eels needed for a statistically meaningful assessment passed the Medway Project during the fall 2020 study.

[1] United States Fish and Wildlife Service (USFWS); Maine Department of Marine Resources (MDMR); Maine Department of Inland Fisheries and Wildlife (MDIFW); Maine Department of Environmental Protection (MDEP); National Marine Fisheries Service (NMFS); Bureau of Indian Affairs (BIA)

The downstream eel passage study was conducted at the Medway Project between October 15 and November 18, 2020. A total of 50 radio-tagged adult silver eels were released upstream of the Project, and 49 of those were observed passing downstream of Medway Dam. Monitoring of adult eel movements focused on residence time prior to passage, passage route selection, and an estimation of downstream passage survival at the Project. The median period of residence for radio-tagged eels upstream of the dam was 7.4 hours, with 62% passing downstream within the first 24 hours of their initial detection. Most radio-tagged eels passed downstream via the turbines, and there was one observation of an adult eel passing downstream via the bypass. Downstream passage survival for the entire Project reach (~500 feet upstream of the dam to the first downstream receiver) was estimated at 92.0% (75% CI = 88.0-96.0%).

As detailed in the report, an additional group of freshly dead eels were radio-tagged and released immediately downstream of Medway Dam and were used to classify live eels passing the Project based on their downstream transit duration relative to the drift duration, the purpose being to incorporate potential delayed eel mortalities from dam passage into the Project survival estimate. Based on this comparison, and when considering test eels as mortalities that exhibited both (1) a migration time from Medway Dam to a monitoring station 3 miles downriver that was in excess of that observed for the dead tailrace release eels, and (2) failure to reach (or a prolonged duration of time to reach) a monitoring station 7.5 miles downriver, the adjusted estimate of Project survival was 84.0% (75% CI = 78.0-90.0%).

Neither of these two estimates of downstream passage survival for adult eels at the Medway Project include any background (i.e., natural) or tagging-related mortality. As a result, these estimates should be viewed as minimum estimates of total Project survival (i.e., due solely to Project effects) for adult eels passing the Medway Project. In addition, due to low West Branch flows during the fall 2020 study, downstream passage route options for radio-tagged adult eels were limited to the downstream bypass or the Project turbines. As a result, this study was conducted under worst case conditions for out-migrating eels.

A draft of this report was distributed for resource agency and tribal review on December 15, 2020. As requested by Black Bear on January 13, 2021, and as approved by the Commission on February 9, 2021, the deadline for filing this report was extended to February 15, 2021, thereby providing the resource agencies and PIN with a 60-day review period. A consultation meeting was remotely held on January 27, 2021 with the resource agencies and PIN to present and review the study results and to answer questions. Responses to questions and comments received during the January 27th meeting are provided in Appendix D of the attached report, while correspondences associated with the agency and tribal reviews of the report are provided in Appendix E. Finally, a copy of the PowerPoint slides prepared and presented by Normandeau Associates at the January 27th meeting are provided in Appendix F. Where appropriate, the report has been revised based on the comments received.

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As acknowledged in the Commission's October 6, 2020 study plan approval for this downstream eel passage evaluation, this study provided information on the routes of passage utilized by downstream-migrating eels at the Medway Project and estimated their survival. However, the Commission further stated that Black Bear would be required to "*assess and potentially improve passage efficiency through the turbines or modify the downstream passage facilities to improve its effectiveness*" if the study determined that eels were not finding the bypass weir. Therefore, based on the 2020 study results and consistent with resource agency and PIN requests detailed in the Commission's October 6, 2020 letter, Black Bear intends to conduct a Hi-Z balloon tag study in 2021 of adult eels at the Medway Project to better document turbine passage survival and turbine-induced injuries. A study plan will be developed and provided to the resource agencies and PIN for 30-day review by April 15, 2021, thereby allowing Black Bear to submit a final study plan to the Commission by May 15, 2021.

Please feel free to contact me by e-mail at Kevin.Bernier@brookfieldrenewable.com or by phone at (207) 951-5006 if you have any questions or comments.

Sincerely,

Kevin Bernier

Kevin Bernier
Senior Compliance Specialist

Attachment

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Brookfield File: HSSE 4a/2666/01

Study Report
for the
Evaluation of Downstream Passage Effectiveness for Adult American Eel

Medway Project (FERC No. 2666)

Prepared For
Black Bear Hydro Partners, LLC
Milford, Maine

Prepared By
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February 2021

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1 Introduction

Black Bear Hydro Partners, LLC (Black Bear), an affiliate of Brookfield Renewable (Brookfield), owns and operates the Medway Hydroelectric Project (FERC No. 2666) on the West Branch of the Penobscot River. By order dated March 29, 1999, the Federal Energy Regulatory Commission (FERC) issued the current license for the Medway Project. Articles 404 and 405 of the license required (1) detailed design drawings of the licensee's proposed upstream and downstream American eel passage facilities, along with construction and operation schedules, and (2) a plan for post-construction studies to monitor the effectiveness of the passage facilities. In compliance with the license articles, the licensee filed with FERC the "Medway Hydroelectric Project American Eel Passage Plan" on September 29, 1999. The 1999 study plan provided a description of the downstream passage facility (i.e., bell mouth weir opening in the abandoned fishway gate) and schedule for operation (August 1 through November 15). The Medway eel passage and effectiveness monitoring plan was approved via FERC order on April 24, 2000.

The effectiveness monitoring plan identified the need to determine if adequate numbers of migrating adult eels could be trapped at a location upstream of the Project to use for effectiveness studies. The licensee conducted video monitoring of the downstream fish passage from 2000 to 2003. Specifically, a video camera with infrared lighting was positioned facing downward to monitor the area from the end of the bell mouth weir (fishway discharge) to a point about ten feet downstream. Even with the surface of the flume covered with a white reflective background, the combination of poor image quality and rapid passage of water through the observation area made it impossible to clearly differentiate eels from moving water and background.

The licensee then attempted to capture study animals at a former eel weir location on Millinocket Stream, about 14 miles upstream of the Medway Project. The licensee summarized trapping efforts for the 2004 to 2006 time period (which resulted in insufficient numbers of eels being collected) in their Downstream Eel Passage Effectiveness Assessment Report filed with FERC on March 7, 2007. In a March 27, 2007 Order, FERC concurred with agency and licensee recommendations to postpone evaluation and monitoring efforts for five years. The licensee was further ordered to report to FERC by March 1, 2012 on consultation efforts related to downstream eel passage at Medway.

In conformance with the March 27, 2007 order, the licensee provided an update to FERC on consultation efforts related to eel evaluations at the Medway Project on March 26, 2012. In that correspondence, the licensee committed to a 2012 field effort to further understand eel distribution and abundance upstream of the Project. The licensee filed a report detailing the 2012 silver eel collection efforts upstream of Medway with FERC on March 28, 2013, along with an additional silver eel collection report on March 31, 2014 that detailed a second year of sampling effort. Despite a range of sampling techniques, collections of silver eels upstream of Medway were limited to a small number of individuals during both sampling years.

Out of basin eels were radio-tagged for downstream eel passage studies conducted on the Lower Penobscot River at the Milford, Stillwater and Orono projects during 2016, and that methodology proved successful for evaluation of passage at those locations. As a result, the out of basin methodology was subsequently implemented at the West Enfield Project during the 2017 outmigration period. In correspondence dated September 26, 2019, FERC acknowledged previous acceptance of insufficient numbers of test eels in the Project area to conduct a meaningful passage evaluation. However, considering the successful out of basin approach implemented on the lower river projects, FERC requested that the licensee consult with the resource agencies[1] and the Penobscot Indian Nation (PIN) to develop downstream eel passage study methods for implementation at the Medway Project in 2020.

Study Plan Development:

Prior to performing the downstream passage evaluate for adult American eels at Medway, the licensee developed a draft study plan[2], which was distributed to the resource agencies and PIN on February 26, 2020. The licensee requested that any comments related to the draft 2020 Evaluation of Downstream Passage Effectiveness for Adult American Eel Study Plan be submitted in writing by March 30, 2020. The draft study plan was discussed during a conference call between Black Bear, the resource agencies, and PIN on March 18, 2020. Following receipt and incorporation of agency comments, the final study plan was filed with FERC on June 15, 2020.

Study Report Development:

The 2020 Medway downstream eel passage study was conducted following the methodologies presented in the FERC-filed study plan, and a draft report summarizing results from that effort was distributed to the agencies and PIN on December 15, 2020. Previous to that distribution, the licensees for the Milford, Stillwater, and Orono Projects (each affiliated with Brookfield, including Black Bear) distributed two draft reports summarizing the results of downstream juvenile alosine studies at those Projects on December 10, 2020. As part of those draft report distributions Black Bear indicated a virtual meeting would be held in early January to discuss and requested receipt of written comments by January 11, 2021 (alosine reports) and January 14, 2021 (Medway eel report). At the request of the agencies and PIN, the licensees for the Milford, Stillwater, and Orono Projects submitted a time extension request to the Commission on December 28, 2020 for submittal of the annual eel and alosine study report for these lower Penobscot facilities. The Commission approved this request on January 11, 2021, thereby extending the report submittal deadline to February 15, 2021. Black Bear intended to hold a

[1] Maine Department of Inland Fisheries & Wildlife (MDIFW); Maine Department of Marine Resources (MDMR): Maine Department of Environmental Protection (MDEP); United States Fish and Wildlife Service (USFWS); National Marine Fisheries Service (NMFS); Bureau of Indian Affairs (BIA)

[2] Normandeau (Normandeau Associates, Inc.). 2020. Study Plan for the Evaluation of Downstream Passage Effectiveness for Adult American Eel at the Medway Project (FERC No. 2666). Plan prepared for Black Bear Hydro Partners, LLC.

single virtual meeting to review and discuss the results from all 2020 fish passage studies (including the Medway downstream eel passage study). As a result, Black Bear submitted a time extension request to the Commission on January 13, 2021 seeking to extend the report submittal deadline to February 15, 2021.

A consultation meeting to discuss the 2020 study results was held virtually on January 27, 2021, and Normandeau provided an overview of the study methods and results to representatives from Brookfield, NMFS, USFWS, MDMR, MDEP and the PIN. A summary of questions and comments from the January 27 meeting is provided in Appendix D. Correspondence related to the distribution of the draft study report, as well as written comments received following agency review, are provided in Appendix E. A copy of the PowerPoint slides presented by Normandeau at the January 27, 2021 meeting is also provided in Appendix F.

2 Project Description

The Medway Project is located in the town of Medway, Penobscot County, Maine, on the West Branch of the Penobscot River. Medway Dam spans the West Branch approximately 0.6 miles upstream of its confluence with the East Branch of the Penobscot River. The Project impoundment is 1.2 miles in length with a surface area of approximately 101.5 acres. The Medway Dam is an L-shaped concrete gravity structure consisting of a 343 foot-long spillway section with an average height of 20 feet, a fishway and log sluice section, a 64 foot-long forebay wall section, and a 170 foot-long intake section covered with bar racks with 2.25 inch clear spacing. The intake section leads directly to the powerhouse that is an integral part of the dam. The spillway section is topped by 68 inch-high wooden flashboards. The powerhouse contains five vertical Francis turbines, each with a capacity discharge of 690 cfs. The units have a runner diameter of 8.7 feet, a rotational speed of 100 rpm, and a gross head of 18.9 feet at full pond. Downstream passage at the Project consists of a sluice gate, which was retrofitted with a 3 foot wide by 6 foot tall bell mouth weir and flume that has been operated since 2000. The bypass entrance is located at the end of the spillway adjacent to the forebay. The weir constricts down to a 5-inch opening, can pass approximately 15 cfs of flow, and sits in the top portion of the water column. The Project is operated in run-of-river mode with a full impoundment elevation of 260.3 ft MSL.

3 Downstream American Eel Passage

3.1 Study Objectives

The objectives of the 2020 downstream passage evaluation for adult American eels at Medway were to:

1. Evaluate project residence time immediately upstream of the Project,
2. Quantify downstream passage route selection, and
3. Estimate total Project survival.

3.2 Field Methodology

3.2.1 Radio Telemetry Equipment

Downstream passage of radio-tagged adult American eels at the Medway Project was documented via a series of stationary radio telemetry receivers. Installed radio telemetry equipment included Orion receivers, manufactured by Sigma Eight, as well as SRX receivers manufactured by Lotek. Receivers were installed following consideration of the detection requirements for the specific area of coverage, as well as the attributes of the receiver model. The Orion receiver is a broadband receiver capable of monitoring multiple frequencies simultaneously within a 1-MHz band, and it is most useful for monitoring tagged fish in areas where movement through the monitoring zone can occur quickly (e.g., the downstream bypass). Although Lotek receivers have a greater detection range than Orion receivers, they can only monitor a single frequency at a time and require frequency switching, which decreases detection efficiency in areas where fish may pass at high rates of speed. As part of monitoring adult downstream eel passage at Medway, Lotek receivers were used at locations requiring longer range and where the intended detection areas are characterized by relatively slow transit speeds for tagged fish (e.g., the approach area in the Medway headpond).

Several types of antennas were used for this study, including aerial Yagi antennas and custom-made underwater antennas (dropper antennas). Yagi antennas were primarily used to confirm the presence of radio-tagged eels within the Project forebay and spillway areas, as well as at the downstream monitoring stations where detection across the full width of the river was required. Dropper antennas were placed at appropriate depths within downstream passage routes and were used to determine route selection (e.g., via the downstream bypass system). Dropper antennas were custom built by stripping the shielded end of RG58 coaxial cables.

Adult silver-phase eels were tagged using transmitters manufactured by Sigma-Eight (model TX-PSC-I-450). The TX-PSC-I-450 transmitters measured approximately 12 x 12 x 46 mm, weighed 8.5 g, and had an estimated battery life of 357 days at the programmed 2.0 second burst rate. Transmitters for this study operated on one of two distinct frequencies (149.400 or 149.340 MHz).

3.2.2 Monitoring Stations

A total of nine stationary receiver locations were installed at Medway, as well as at points downstream of the Project. Each monitoring station consisted of a data-logging receiver, antenna, and a power source. Each was configured to receive transmitter signals from a designated area continuously throughout the study period. During installation of each station, range testing was conducted to configure the antennas and receivers in a manner which maximized detection efficiency at each location. The operation of the system as a whole was confirmed during installation and throughout the study period by using beacon tags. These beacon tags were stationed at strategic locations within the detection range of either multiple or single antennas and emitted a signal at a programmed time interval. These signals were detected and logged by the receivers and used to record the functionality of the system throughout the study period. Although each monitoring station was installed in a manner which limited the ability to detect transmitters from unwanted areas, the possibility of such detections did still exist. As a result, behavioral data collected in this study (i.e., duration at a specific location or passage route) were inferred based on the signal strength and the duration and pattern of contacts documented across the entire detection array.

The locations of the monitoring stations for downstream passage of adult American eels at the Project are outlined below and presented visually in Figure 3-1.

Monitoring Station M1: Station M1 consisted of aerial coverage and was installed in a manner which detected radio-tagged eels as they approached within 200 m of the upstream side of Medway Dam. Detections from this location were used to determine when eels arrived at the Project dam and were a component of the determination of residence time upstream of the dam and prior to passage.

Monitoring Station M2: This station consisted of aerial coverage and was installed in a manner which detected radio-tagged eels as they entered the powerhouse intake area. Detections from this location were used to help inform on downstream passage via the turbine units.

Monitoring Station M3: Station M3 consisted of a single receiver and underwater drop antenna for coverage of the downstream eel bypass. Detections on this receiver were used to identify eels passing downstream via this route.

Monitoring Station M4: Station M4 consisted of a single receiver and underwater drop antenna for coverage of the forebay sluice gate. This station was installed to identify eels passing downstream via this route in the event that this gate was open during the 2020 evaluation.

Monitoring Station M5: This station consisted of aerial coverage and was installed in a manner which detected radio-tagged eels as they entered the powerhouse discharge area. Detections from this location were examined relative to the sequence of previous detections at Stations M2, M3, and M4 to determine downstream passage via the turbine units.

Monitoring Station M6: Station M6 consisted of aerial coverage and was installed in a manner which detected radio-tagged eels following passage downstream of Medway Dam via the spillway. In the event that spill conditions were present at Medway Dam during the study period, detections from this receiver (and an absence of detections at M2, M3, M4, and M5 at the time of passage) were used to identify eels passing downstream via the spillway.

Monitoring Station M7: Station M7 consisted of aerial, cross-river coverage and was installed in a manner which detected radio-tagged eels following passage and as they moved towards the Nicatou Bridge located just downstream of Medway Dam. Detections from Station M7 were used to help confirm the presence of radio-tagged individuals downstream of the dam following passage at one of the available routes.

Monitoring Station M8: Station M8 served as a first stationary receiver location downstream of Medway, and detections from this location were used to inform on downstream passage survival of radio-tagged eels. Station M8 was installed approximately 3.0 miles downstream of Medway Dam off of Dickey Moore Road in Medway, Maine. Station M8 consisted of a single receiver and aerial antenna installed to ensure full coverage of the river (i.e., bank to bank).

Monitoring Station M9: This station consisted of aerial coverage and was installed facing upstream in a manner to detect radio-tagged eels as they approached the Mattaceunk Project dam (Weldon Dam). Detections from Station M9 were used to inform passage survival determination for radio-tagged eels following downstream passage at Medway.

3.2.3 Tagging and Release Procedures

Adult silver-phase American eels were obtained from a commercial trapping operation on the St. Croix River in eastern Maine. Study eels were transported by truck on October 12th from the St. Croix River by the vendor to a temporary tank facility established downstream of Medway at the West Enfield Project. Transported eels were held for at least 24 hours prior to any tagging. In advance of tagging, eels were visually examined; healthy eels suitable for tagging were then anesthetized in a clove oil and ethanol solution. Eels were held and visually monitored in the anesthesia bath until sufficiently sedated. Once sedated, eels were removed from the bath and placed in a specially designed restraining holder (Figure 3-2). The total length and eye diameter (horizontal and vertical; nearest 0.1 mm) were measured. A previously described correlation between eye size, body length, and gonad development was used to confirm whether individuals were mature and could be considered as active “silver phase” outmigrants (Pankhurst, 1982). This eye index relationship (I) was described using the formula:

$$I = \left[\frac{\left(\frac{A+B}{4}\right)^2 \pi}{L}\right] * 100$$

where A = horizontal eye diameter, B = vertical eye diameter, and L = total body length. Silver-phase American eels typically have an eye index between 6.0 and 13.5, with a bronze coloration along the lateral line that separates the dark, silver back from the white belly. Although eels collected from the St. Croix have a high probability of being silver eels based on the weir methodology used to collect them, eye measurements were recorded regardless.

For tagging, an incision was made off-center on the ventral surface of the individual. A hollow needle was inserted into the incision and pushed through the body wall just off the ventral mid-line and at a point posterior to the incision. The antenna was then fed through the needle and gently pulled so that the transmitter enters the body cavity. The needle was pulled through the body wall and removed from the antenna. The transmitter was positioned by pulling the antenna so that it lay directly under the incision. The incision was closed with two or three interrupted sutures. A small amount of an antibacterial ointment was applied to the incision site to prevent infection. Following tagging, each individual was transferred to a second holding tank supplied with ambient river water for an additional 24-hour observation/recovery period.

A total of 50 radio-tagged adult American eels were transported by truck from the holding tank at West Enfield and released into the West Branch of the Penobscot River towards the upper extent of the Medway Project impoundment (roughly one-half mile below the East Millinocket dam at the former East Millinocket Mill site). Two separate release events were conducted: one on October 15 and one on October 16, with each event consisting of 25 radio-tagged individuals. Both releases were conducted during the evening hours (~ 17:45 hrs).

3.2.4 Data Collection

3.2.4.1 Stationary Telemetry Data

Data were off-loaded from receivers using a laptop computer and stored on a removable memory stick. Data downloads occurred weekly during the period from the initial tag and release date until November 15, 2020, following closure of the Medway downstream bypass. Backup copies of all telemetry data files were made prior to receiver initialization. Field tests to ensure data integrity and receiver performance included confirmation of file integrity, confirmation that the last record was consistent with the downloaded data (beacon tags were critical to this step), and lastly, confirming that the receiver was operational upon restart and actively collecting data post download. The field data collection procedures were part of the overall project QA/QC standards. Within a data file, transmitter detections were stored as a single event (i.e., single data line). Each event included the date and time of detection, frequency, ID code, and signal strength.

3.2.4.2 Manual Telemetry Data

To provide supplemental detection information to the stationary receiver data set, manual tracking was conducted during the monitoring period. Manual tracking was conducted by foot/truck in accessible areas located immediately upstream and downstream of the Medway Dam on each receiver download date. In addition, a single boat-based manual tracking event was conducted on November 18, 2020, which covered the section of the Penobscot upstream of Medway Dam to the release site, and then downstream of Medway Dam to Weldon Dam.

3.2.4.3 River and Project Operational Data

In addition to the manual and stationary radio telemetry data, river and project operations data were collected during the 2020 evaluation period. River temperature was recorded on an hourly basis via a logger installed into the Medway headpond just upstream of the powerhouse.

Project discharge (unit and waste), unit operations (total cfs), and downstream bypass settings were obtained from Brookfield upon completion of the study period. The Project was operated under "baseline" conditions for the study period (i.e., units in operation and downstream bypass system open).

During development of the study plan, the resource agencies requested additional site and passage condition information at Medway during the eel monitoring period. This included lunar cycle, precipitation, bypass approach velocity, and photographs of downstream passage routes taken during receiver download events.

3.2.4.4 Downstream Drift and Travel Assessment

In addition to the 50 radio-tagged eels released upstream of Medway, a total of six freshly dead and four live adult American eels were radio-tagged and released downstream of Medway Dam during the 2020 study period. Concurrent with each upstream release group, a total of three freshly dead individuals and two live individuals were radio-tagged and released downstream. On a given eel release date, downstream test eels were released as follows:

- One (1) whole-body dead radio-tagged eel released into the downstream bypass;
- One (1) whole-body dead radio-tagged eel released into the discharge of an operating turbine unit;
- One (1) partially severed dead radio-tagged eel released into the discharge of an operating turbine unit;
- One (1) live radio-tagged eel released into the downstream bypass; and
- One (1) live radio-tagged eel released into the discharge of an operating turbine unit.

The downstream progression of these individuals was recorded by stationary receivers M8 and M9.

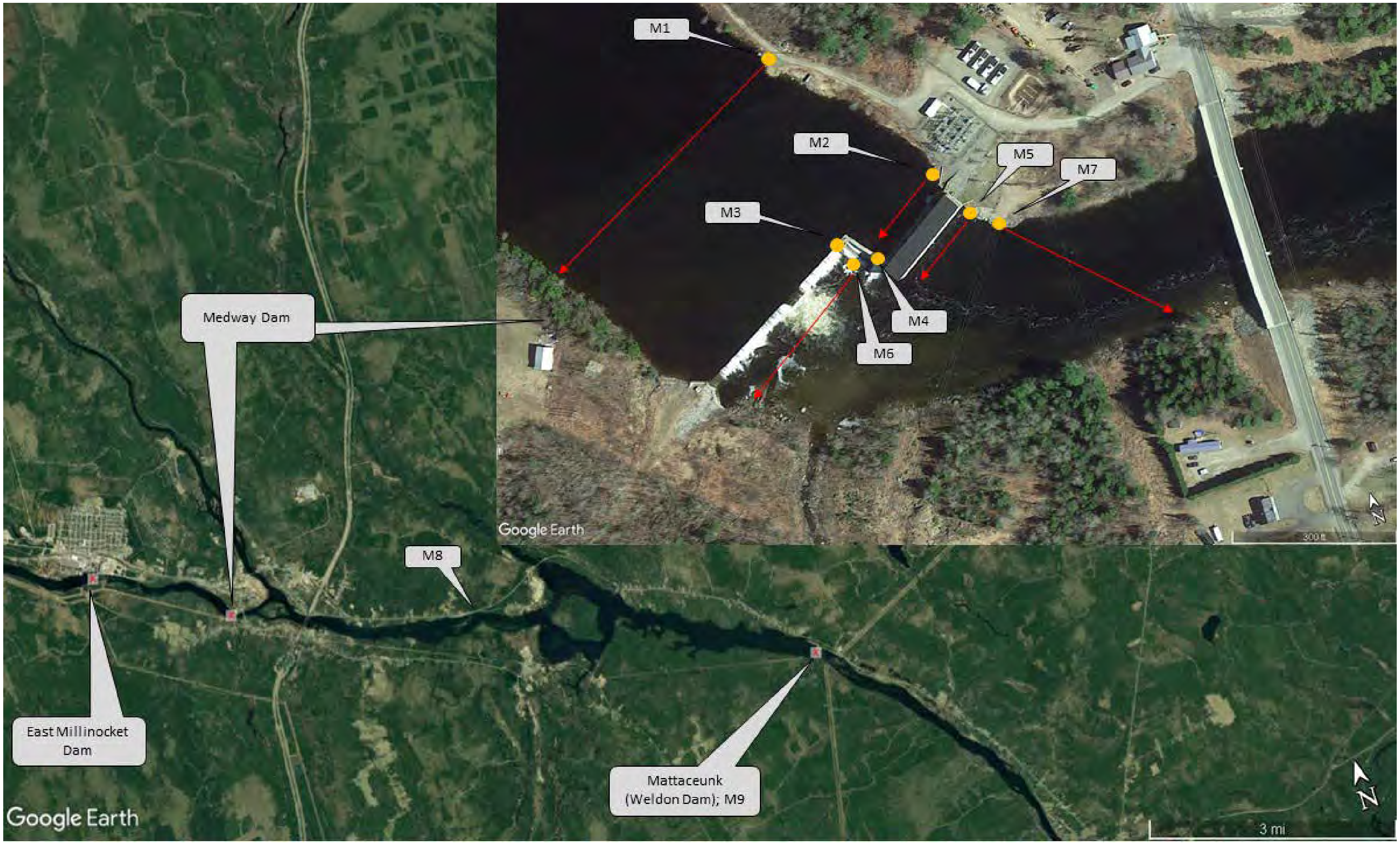


Figure 3–1. Approximate locations and coverage areas for Monitoring Stations installed for evaluation of downstream passage of adult American eels at Medway during 2020.

Figure 3–2. Restraint device for holding and positioning adult silver eels during radio-tagging.

3.3 Analysis and Reporting

3.3.1 Upstream Residency Time and Downstream Passage Routes

Following completion of field data collection and processing, a complete record of all valid detections for each uniquely coded radio-tagged silver eel was generated, and the pattern and timing of detections in these individual records was reviewed. For the full set of radio-tagged eels released into the West Branch upstream of Medway Dam, the arrival, passage times, and downstream route of passage were determined. In instances where a specific passage route was not clearly defined by the available data, the passage route for that individual was classified as “unknown”.

The stationary telemetry dataset collected using the monitoring stations described above also permitted the evaluation of residence time for radio-tagged silver eels between any two adjacent monitoring stations both prior to and following downstream passage. Passage duration through any defined river reach was calculated as the duration from initial detection at the stationary receiver on the upstream end of the reach until initial detection at the stationary receiver on the downstream end of the reach. For radio-tagged eels which approached Medway Dam, a ‘project residence duration’ was defined as the duration of time from initial detection at the dam (i.e., detection at Monitoring Station M1) until successful downstream passage at the Project.

3.3.2 Parameter Estimates for Evaluation of Project Survival

Survivorship (*Phi*) and detection (*p*) probabilities were estimated for eel passage at Medway using a Cormack-Jolly Seber model (CJS) constructed in Program MARK (White and Burnham 1999). Parameter estimates for *Phi* and *p* were obtained using the encounter histories constructed for each radio-tagged individual indicating their presence or absence at detection locations from the approach receiver (i.e., 200 m upstream of the dam) through the first receiver downstream of the Project (i.e., Station M8). The CJS model generated reach-specific survival estimates for radio-tagged eels released upstream of Medway from:

a) the point 200 m upstream of the dam until passage downstream; and
b) from passage by the dam until the first downstream receiver (i.e., Station M8).

The joint probability of the two reach-specific survival estimates was used as the estimate of total Project survival. This approach assumed that the background mortality (i.e., natural mortality such as predation) was negligible for adult eels in the 200 m reach upstream of the dam, as well as the reach downstream of the dam to Station M8, and that the observed losses are attributable solely to Project effects. The use of this assumption resulted in a minimum estimate of total Project survival for adult American eels passing downstream of the Medway Dam.

To evaluate survival using Program MARK, a suite of candidate models were developed based on whether survival, recapture (i.e., detection), or both, vary or are constant among stations. Models run included:

- *Phi*(t)*p*(t): survival and recapture may vary between receiver stations;
- *Phi*(t)*p*(.): survival may vary between stations; recapture is constant between stations;
- *Phi*(.)*p*(t): survival is constant between stations; recapture may vary between stations;
- *Phi*(.)*p*(.): survival and recapture are constant between stations;

Where;

- *Phi* = probability of survival
- *p* = probability of detection
- (t) = parameter varies
- (.) = parameter is constant

Prior to comparison among models, a goodness of fit test was conducted for the “starting model” (i.e., the fully parameterized model) using the function RELEASE within Program MARK. Akaike’s Information Criterion (AIC) was used to rank the models as to how well they fit the observed mark-recapture data. Lower AIC values denote a more explanatory yet parsimonious fit than higher AIC values.

Drift information collected from freshly-dead eels intentionally released downstream of the Project (see Section 3.2.4.4) was reviewed during the compilation of encounter histories. Test eels reaching Station M8 in a duration of time longer than the median duration recorded for dead individuals released directly in the tailrace were classified as a Project mortality.

Models were subsequently prepared which evaluated the downstream passage success of adult eels at Medway as follows:

- All eels – based on detection of individuals from upstream release groups at Stations M1, M8, and M9;
- All eels – adjusted for median “travel time” for freshly dead eels released in the Medway tailrace to reach Station M8 (i.e., test eels with downstream travel times in excess of median drift duration manually adjusted to reflect a mortality at the Project); and
- All eels – by downstream passage route (where sample size was adequate).

4 Results

4.1 Penobscot River Conditions and Project Operations

Figure 4-1 presents Medway Station flow (i.e., the sum of unit discharge) and water temperature for the period October 15 to November 15, 2020. Medway Station flow ranged between 1,996 and 3,958 cfs during the fall study period. Mean daily river flow was below station capacity at 3,045 cfs and 2,867 cfs on the two dates of release for radio-tagged silver eels (October 15 and October 16). Water temperatures ranged between 12.4 and 4.6°C from the time of first release until the end of monitoring period. Mean daily Penobscot River temperatures were 11.6-12.5 °C on the two release dates for radio-tagged adult eels.

Turbine units in the Medway powerhouse were in operation throughout the study period. Due to relatively low flow conditions in the West Branch of the Penobscot River, there were no significant spill events during the monitoring period. Figure 4-2 provides the daily cumulative precipitation (as recorded at the USGS gage station 451031069185301 near Dover-Foxcroft, Maine) versus mean daily total flow at Medway. Precipitation events in excess of 0.25 inches were limited to October 16-17, November 1-3, and November 15. Precipitation on October 16-17 coincided with the presence of radio-tagged eels upstream of Medway Dam and resulted in a minor (~500 cfs) increase in mean daily total flow at Medway. The downstream bypass was operated normally throughout the study period, passing a relatively constant 15 cfs until closure on November 15. An approach velocity was measured at 7.0 ft/s for the Medway downstream bypass on October 15. The measurement was taken at approximately 3 feet of depth and 2.5 feet in front of the entrance.

Table 4-1 provides a summary of moon phase, rise, and set times during the Medway eel monitoring period. Releases were conducted under a waning crescent (October 15) and new moon (October 16). As requested by the resource agencies, a series of site photographs of potential passage routes were taken by staff conducting receiver downloads throughout the monitoring period. Those photographs can be found in Appendix C.

Table 4–1. Lunar phase and rise/set times for study period – October 15-November 15, 2020

Date	Moon		Moon Phase[3]
	Rise	Set	
10/15/20	3:57AM	4:41PM	Waning Crescent
10/16/20	5:19AM	5:07PM	New Moon
10/17/20	6:42AM	5:35PM	Waxing Crescent
10/18/20	8:04AM	6:07PM	Waxing Crescent
10/19/20	9:26AM	6:45PM	Waxing Crescent
10/20/20	10:43AM	7:31PM	Waxing Crescent
10/21/20	11:51AM	8:25PM	Waxing Crescent
10/22/20	12:48PM	9:26PM	Waxing Crescent
10/23/20	1:33PM	10:32PM	First Quarter
10/24/20	2:09PM	----	Waxing Gibbous
10/25/20	2:39PM	11:38PM	Waxing Gibbous
10/26/20	3:03PM	12:45AM	Waxing Gibbous
10/27/20	3:24PM	1:49AM	Waxing Gibbous
10/28/20	3:43PM	2:52AM	Waxing Gibbous
10/29/20	4:03PM	3:54AM	Waxing Gibbous
10/30/20	4:23PM	4:57AM	Waxing Gibbous
10/31/20	4:44PM	5:59AM	Full Moon
11/1/20	5:08PM	7:02AM	Waning Gibbous
11/2/20	5:36PM	8:06AM	Waning Gibbous
11/3/20	6:09PM	9:09AM	Waning Gibbous
11/4/20	6:51PM	10:10AM	Waning Gibbous
11/5/20	7:41PM	11:07AM	Waning Gibbous
11/6/20	8:40PM	11:57AM	Waning Gibbous
11/7/20	9:47PM	12:40PM	Waning Gibbous
11/8/20	10:58PM	1:17PM	Last Quarter
11/9/20	----	1:48PM	Waning Crescent
11/10/20	12:13AM	2:15PM	Waning Crescent
11/11/20	1:30AM	2:40PM	Waning Crescent
11/12/20	2:48AM	3:05PM	Waning Crescent
11/13/20	4:08AM	3:31PM	Waning Crescent
11/14/20	5:31AM	4:01PM	Waning Crescent
11/15/20	6:54AM	4:35PM	New Moon

[3] Data obtained from:
https://www.weatherforyou.com/reports/index.php?forecast=solunar&zipcode=04462&pands=&place=millinocket&state=me&country=us&smon=11&syear=2020&submit=Go

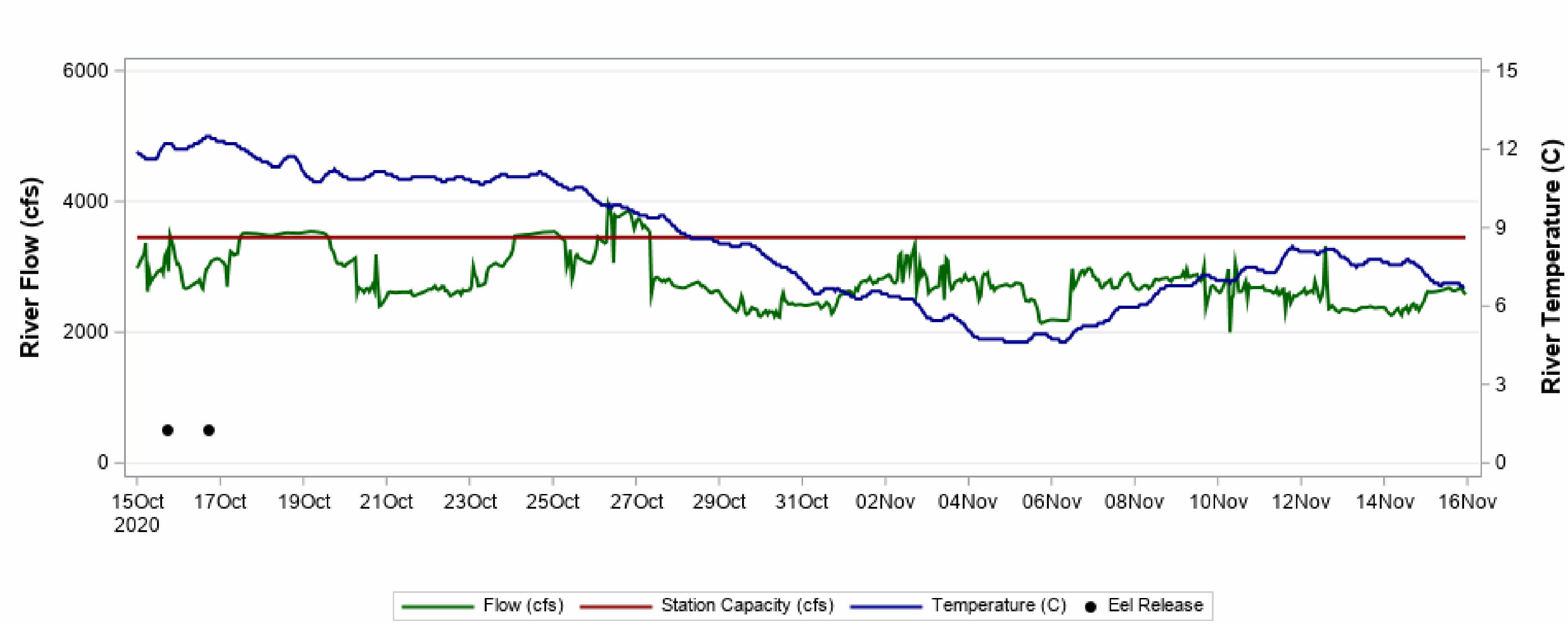


Figure 4-1: Total flow and water temperature as recorded at Medway for the period October 15 to November 15, 2020.

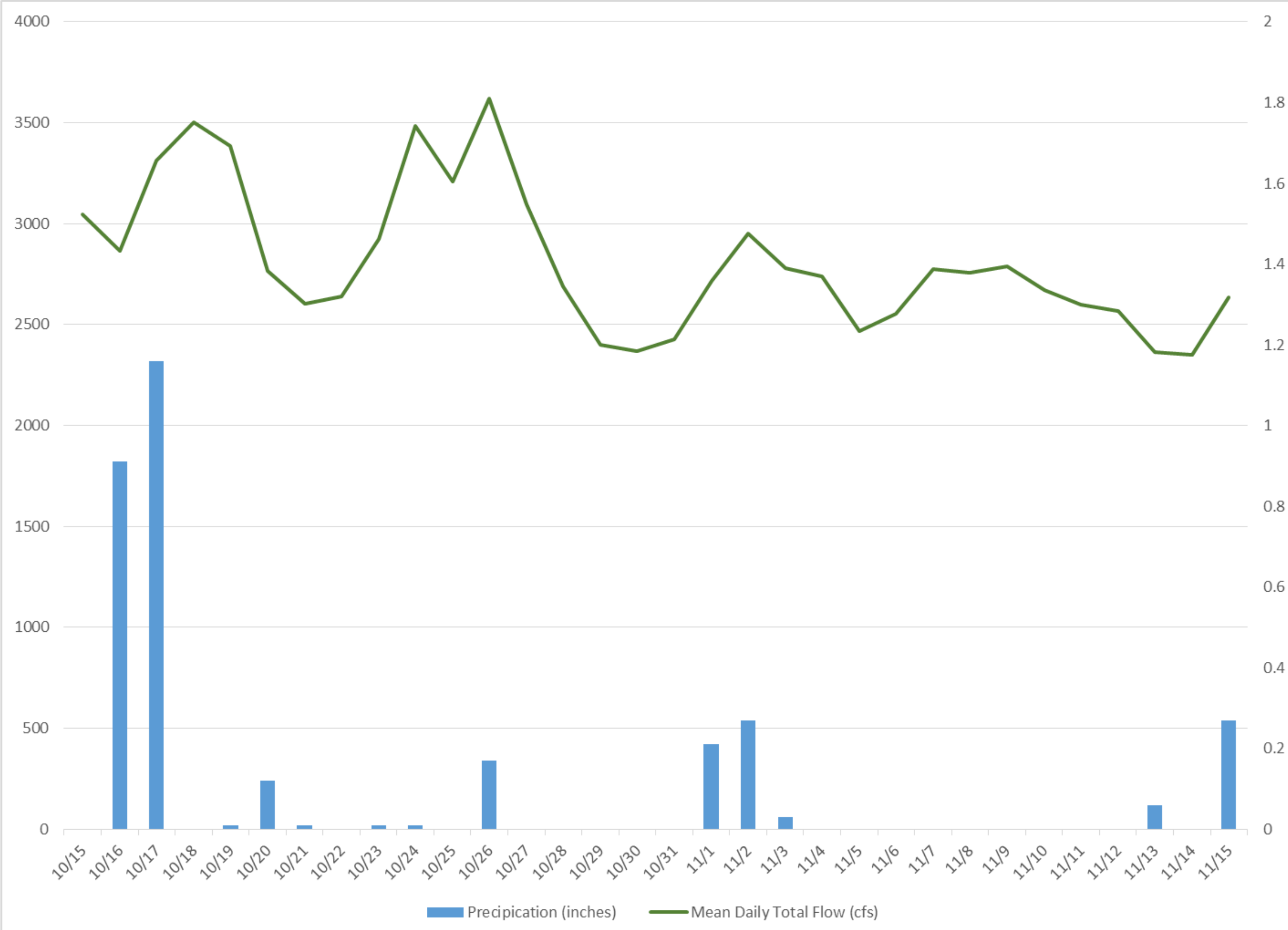


Figure 4-2: Daily precipitation (as recorded at Dover-Foxcroft) and mean daily total flow at Medway for the period October 15 to November 15, 2020.

4.2 Monitoring Station Functionality

Radio-tagged adult American eels were released upstream of Medway into the West Branch of the Penobscot River beginning on October 15, 2020, and the study plan called for continuous monitoring at each stationary receiver location until completion of the downstream passage season (i.e., removal of the downstream bypass facility on November 15). With the exception of a single location (Station M1), each of the radio telemetry monitoring stations installed to evaluate eel passage at Medway during the fall study operated without issue for the full period.

The Lotek receiver installed at Station M1 suffered an internal malfunction following its initial installation and pre-release check, which caused an interruption in coverage for the upstream approach from 1700 on October 15 until 1000 on October 16. Upon identification of this issue, the initial receiver was removed and replaced with a second Lotek unit. The replacement receiver operated without interruption for the duration of the monitoring period. It should be noted that the receiver failure at Station M1 resulted in missing "approach" data at the 200 m mark upstream of Medway Dam for individuals from the first release group. Although Station M1 was offline at the time of approach for those individuals, detections were still available from receivers operating at Stations M2 through M9; as a result, downstream passage route selection could still be determined. Initial detections from the set of receivers monitoring the area upstream of Medway (i.e., Stations M2, M3 or M4) were used as a surrogate for "arrival time", and estimates of upstream project residence time were calculated using those values.

4.3 Medway Project Residence and Downstream Passage

A total of 50 silver-phase American eels were delivered to holding tanks at West Enfield on October 12, 2020 (Table 4-2). Eels were held overnight and then visually evaluated the following day to ensure they were active in the tank following transport. Eels were tagged and released in two groups of 25 individuals each. Releases upstream of Medway occurred on October 15 and 16. Eels obtained and tagged as part of the 2020 passage evaluation ranged in length from 646 to 960 mm, with the majority of individuals between 700-800 mm (Figure 4-3). Eye index values recorded as part of this study (6.2-13.4) were all within the reported range (6.0-13.5) for outmigrating eels. A listing of tagging and biocharacteristic information for eels released during the 2020 study is provided in Appendix A.

4.3.1 Return Duration

A summary of the approach durations (i.e., the duration of time from release into the river until arrival at Medway Dam as primarily determined by detection at Station M1) for radio-tagged eels released upstream of Medway on October 15 and 16 is provided in Table 4-3 and illustrated in Figure 4-4. As described in Section 4.2, the first detection at Station M2, M3, or M4 was used as a surrogate for arrival time at the dam to evaluate approach duration for some eels released on October 15. When adult eels from both releases are considered, the median approach duration was 5.5 hours (range = 4.2 hours to 4.4 days).

4.3.2 Project Residence Time

The duration of time radio-tagged individuals were present upstream of Medway was determined for all individuals which approached and eventually passed downstream. Upstream residence duration was calculated as the duration of time from release until confirmed downstream passage via one of the available routes. When all individuals are considered, upstream residence time prior to downstream passage ranged between 5.1 hours to 4.5 days (median = 7.4 hours; Table 4-4; Figure 4-5). Of the radio-tagged eels which approached Medway Dam, 62% passed in fewer than 24 hours following initial detection at the dam. A total of 16% of outmigrating American eels took greater than two days (48 hours) to pass downstream of Medway following initial detection at the dam.

4.3.3 Downstream Passage

A summary of passage route utilization for the 50 radio-tagged silver eels released upstream of Medway Dam is presented in Table 4-5. The majority of individuals passed downstream of the dam via the turbines (84%). In addition, one individual (2%) passed via the downstream bypass. Although confirmed to have passed downstream based on detections at Stations M8 and M9, six eels had inconclusive passage routes, and one individual had not passed downstream of Medway Dam as of the removal of monitoring equipment on November 18. No radio-tagged eels were detected using the spillway or the forebay sluice, as there was no spill recorded and the forebay sluice gate was restricted to minimal leakage during the study period.

Radio-tagged silver eels were observed passing downstream of Medway Dam between the dates of October 15 and October 21 (Figure 4-6). The majority of individuals passed downstream at dusk or at night, with two peaks in the number of downstream passage events during the hours of 1900 and 0200 (Figure 4-7).

4.3.4 Downstream Transit Durations

Two monitoring stations were installed downstream of the Project for the purpose of detecting radio-tagged adult eels following passage at Medway Dam. Those receivers were located approximately 3.0 miles downstream of the dam (Monitoring Station M8) and 7.5 miles downstream (Monitoring Station M9). Monitoring Station M9 was located at Weldon Dam and recorded arrival times for radio-tagged adult eels at the downstream end of the study reach. The range of downstream transit times through these reaches are presented in Table 4-6. Median transit times for radio-tagged eels downstream of Medway were 8.1 and 11.4 hours, respectively, for the reaches from Medway to Station M8 and from Station M8 to Station M9. Of the 49 radio-tagged adult silver eels which passed downstream at Medway, 44 (90%) were determined to have reached Weldon Dam. Downstream transit times for those individuals ranged between 3.0 hours to 23.0 days (median = 29.5 hours; Figure 4-8).

4.3.5 Downstream Drift and Live Eel Assessment

Table 4-7 provides a summary of the release schedule and date-time of first detection for the drift eels to arrive at monitoring stations downstream of Medway (Stations M8 and M9). A total of six freshly dead, radio-tagged American eels were released immediately downstream of Medway Dam during the 2020 evaluation period. These individuals were placed either directly into the upper portion of the discharge from an active turbine unit or into the discharge of the downstream bypass. Of the six freshly dead eels radio-tagged eels released at Medway, three were subsequently detected downstream at Station M8 (3.0 miles downstream of the tailrace) and one was eventually detected at Station M9 (located at Weldon Dam, 7.5 miles downstream of the tailrace). The median duration for a freshly dead radio-tagged eel to drift following its release in the Medway tailrace downstream to Station M8 was 38.7 hours (range = 30.6 – 79.0 hours). The single freshly dead radio-tagged eel reaching Station M9 did so in 2.7 days. Of the three freshly dead eels radio-tagged eels which did not drift the full distance from the tailrace to Station M8, two remained stationary in the Medway tailrace and one was undetected.

In addition to the six freshly-dead eels, a group of four live eels were radio-tagged and released directly into the upper portion of the discharge from an active turbine unit or into the discharge of the downstream bypass (Table 4-7). All four individuals were detected at Station M8 (3.0 miles downstream of the tailrace) and three of the four were eventually detected at Station M9 (located at Weldon Dam, 7.5 miles downstream of the tailrace). Transit from the Medway tailrace to Station M9 at Weldon Dam ranged from 4.2 to 26.7 hours.

4.3.6 Project Survival

4.3.6.1 Project Survival – All Eels

The CJS model *Phi(t)p(t)* provided the best fit for the observed mark-recapture data associated with downstream movements of radio-tagged adult American eels approaching Medway Dam (Table 4-8). The reach-specific survival estimates at Medway ranged between 1.0-0.94 among river reaches from release to dam approach, dam approach to passage, and passage to the first downstream receiver (Table 4-9). The detection efficiency for telemetry receivers recording passage of adult eels at Medway and the remote riverside locations ranged from 1.00 to 0.52. The poor detection efficiency rate (0.52) was estimated for the approach receiver (Station M1) and can be directly attributed to the lack of approach detections for eels released on October 15 when the receiver malfunctioned. However, detection was 1.00 at Station M1 for eels approaching on or after October 16, as well as for the downstream passage receivers at Medway and Station M8.

The CJS-derived survival estimates for the two Medway project reaches (i.e., dam approach (Station M1) to passage; passage to first downstream receiver (Station M8)) were 0.98 and 0.94 (Table 4-9), which resulted in an estimate of survival for the entire project reach (~500 feet upstream of the dam to the first downstream receiver) of 92.0% (75% CI =88.0-96.0%). This estimate of downstream passage survival for adult eels at Medway includes any background (i.e., natural) or tagging-related mortality for the species in the reach from the approach receiver to the first downstream receiver. As a result, this estimate should be viewed as a minimum estimate of total project survival (i.e., those due solely to project effects).

An estimate of survival for the final study reach (i.e., passage from Station M8 to M9) cannot be estimated using the CJS model used to determine passage survival at the Project. In lieu of that, a point estimate was generated based on the number of eels determined to have passed downstream of Station M8 and subsequently detected at Station M9. When those detections are considered, 96% of radio-tagged eels detected at Station M8 (44 of 46 individuals) were subsequently detected at Weldon Dam.

Three of the 49 radio-tagged eels which were confirmed to have passed downstream at Medway failed to reach the first downstream monitoring station (Station M8). Of the silver eels failing to reach the downstream station, all three were known to have passed Medway Dam via the turbines. The route-specific estimate of passage survival for silver eels passing via the Medway turbine units was calculated at 92.8% (75% CI = 88.1-97.6%).

4.3.6.2 Project Survival – Adjustment for Drift

As described in Section 3.3.2, an adjusted estimate for downstream passage survival of adult American eels at Medway was generated following the manual modification of the individual encounter histories for test eels with downstream travel times to Station M8 in excess of the median drift duration observed for freshly dead radio-tagged eels released downstream of the Project (38.7 hours; Section 4.3.5). Based on this assumption, 12 test fish were adjusted because they exhibited downstream transit durations from Medway to Station M8 greater than 38.7 hours (n = 12; range = 47.9 – 650.7 hours).

When informed using the adjusted encounter histories, the CJS model *Phi(t)p(t)* provided the best fit for the observed mark-recapture data associated with the adjusted downstream movements of radio-tagged adult American eels approaching Medway Dam (Table 4-10). The reach-specific survival estimates at Medway ranged between 1.0-0.69 among river reaches from release to dam approach, dam approach to passage, and passage to the first downstream receiver (Table 4-11).

The adjusted CJS-derived survival estimates for the two Medway project reaches (i.e., dam approach (Station M1) to passage; passage to first downstream receiver (Station M8)) were 0.98 and 0.69 (Table 4-11), which resulted in an estimate of survival for the entire project reach (~500 feet upstream of the dam to the first downstream receiver) of 68.0% (75% CI = 60.0-76.0%). This estimate of downstream passage survival for adult eels at Medway includes any background (i.e., natural) or tagging-related mortality for the species in the reach from the approach receiver to the first downstream receiver. As a result, this estimate should be viewed as a minimum estimate of total project survival (i.e., those due solely to project effects).

An adjusted estimate of survival for the final study reach (i.e., passage from Station M8 to M9) cannot be estimated using the CJS model used to determine passage survival at the Project. In lieu of that, a point estimate for the adjusted scenario was generated based on the number of eels determined to have passed downstream of Station M8 and subsequently detected at Station M9. When those detections are considered, 97% of radio-tagged eels detected at Station M8 (33 of 34 individuals) were subsequently detected at Weldon Dam.

4.3.6.3 Project Survival – Modified Adjustment for Drift

The downstream passage durations for the 12 test fish (identified in Section 4.3.6.2) which moved downstream from Medway to Station M8 in greater than 38.7 hours were subsequently examined for the reach from Station M8 to Station M9. During that review it was determined that the duration of time for eight of those twelve individuals to move from Station M8 to M9 was comparable (i.e., within the quartile range (P25 = 3.9 hours; P75 = 25.9 hours)) observed for upstream released live radio-tagged eels which approached Station M8 at a shorter duration than observed for freshly dead eels released in the tailrace. The remaining four individuals were determined to have (1) a duration from Medway to Station M8 in excess of that observed for the freshly dead tailrace release individuals, and (2) failure to reach or a prolonged duration of time to reach Station M9.

Encounter histories for those four individuals were modified to reflect mortality following passage at Medway. When informed using the modified-adjusted encounter histories, the CJS model *Phi(t)p(t)* provided the best fit for the observed mark-recapture data associated with the modified -adjusted downstream movements of radio-tagged adult American eels approaching Medway Dam (Table 4-12). The reach-specific survival estimates at Medway ranged between 1.0-0.86 among river reaches from release to dam approach, dam approach to passage, and passage to the first downstream receiver (Table 4-13).

The adjusted CJS-derived survival estimates for the two Medway project reaches (i.e., dam approach (Station M1) to passage; passage to first downstream receiver (Station M8)) were 0.98 and 0.86 (Table 4-13), which resulted in an estimate of survival for the entire project reach (~500 feet upstream of the dam to the first downstream receiver) of 84.0% (75% CI = 78.0-90.0%). This estimate of downstream passage survival for adult eels at Medway includes any background (i.e., natural) or tagging-related mortality for the species in the reach from the approach receiver to the first downstream receiver. As a result, this estimate should be viewed as a minimum estimate of total project survival (i.e., those due solely to project effects).

A modified -adjusted estimate of survival for the final study reach (i.e., passage from Station M8 to M9) cannot be estimated using the CJS model used to determine passage survival at the Project. In lieu of that, a point estimate for the modified -adjusted scenario was generated based on the number of eels determined to have passed downstream of Station M8 and subsequently detected at Station M9. When those detections are considered, 95% of radio-tagged eels detected at Station M8 (42 of 44 individuals) were subsequently detected at Weldon Dam.

4.3.7 Manual Tracking

In addition to the continuous monitoring provided by the nine stationary receivers installed throughout the Project area and operated from the date of first release (October 15) through the completion of the downstream passage season at Medway (November 15), a total of ten manual detections representing nine individuals were recorded during the study period. Appendix B contains a listing of manual detections along with manual location information, as well as their last known river reach as determined by the stationary receivers.

One individual was recorded on multiple occasions in the Medway headpond and did not pass downstream through Medway Dam during the monitoring period. A total of eight individuals were located a single time within the reach downstream of Medway. Of those, three were detected near to Medway Dam, one in the reach between Medway and Station M8, and four in the reach between Station M8 and M9. Of the eight individuals detected between Medway and Weldon Dams, only four were radio-tagged eels originally released upstream of Medway. The remaining four individuals had been released directly into the discharge from the turbine units.

Table 4–2. Summary of tagging and release information for adult American eels radio-tagged and released upstream of Medway during October 2020

Silver Eels	Release Group	
	#1	#2
Release Location	0.5 mi Upstream of Project	
Release Date	15-Oct-20	16-Oct-20
Release Time	17:22	17:43
River Temperature (°C)	12.2	12.5
Station Discharge (cfs)	3219	2992
Spill Flow (cfs)	0	0
No. Tagged Released	25	25
Min. Total Length (mm)	675	646
Max Total Length (mm)	960	928
Mean Total Length (mm)	795	788

Table 4–3. Minimum, maximum, and quarterly percentiles (P 25, P 50 (median), and P 75) for the observed duration of time for radio-tagged adult American eels to approach Medway following release

Release Group	Approach Duration (hrs)					
	n	Min	Max	P 25	Median	P 75
15-Oct	17	4.3	38.1	5.5	5.7	6.0
16-Oct	26	4.2	106.4	5.1	5.4	6.6
All	**43**	**4.2**	**106.4**	**5.1**	**5.5**	**6.3**

Table 4–4. Minimum, maximum and quarterly percentiles (P 25, P 50 (median), and P 75) for radio-tagged adult American eel upstream residence duration prior to downstream passage at Medway

Release Group	Upstream Residence Duration (hrs)					
	n	Min	Max	P 25	Median	P 75
15-Oct	18	5.1	53.2	6.1	6.4	29.1
16-Oct	25	5.3	107.1	6.6	11.0	37.1
All	**43**	**5.1**	**107.1**	**6.1**	**7.4**	**29.1**

Table 4–5. Summary of downstream passage route distribution for radio-tagged adult American eels at Medway during October 2020

Passage Route	No. of Individuals	Percentage
DS Bypass	1	2
Turbines	42	84
Spillway	0	0
Forebay Sluice	0	0
Unknown	6	12
Did Not Pass	1	2

Table 4–6. Minimum, maximum and quarterly percentiles (P 25, P 50 (median), and P 75) for radio-tagged adult American eel downstream transit duration following downstream passage at Medway

River Reach	Downstream Transit (hrs)					
	n	Min	Max	P 25	Median	P 75
Medway to Station F9 (Weldon)	38	5.2	628.5	20.0	29.5	53.3
Medway to F8	40	2.0	650.7	3.1	8.1	48.4
Station F8 to F9 (Weldon)	44	3.0	550.9	4.0	11.4	24.4

Table 4–7. Summary of the downstream drift distance and duration for freshly dead and live radio-tagged silver eels released in the Medway tailrace during the October 2020 downstream passage assessment

Release Date	River Condition		Frequency (ID)	Total Length (mm)	Release State	Station F8 Arrival		Station F9 Arrival		Drift Duration (hours)		
	Station Flow (cfs)	Spill (cfs)				Date	Time	Date	Time	Medway to M8	M8 to M9	Medway to M9
15-Oct	3,219	0	149.440 (150)	688	Alive – Bypass	10/15	21:43	10/16	1:56	4.4	4.2	8.6
			149.440 (154)	690	Alive – Tailrace	10/21	1:10	-	-	127.8	-	-
			149.440 (151)	741	Dead – Tailrace	-	-	-	-	-	-	-
			149.440 (152)	711	Dead – Bypass	10/19	0:21	-	-	79.0	-	-
			149.440 (153)	925	Dead – Severed, Tailrace	10/16	23:55	10/19	16:03	30.6	64.1	94.7
16-Oct	2,992	0	149.400 (158)	697	Alive – Bypass	10/17	19:30	10/18	22:12	25.8	26.7	52.5
			149.400 (157)	845	Alive – Tailrace	10/17	4:21	10/18	2:28	10.6	22.1	32.8
			149.440 (155)	735	Dead – Tailrace	10/18	8:25	-	-	38.7	-	-
			149.440 (156)	846	Dead – Bypass	-	-	-	-	-	-	-
			149.440 (159)	961	Dead – Severed, Tailrace	-	-	-	-	-	-	-

Table 4–8. CJS model selection criteria for downstream passage of adult American eels at Medway during October 2020

Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Parameters	Deviance
Phi(t)p(t)	126.31	0.00	0.76	1.00	4	1.74
Phi(.)p(t)	128.67	2.36	0.24	0.31	3	6.19
Phi(t)p(.)	187.72	61.42	0.00	0.00	3	65.25
Phi(.)p(.)	188.60	62.29	0.00	0.00	2	68.2

Table 4–9. Reach-specific survival probability estimates (*Phi*), standard errors and likelihood 75 and 95% confidence intervals for radio-tagged adult American eels approaching and passing Medway Dam during October 2020

Reach	Reach Length (mile)	*Phi*	SE	95% CI		75% CI	
Release – US of Medway	1.3	1.00	0.00	-	-	-	-
–US of Medway to DS of Medway	0.2	0.98	0.02	0.87	1.00	0.94	0.99
Pass - Station M8	3.0	0.94	0.03	0.83	0.98	0.89	0.97

Table 4–10. Adjusted CJS model selection criteria for downstream passage of adult American eels at Medway during October 2020

Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Parameters	Deviance
Phi(t)p(t)	156.69	0.00	1.00	1.00	4	5.15
Phi(.)p(t)	186.47	29.79	0.00	0.00	2	39.12
Phi(t)p(.)	209.79	53.11	0.00	0.00	2	62.44
Phi(.)p(.)	240.14	83.46	0.00	0.00	2	92.79

Table 4–11. Adjusted reach-specific survival probability estimates (*Phi*), standard errors and likelihood 75 and 95% confidence intervals for radio-tagged adult American eels approaching and passing Medway Dam during October 2020

Reach	Reach Length (mile)	*Phi*	SE	95% CI		75% CI	
Release – US of Medway	1.3	1.00	0.00	-	-	-	-
–US of Medway to DS of Medway	0.2	0.98	0.02	0.87	1.00	0.94	0.99
Pass - Station M8	3.0	0.69	0.07	0.55	0.81	0.61	0.76

Table 4–12. Modified-adjusted CJS model selection criteria for downstream passage of adult American eels at Medway during October 2020

Model	AICc	Delta AICc	AICc Weight	Model Likelihood	No. Parameters	Deviance
Phi(t)p(t)	136.93	0.00	0.99	1.00	4	4.24
Phi(.)p(t)	145.87	8.94	0.01	0.01	2	17.35
Phi(t)p(.)	196.13	59.21	0.00	0.00	2	67.62
Phi(.)p(.)	207.42	70.49	0.00	0.00	2	78.91

Table 4–13. Modified-adjusted reach-specific survival probability estimates (*Phi*), standard errors and likelihood 75 and 95% confidence intervals for radio-tagged adult American eels approaching and passing Medway Dam during October 2020

Reach	Reach Length (mile)	*Phi*	SE	95% CI		75% CI	
Release – US of Medway	1.3	1.00	0.00	-	-	-	-
–US of Medway to DS of Medway	0.2	0.98	0.02	0.87	1.00	0.94	0.99
Pass - Station M8	3	0.86	0.05	0.73	0.93	0.61	0.76

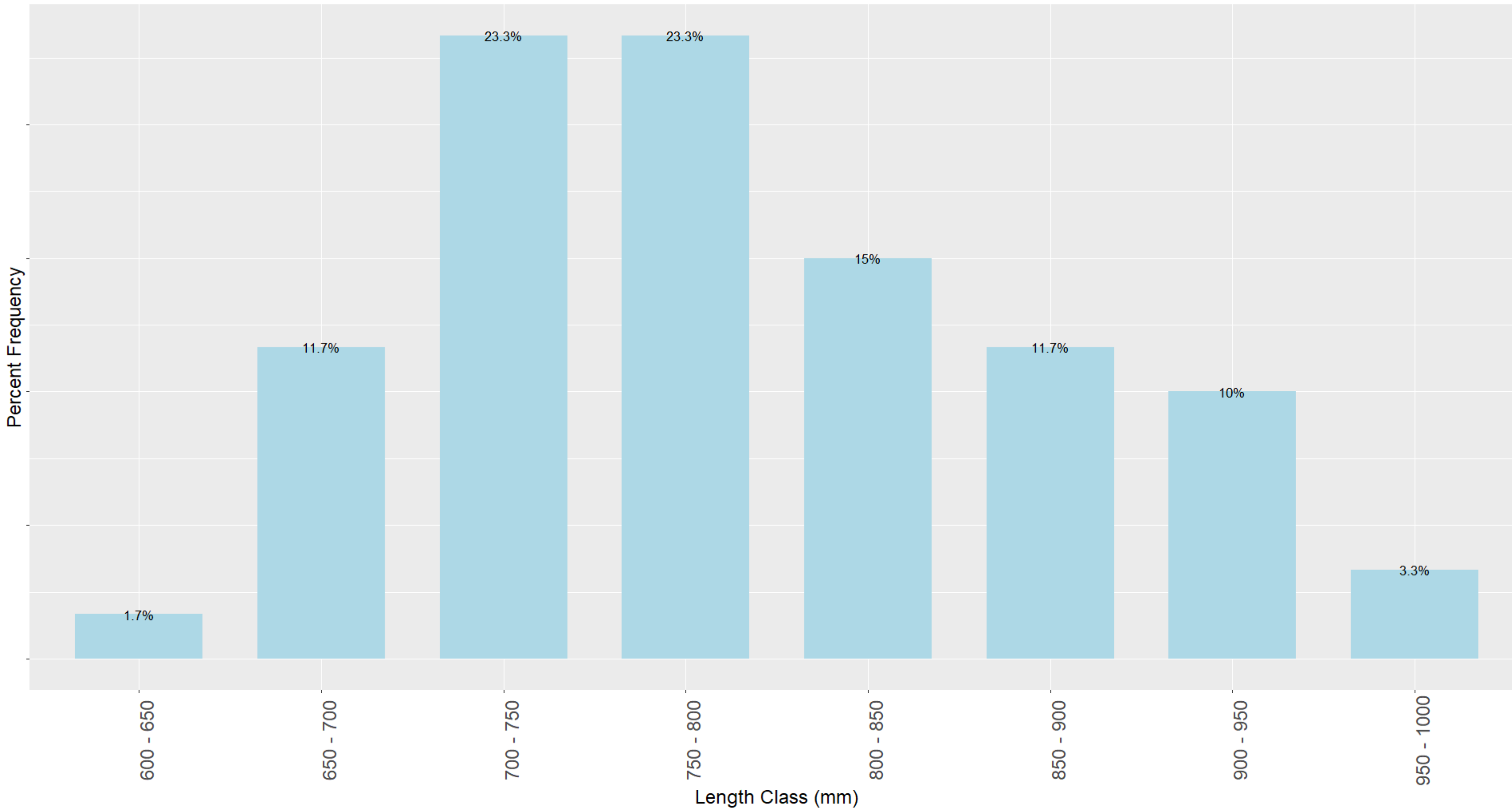


Figure 4-3. Frequency distribution of total length (50 mm length classes) for radio-tagged adult American eels released upstream of Medway.

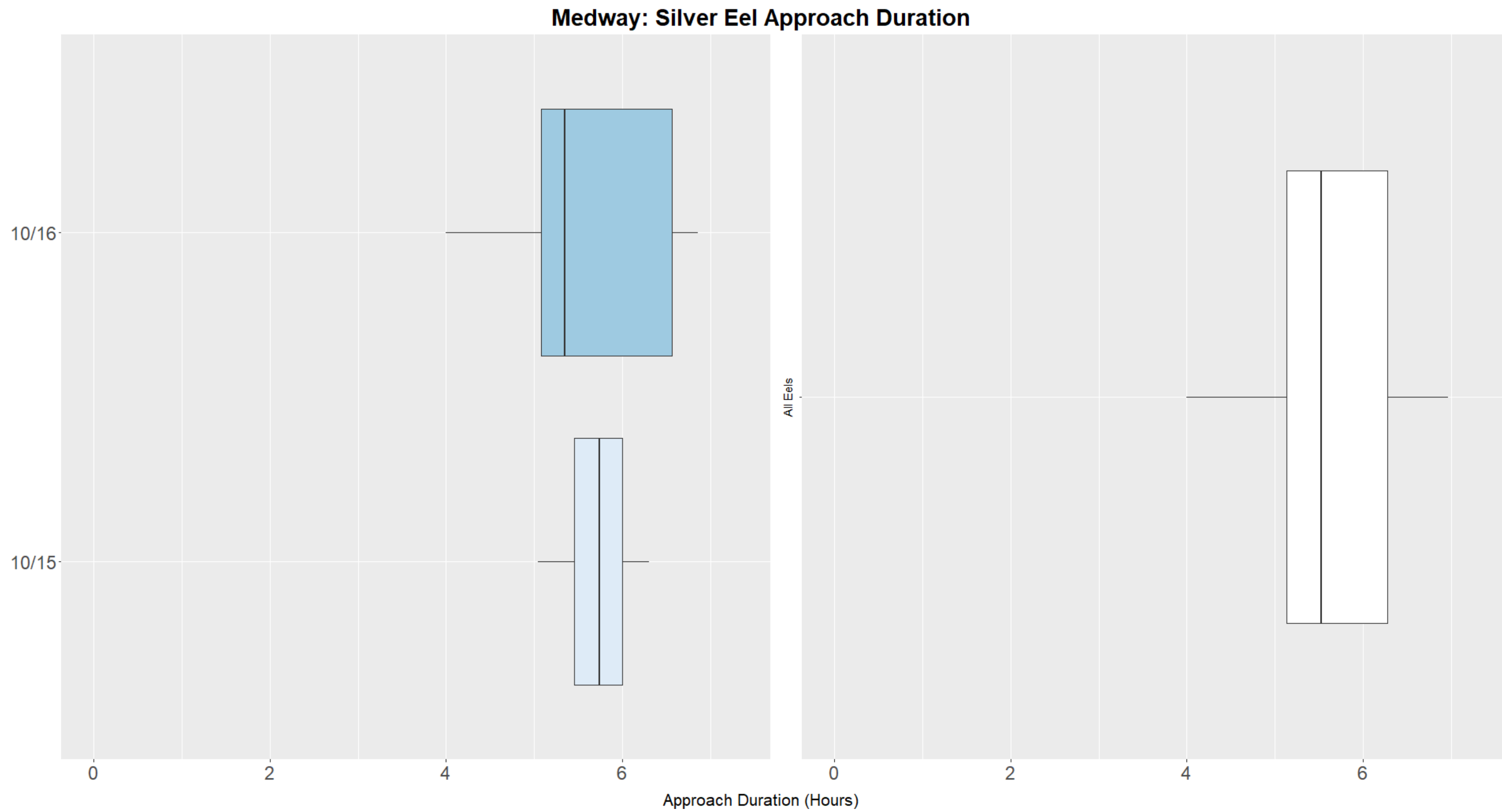


Figure 4-4. Boxplot showing approach duration for radio-tagged adult American eels at Medway prior to downstream passage, October 2020. [4]

[4] The solid line represents the median while left and right portions of the box represent the first and third quartiles, respectively. Whiskers extend to the range of the data within the interquartile range (quartile*1.05) such that outliers outside of this range are not displayed.

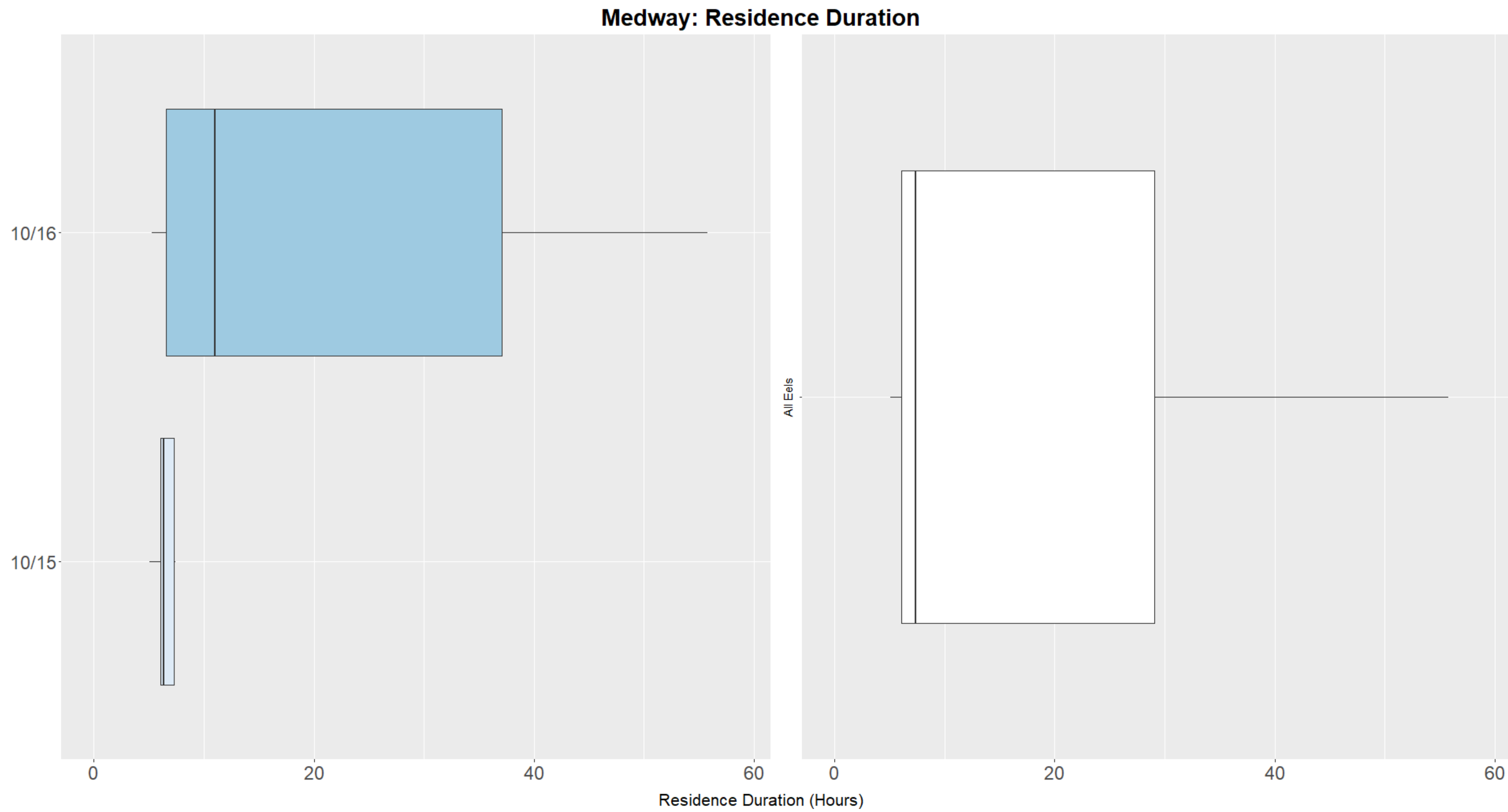


Figure 4-5. Boxplot showing upstream residence duration for radio-tagged adult American eels at Medway prior to downstream passage, October 2020. [5]

[5] The solid line represents the median while left and right portions of the box represent the first and third quartiles, respectively. Whiskers extend to the range of the data within the interquartile range (quartile*1.05) such that outliers outside of this range are not displayed.

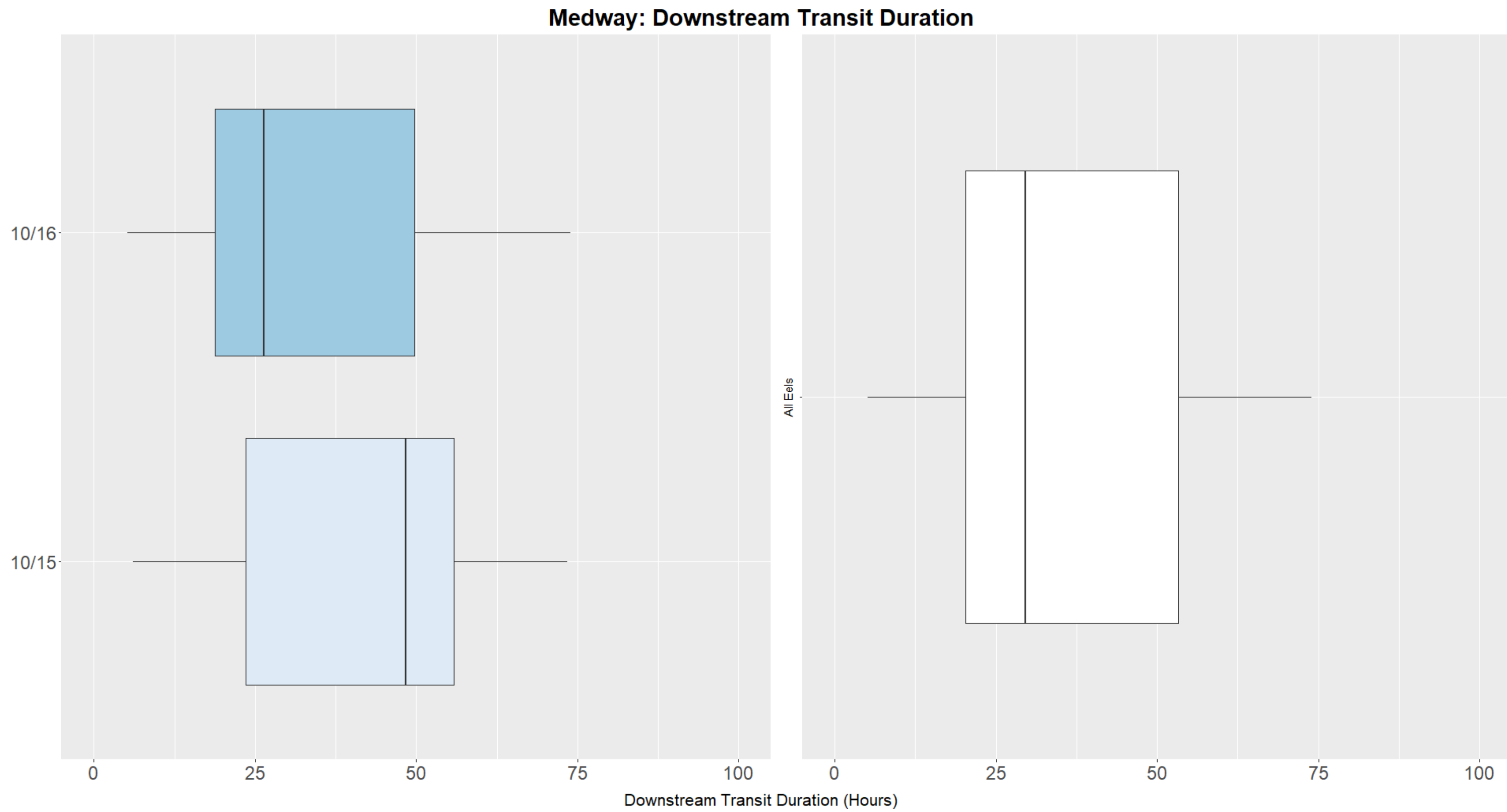


Figure 4-6. Boxplot showing transit duration for radio-tagged adult American eels following downstream passage at Medway until detection at Station M9 during October, 2020. [6]

[6] The solid line represents the median while left and right portions of the box represent the first and third quartiles, respectively. Whiskers extend to the range of the data within the interquartile range (quartile*1.05) such that outliers outside of this range are not displayed.

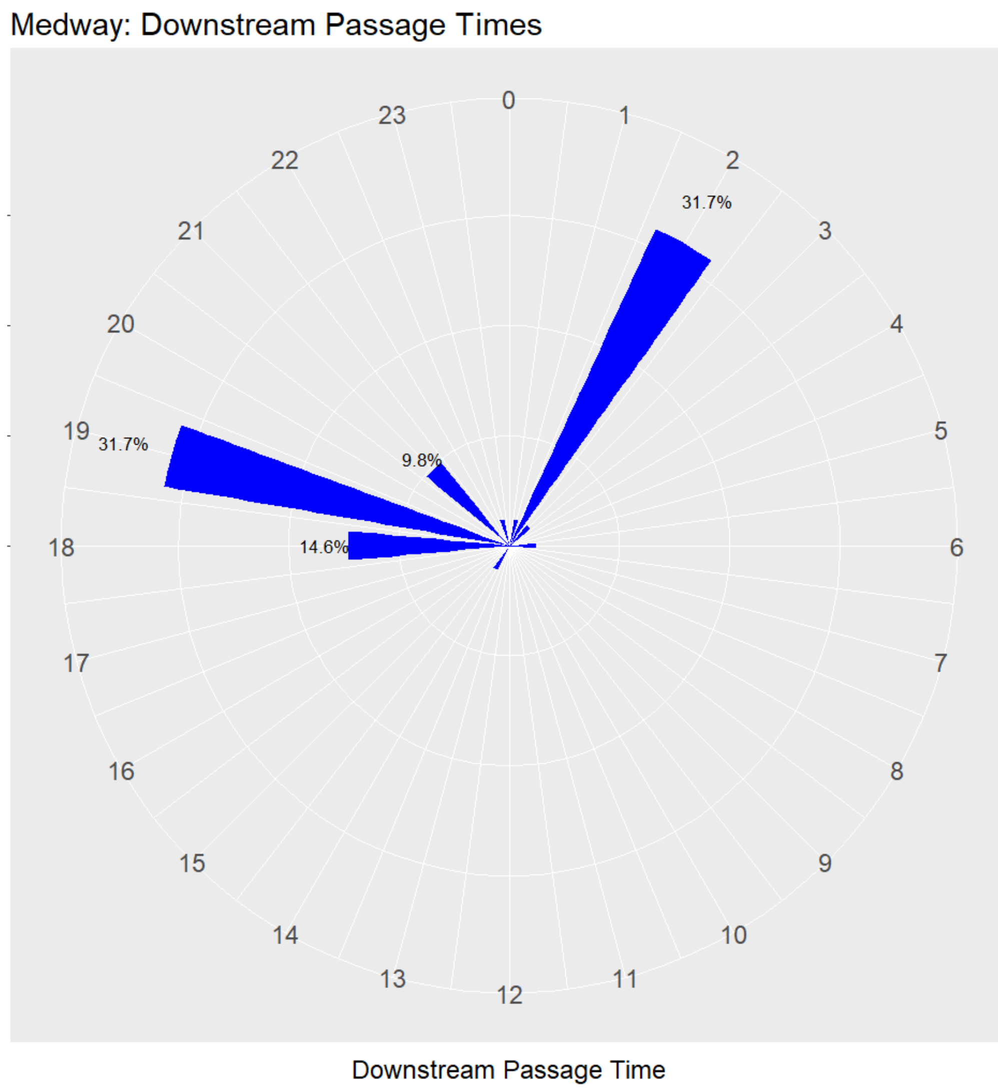


Figure 4-7: Distribution of downstream passage hour for radio-tagged adult American eels at Medway during October 2020.

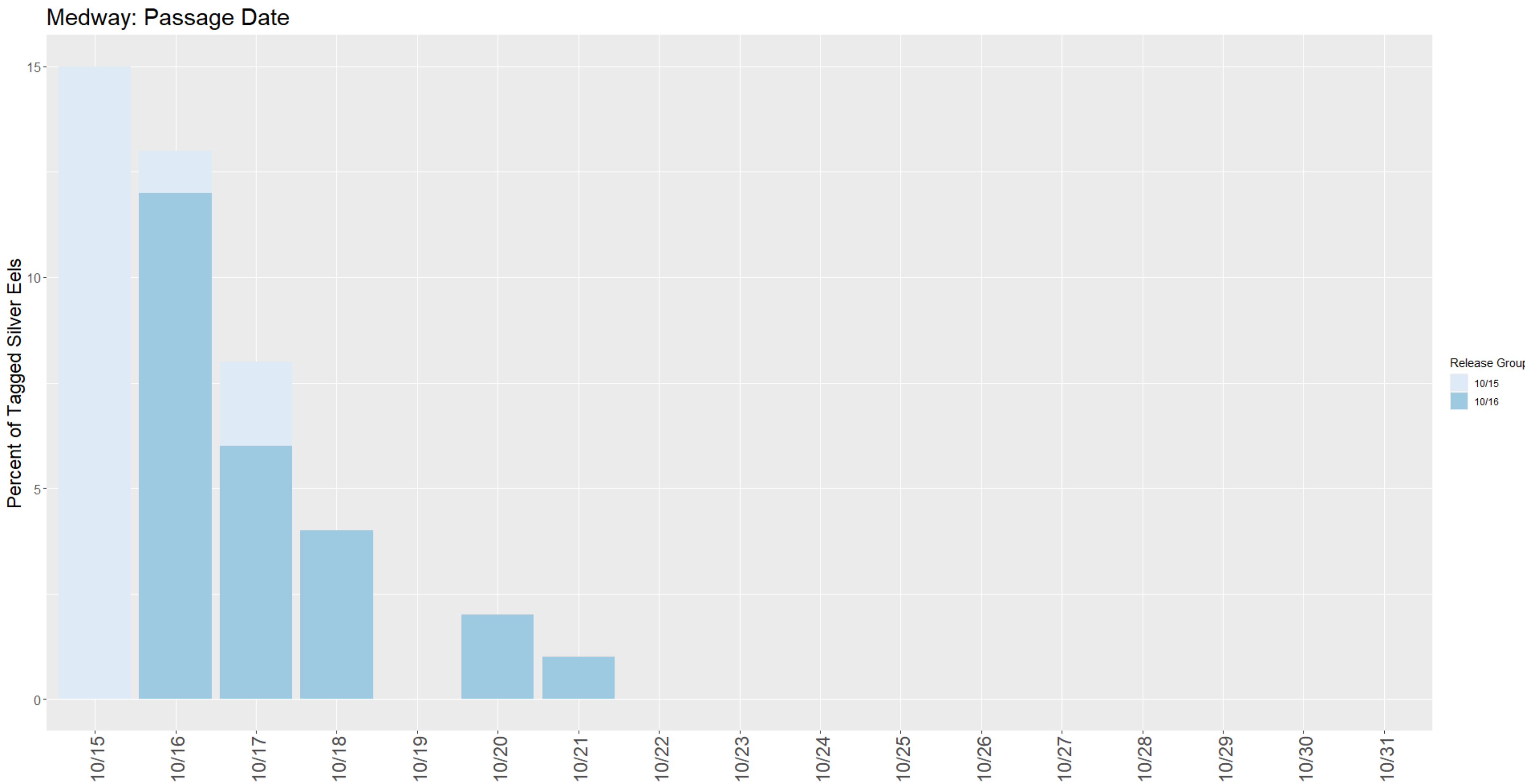


Figure 4-8: Distribution of downstream passage dates for radio-tagged adult American eels at Medway during October 2020.

5 Summary

A total of 50 adult silver eels were obtained from a commercial vendor operating on the St. Croix River in eastern Maine and were transported for evaluation of downstream passage at the Medway Hydroelectric Project on the West Branch of the Penobscot River. All 50 individuals were surgically tagged and released upstream of the Project on one of two release dates in mid-October, 2020. Downstream passage effectiveness was evaluated using radio telemetry between the dates of October 15 and November 18. Monitoring of adult eel movements focused on residence time prior to passage, passage route selection, and an estimation of downstream passage survival at the Project.

Downstream passage was observed for the majority of radio-tagged eels released upstream of Medway and occurred over a range of dates from October 15 to October 21. The median period of residence for radio-tagged eels upstream of the dam was 7.4 hours, with 62% passing downstream within the first 24 hours of their initial detection. Based on low West Branch flows and operational conditions at Medway, downstream passage route options for radio-tagged adult eels tagged during this study were limited to the downstream bypass or the operating turbines. As a result, this study was conducted under worst case conditions for outmigrating eels. Most radio-tagged eels passed downstream via the turbines, and there was one observation of an adult eel passing downstream via the bypass. Downstream passage survival for the entire project reach (~500 feet upstream of the dam to the first downstream receiver) was estimated at 92.0% (75% CI = 88.0-96.0%).

An additional group of freshly dead eels were radio-tagged and released immediately downstream of Medway. The median duration for those individuals to drift downstream to Station M8 (38.7 hours; range = 30.6 – 79.0 hours) was used to classify live eels passing Medway based on their downstream transit duration relative to the drift duration. Individuals whose downstream transit duration exceeded 38.7 hours (n = 12) were considered as Project mortalities at Medway; the adjusted model results produced a project survival of 68.0% (75% CI = 60.0-76.0%). A second adjusted model (i.e., the revised-adjusted model) was developed which considered only test eels which exhibited (1) a duration from Medway to Station M8 in excess of that observed for the freshly dead tailrace release individuals, and (2) failure to reach or a prolonged duration of time to reach Station M9 as a Project mortality at Medway. When that assumption was made, the revised-adjusted estimate of project survival was 84.0% (75% CI = 78.0-90.0%).

None of the three estimates of downstream passage survival for adult eels at Medway include any background (i.e., natural) or tagging-related mortality for the species in the reach from the approach receiver to the first downstream receiver. As a result, these estimates should be viewed as minimum estimates of total project survival (i.e., due solely to project effects) for adult eels at the Project.

6 Appendices

Appendix A. Transmitter and length information for adult Silver Eels radio-tagged and released upstream of Medway during October, 2020.

Tag ID	Frequency	Horizontal Eye (mm)	Vertical Eye (mm)	Length (mm)	Release Date	Release Time	Location
150	149.440	9.23	8.61	688	15-Oct	17:22:00	Alive-Bypass
154	149.440	7.97	6.76	690	15-Oct	17:22:00	Alive-Tailrace
152	149.440	8.95	8.24	711	15-Oct	17:22:00	Dead-Bypass
153	149.440	10.92	9.95	925	15-Oct	17:22:00	Dead-Severed-Tailrace
151	149.440	9.90	9.10	741	15-Oct	17:22:00	Dead-Tailrace
30	149.400	9.18	8.71	745	15-Oct	17:22:00	Upstream
31	149.400	10.15	9.95	832	15-Oct	17:22:00	Upstream
32	149.400	9.01	8.79	778	15-Oct	17:22:00	Upstream
33	149.400	9.95	9.25	767	15-Oct	17:22:00	Upstream
34	149.400	9.15	9.59	774	15-Oct	17:22:00	Upstream
35	149.400	9.41	9.30	794	15-Oct	17:22:00	Upstream
36	149.400	9.29	8.42	705	15-Oct	17:22:00	Upstream
37	149.400	9.26	9.26	860	15-Oct	17:22:00	Upstream
38	149.400	9.23	9.23	790	15-Oct	17:22:00	Upstream
39	149.400	10.20	10.04	960	15-Oct	17:22:00	Upstream
40	149.400	10.72	10.45	912	15-Oct	17:22:00	Upstream
41	149.400	9.59	9.59	726	15-Oct	17:22:00	Upstream
55	149.440	11.74	11.38	922	15-Oct	17:22:00	Upstream
56	149.440	9.35	9.36	701	15-Oct	17:22:00	Upstream
57	149.440	9.07	9.27	817	15-Oct	17:22:00	Upstream
58	149.440	9.03	8.75	735	15-Oct	17:22:00	Upstream
59	149.440	8.78	8.76	696	15-Oct	17:22:00	Upstream
60	149.440	10.97	10.09	899	15-Oct	17:22:00	Upstream
61	149.440	9.12	8.90	675	15-Oct	17:22:00	Upstream
62	149.440	11.08	9.89	947	15-Oct	17:22:00	Upstream
63	149.440	8.67	8.12	722	15-Oct	17:22:00	Upstream
64	149.440	8.08	7.94	716	15-Oct	17:22:00	Upstream
65	149.440	8.79	8.64	752	15-Oct	17:22:00	Upstream
66	149.440	10.21	9.44	807	15-Oct	17:22:00	Upstream
67	149.440	10.17	9.54	851	15-Oct	17:22:00	Upstream
157	149.400	9.29	8.83	845	16-Oct	17:43:00	Alive-Bypass
158	149.400	9.09	8.98	697	16-Oct	17:43:00	Alive-Tailrace
156	149.400	10.62	10.60	846	16-Oct	17:43:00	Dead-Bypass
159	149.400	10.91	10.19	961	16-Oct	17:43:00	Dead-Severed-Tailrace
155	149.400	9.47	9.37	735	16-Oct	17:43:00	Dead-Tailrace
42	149.400	8.01	8.44	734	16-Oct	17:43:00	Upstream
43	149.400	10.65	10.35	903	16-Oct	17:43:00	Upstream
44	149.400	10.66	9.73	888	16-Oct	17:43:00	Upstream
45	149.400	8.85	9.61	791	16-Oct	17:43:00	Upstream
46	149.400	9.13	8.94	646	16-Oct	17:43:00	Upstream
47	149.400	9.69	8.86	756	16-Oct	17:43:00	Upstream
48	149.400	10.42	9.06	805	16-Oct	17:43:00	Upstream
49	149.400	9.74	9.43	796	16-Oct	17:43:00	Upstream

Tag ID	Frequency	Horizontal Eye (mm)	Vertical Eye (mm)	Length (mm)	Release Date	Release Time	Location
50	149.400	9.03	9.37	754	16-Oct	17:43:00	Upstream
51	149.400	10.55	9.97	884	16-Oct	17:43:00	Upstream
52	149.400	11.73	10.78	846	16-Oct	17:43:00	Upstream
53	149.400	12.33	12.19	880	16-Oct	17:43:00	Upstream
54	149.400	10.05	9.45	708	16-Oct	17:43:00	Upstream
68	149.440	10.88	10.17	878	16-Oct	17:43:00	Upstream
69	149.440	9.50	9.01	654	16-Oct	17:43:00	Upstream
70	149.440	10.63	9.40	798	16-Oct	17:43:00	Upstream
71	149.440	10.24	9.05	772	16-Oct	17:43:00	Upstream
72	149.440	10.95	11.10	928	16-Oct	17:43:00	Upstream
73	149.440	9.91	9.48	677	16-Oct	17:43:00	Upstream
74	149.440	8.72	8.60	782	16-Oct	17:43:00	Upstream
75	149.440	8.45	8.12	715	16-Oct	17:43:00	Upstream
76	149.440	8.72	8.28	815	16-Oct	17:43:00	Upstream
77	149.440	8.50	8.20	701	16-Oct	17:43:00	Upstream
78	149.440	8.90	8.12	821	16-Oct	17:43:00	Upstream
79	149.440	9.76	9.73	780	16-Oct	17:43:00	Upstream

Appendix B. Listing of manual tracking detections within the Medway Project area.

Date	Time	Frequency	ID	Original Release	Manual Location	Project Reach	Tracking Method
11/4	9:18	149.440	64	Upstream	Headpond	Release Site – M1	Truck
11/4	9:20	149.400	159	Downstream-Turbine (dead)	Tailrace	Medway to M7	Truck
11/18	8:35	149.440	64	Upstream	Headpond	Release Site – M1	Boat
11/18	11:54	149.440	151	Downstream-Turbine (dead)	Nicatou Bridge	Medway to M7	Boat
11/18	11:54	149.400	55	Upstream	Nicatou Bridge	Medway to M7	Boat
11/18	12:09	149.440	62	Upstream	(45.5969, -68.5127)	M7 – M8	Boat
11/18	12:12	149.400	155	Downstream-Turbine (dead)	(45.5942, -68.5011)	M8 – M9	Boat
11/18	12:20	149.440	154	Downstream-Turbine (alive)	(45.5915, -68.4804)	M8 – M9	Boat
11/18	12:36	149.400	45	Upstream	(45.5786, -68.4316)	M8 – M9	Boat
11/18	12:40	149.400	74	Upstream	(45.5747, -68.4194)	M8 – M9	Boat

Appendix C. Medway passage route photo series – October 13 through November 18, 2020.

10/13/2020
(Pre-Release)

M2: Intakes

M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

10/15/2020
(Pre-Release)

M2: Intakes

M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

10/16/2020
(One Release Event)

M2: Intakes

M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

10/20/2020
(All Eels Released)

M2: Intakes

M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

10/26/2020
(All Eels Released)

M2: Intakes

M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

11/4/2020
(All Eels Released)

M2: Intakes

M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

11/12/2020
(All Eels Released)

M2: Intakes

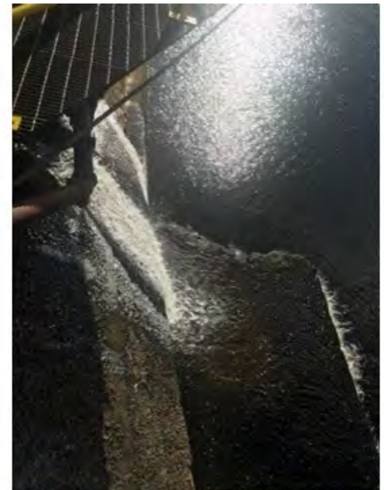
M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

11/18/2020
(All Eels Released)

M2: Intakes



M4: Forebay Sluice

M3: DS Bypass

M3: DS Bypass Sluice

Appendix D. Summary of questions and topics discussed at the January 27, 2021 resource agency and PIN study discussion meeting.

General Discussion:

As part of the PowerPoint presentation (Appendix F) Normandeau included an additional review of downstream passage survival incorporating the drift information collected from the radio-tagged eels released directly into the tailrace. Based on observations of drift rates between the downstream stations an additional estimate of survival was generated. Section 4.3.6 of this report has been updated to reflect this.

Question 1: *Were any of the dead eels released directly in the Medway tailrace detected downstream at Weldon?*

Response 1: Yes, one of the six eels released dead in the Medway tailrace was detected at Weldon Dam and took 64 hours to drift that distance.

Appendix E. Correspondence related to the distribution and comment on the draft Medway downstream eel passage study report.

From: Bernier, Kevin
Sent: Tuesday, December 15, 2020 2:02 PM
To: Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Harold Peterson <harold.peterson@bia.gov>; Antonio Bentivoglio <antonio_bentivoglio@fws.gov>; Kenneth J Hogan <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Bryan Sojkowski <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Julianne Rosset (julianne_rosset@fws.gov) <julianne_rosset@fws.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: Medway Project downstream eel passage draft study report

As promised, attached is Normandeau's draft report on the downstream eel studies conducted this fall at the Medway Project. Please provide any comments on this report **by January 14, 2021**. As indicated below, we will be scheduling a Teams Meeting for early January to discuss these reports.

Thank you, Kevin Bernier

Brookfield
Renewable

January 13, 2021

FERC No. 2666
Article 405

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Medway Project (FERC No. 2666), Article 405;
Time Extension Request for American Eel Downstream Passage Study Report

Dear Secretary Bose:

On June 15, 2020, Black Bear Hydro Partners, LLC (Black Bear), licensee for the Medway Project on the West Branch of the Penobscot River in Maine and an affiliate of Brookfield Renewable (Brookfield), submitted to the Commission a *"Study Plan for the Evaluation of Downstream Passage Effectiveness for Adult American Eel"* at the Medway Project. This study plan was in reply to a September 26, 2019 Commission letter requesting that Black Bear conduct a downstream eel study at the Medway Project in the fall of 2020. The study was completed in the fall of 2020, and a draft study report was distributed to resource agencies[1] and the Penobscot Indian Nation (PIN) for review on December 15, 2020.

At the request of the agencies and PIN, licensees for the Milford, Stillwater, and Orono Projects (each affiliated with Brookfield, including Black Bear) submitted a time extension request to the Commission on December 28, 2020 for submittal of an annual eel and alosine study report for these lower Penobscot facilities. The Commission approved this request on January 11, 2021, thereby extending the report submittal deadline to February 15, 2021. A meeting has been scheduled for January 27, 2021 with the agencies and PIN to review and discuss the lower Penobscot eel and alosine study report. Consistent with past years, Black Bear intends to also review and discuss the results from the Medway downstream eel passage study at this meeting. Therefore, Black Bear is also requesting a time extension request to February 15, 2021[2] for submittal of the Medway Project downstream eel passage report in order to incorporate any comments and discussions that result from the January 27 meeting, and to provide the agencies and PIN with sufficient time to then provide any written comments that they have.

[1] United States Fish and Wildlife Service (USFWS); Maine Department of Marine Resources (MDMR); Maine Department of Inland Fisheries and Wildlife (MDIFW); Maine Department of Environmental Protection (MDEP); National Marine Fisheries Service (NMFS); Bureau of Indian Affairs (BIA)

[2] Although the Commission has not responded, Black Bear's June 15, 2020 *"Study Plan for the Evaluation of Downstream Passage Effectiveness for Adult American Eel"* indicated a report submittal date of January 15, 2021

1024 Central Street
Millinocket, ME 04462
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Tel: 207.723.4341
Fax: 207.723.4597

Brookfield
Renewable

Please feel free to contact me at kevin.bernier@brookfieldrenewable.com or call me at (207) 951-5006 if you have any questions or comments on this extension of time request.

Sincerely,

Kevin Bernier
Senior Compliance Specialist

cc: S. Michaud, N. Stevens, R. Brochu, J. Cole, R. Dill, K. Maloney. L. Macomber; Black Bear
D. Trested; Normandeau

Black Bear File: HSSE 4a/2666/01

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

JANET T. MILLS
GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

January 8, 2021

Kevin Bernier
Senior Compliance Specialist
Brookfield Renewable
1024 Central Street, Millinocket, ME 04462

Dear Kevin:

I have reviewed the Draft Study Report for the Evaluation of Downstream Passage Effectiveness for Adult American Eel for the Medway project (FERC No. 2666) for the Department of Marine Resources.

Major findings of the study were:

1) 84% (42/50) of the eels passed through the turbines;
2) 12% (6/50) of the eels passed by an unknown route, but turbine passage seems likely since rack spacing is 2.25-inch clear spacing;
3) 2% (1/50) of the eels used the bypass;
4) 2% (1/50) of the eels did not pass; and
5) When adjusted for transit time > 38.7 hours, 61-76% (75% CI) of the eels survived from passage to Station M8.

I have the following recommendations:

1) Please include a line showing the Medway station hydraulic capacity in Figure 4-1.
2) Please add the sample size to each table.
3) Please include the reach-specific survival estimate from station M8 to M9 in Table 4-9 and Table 4-11.
4) Please add clarification in the descriptions for Table 4-9 and 4-11. The report states that Station M1 was not functioning from 1700 on 10/15 to 1000 on 10.16 and that Stations M2, M3, or M4 were used as surrogates for "arrival time." However, the reaches in Table 4-9 and 4-11 only list Station M1.

Sincerely,

Gail Wippelhauser, Ph. D.
Marine Resources Scientist III

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From: Rosset, Julianne [mailto:julianne_rosset@fws.gov]
Sent: Monday, January 11, 2021 3:37 PM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Gail Wippelhauser <gail.wippelhauser@maine.gov>; Casey.Clark@maine.gov; Mitch Simpson <Mitch.Simpson@maine.gov>; Daniel McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Peterson, Harold S <Harold.Peterson@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Jeff.Murphy@noaa.Gov; donald.dow@noaa.gov; Sojkowski, Bryan <Bryan_Sojkowski@fws.gov>; Kathy Howatt <Kathy.howatt@maine.gov>; Christopher Sferra <Christopher.Sferra@maine.gov>; Jason Valliere <Jason.Valliere@maine.gov>; Kevin Dunham <Kevin.Dunham@maine.gov>; John Perry <john.perry@maine.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Sean M Ledwin - Maine Department of Marine Resources (Sean.M.Ledwin@maine.gov) <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: Re: [EXTERNAL] Medway Project downstream eel passage draft study report

Hi Kevin,

The United States Fish and Wildlife Service (Service) has reviewed the Medway Hydroelectric Project (FERC No. 2666) *Evaluation of Downstream Passage Effectiveness for Adult American Eel,* which Black Bear Hydro Partners, LLC (BBH) emailed to the agencies on December 15, 2020. The Service has the following comments.

85 percent of the tagged eels, or 42 out of 50, passed through the Project's turbines while 2 percent of the tagged eels, or 1 out of 50, used the existing downstream bypass. When adjusted for transit time, model results indicate 60 to 76 percent of eels survived passage at Medway to Station M8 (the first receiver downstream of the Project). After reviewing the study, the Service recommends BBH provide the following, additional, information (1) total survival of tagged eels (not adjusted for drift) detected at monitoring Station M9; and (2) clarification about the descriptions for Tables 4-9 and 4-11 as the reaches in these tables only list Station M1 while the report itself states M1 was not functioning and Stations M2, M3, and M4 were used as surrogates. Additionally given the results of the evaluation, the Service recommends BBH arrange a meeting with the agencies in February 2021 to discuss next steps (i.e., proposed operational changes, structural changes, etc).

Thank you for this opportunity to comment. If you have any questions, please feel free to contact me.

Kind regards,

Julianne

Julianne Rosset
USFWS Fish and Wildlife Biologist
Migratory Fish/Hydropower
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From: Sferra, Christopher [mailto:Christopher.Sferra@maine.gov]
Sent: Tuesday, January 12, 2021 8:58 AM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>; Wippelhauser, Gail <Gail.Wippelhauser@maine.gov>; Clark, Casey <Casey.Clark@maine.gov>; Simpson, Mitch <Mitch.Simpson@maine.gov>; Dan McCaw <dan.mccaw@penobscotnation.org>; John.Banks@penobscotnation.org; Harold Peterson <harold.peterson@bia.gov>; Bentivoglio, Antonio <antonio_bentivoglio@fws.gov>; Kenneth J Hogan <kenneth_hogan@fws.gov>; jeff.murphy <jeff.murphy@noaa.gov>; donald.dow <Donald.Dow@noaa.gov>; Sojkowski, Bryan <bryan_sojkowski@fws.gov>; Howatt, Kathy <Kathy.Howatt@maine.gov>; Valliere, Jason <Jason.Valliere@maine.gov>; Dunham, Kevin <Kevin.Dunham@maine.gov>; Perry, John <John.Perry@maine.gov>; Rosset, Julianne <julianne_rosset@fws.gov>; Gallant, Kevin <Kevin.Gallant@maine.gov>; Ledwin, Sean M <Sean.M.Ledwin@maine.gov>
Cc: Maloney, Kelly <Kelly.Maloney@brookfieldrenewable.com>; Brochu, Robert <Robert.Brochu@brookfieldrenewable.com>; Cole, James <James.Cole@brookfieldrenewable.com>; Drew Trested <dtrested@normandeau.com>; Stevens, Nate <Nathan.Stevens@brookfieldrenewable.com>; Michaud, Steve <Stephen.Michaud@brookfieldrenewable.com>; Macomber, Lance <Lance.Macomber@brookfieldrenewable.com>; Osborne, Michael <Michael.Osborne@brookfieldrenewable.com>; Mapletoft, Thomas <Thomas.Mapletoft@brookfieldrenewable.com>; Kessel, Miranda <Miranda.Kessel@brookfieldrenewable.com>
Subject: RE: Medway Project downstream eel passage draft study report

Hello all,

MDEP has reviewed the Medway downstream eel passage draft study report and concurs with the comments provided by the fisheries resource agencies (NMFS, USFWS and MDMR). MDEP has no further comments on the report at this time. Thanks and have a good week.

Christopher Sferra (he/him)
Environmental Specialist III, Hydropower Unit
Bureau of Land Resources
Maine Department of Environmental Protection
Cell: (207) 446 – 1619
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From: Dan McCaw [mailto:Dan.McCaw@penobscotnation.org]
Sent: Thursday, January 14, 2021 11:27 AM
To: Bernier, Kevin <Kevin.Bernier@brookfieldrenewable.com>
Cc: Jeff Murphy - NOAA Federal <jeff.murphy@noaa.gov>; Clark, Casey <Casey.Clark@maine.gov>; Ledwin, Sean M <Sean.M.Ledwin@maine.gov>; Sferra, Christopher <Christopher.Sferra@maine.gov>; Kathy Howatt (Kathy.howatt@maine.gov) <Kathy.howatt@maine.gov>; Dunham, Kevin (Kevin.Dunham@maine.gov) <Kevin.Dunham@maine.gov>; julianne.rosset@fws.gov; John Banks <John.Banks@penobscotnation.org>; John Perry (john.perry@maine.gov) <john.perry@maine.gov>; Joseph Zydlewski <josephz@maine.edu>
Subject: Medway eel study 2020

Good morning Kevin,

The Penobscot Indian Nation (PIN) has reviewed the Study Report for the ***Evaluation of Downstream Passage Effectiveness for Adult American Eel at the Medway Project*** **(FERC No. 2666**).

The PIN concurs with the questions and comments provided by the resource agencies to date. The PIN would also like to submit these additional comments and questions on this long overdue assessment.

1) Were any of the tagged study animals detected at the West Enfield, Stillwater, Orono, or Milford facilities?
2) If so, what passage route did they take at the facilities, and what were the detections downstream of those facilities?
3) Is it possible to see a table that contains each of the study fish, and all of its' detections from Medway to lower Penobscot River and the end of the telemetry receivers set up in 2020? The West Enfield, Stillwater, Orono and Milford facilities were all extensively wired up with telemetry receivers for project specific studies and should have been able to detect these tagged eels. The USFWS, in their letter dated 3/23/2020, stated the importance of gathering data on these study fish at the lower Penobscot River projects, and the PIN strongly agreed with the need for comprehensive studies in the PIN letter dated 3/19/2020. In the future, comprehensive studies will be needed (see FERC Order approving this study plan, dated 6/15/2020) to determine the cumulative effects of these facilities on adult eels, and any preliminary information or insight would be valuable to examine before those plans are drafted in consultation with the agencies.

4) Maine DMR comments on the study plan, dated 3/30/2020, suggested that the time limit for study fish to be determined as dead was 8.7 hours from passing the Medway project to arrival at the Mattaceunk project. MDMR calculated a live, healthy adult American eel could make it to the Mattaceunk facility in 8.7 hours, not including the increased rate of travel due to water currents. Can you explain how this number fits into the data from your dead drift study, and why it was not used to determine which study fish were indeed deceased?
5) Is it possible to determine potential injury of study fish based on their time of travel to the Mattaceunk project, or other projects downstream, and then consider them as a delayed mortality as the goal of safe passage at the Medway facility was not realized?
6) The USFWS stated in their comments, dated January 11th, 2021, that; *"Additionally given the results of the evaluation, the Service recommends BBH arrange a meeting with the agencies in February 2021 to discuss next steps (i.e., proposed operational changes, structural changes, etc).*" The PIN strongly supports these comments from USFWS. The FERC stated in their Order from 6/15/2020, that when it comes to the downstream bypass, the, "intent is for eels to avoid passing through the turbines at all". It is clear from these study results that the downstream bypass is near completely ineffective in attracting and safely transporting downstream migrants. The PIN suggests that the licensee immediately commence the design of an angled rack structure and dedicated bypass similar to the system installed at the Stillwater B project downstream, which has successfully deterred multiple species of fish at multiple life stages from passing through the turbines. The bypass at the Stillwater B project has proven to be the most efficient bypass structure at any hydro facility in Maine and should be used as a blueprint for the construction of angled racks at other facilities. The construction of such a facility will eliminate the costly, and lengthy process of assessing injury, delayed mortality, and the effectiveness of the bypass under alternative flow conditions. The studies conducted in 2020, under no spill conditions, gave the bypass the best chance to be successful, and it completely failed. The PIN looks forward to these important design discussion and planning efforts.

Please feel free to reach out at any time with any questions you may have.

Sincerely,

Dan McCaw

Daniel E. McCaw
Fisheries Program Manager

Penobscot Indian Nation
Department of Natural Resources
12 Wabanaki Way

Indian Island, Maine 04468-1254

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Written comments on the draft Medway eel passage study report were provided by MDMR, USFWS, MDEP and the PIN. Questions or requests related to the technical draft report are reproduced here along with the associated response.

Question 1: *Please include a line showing the Medway station hydraulic capacity in Figure 4-1.*

Response 1: The Medway powerhouse contains a total of five vertical Francis turbines, each with a capacity discharge of 690 cfs. A reference line for the station capacity (3,450 cfs) has been added to Figure 4-1.

Question 2: *Please add the sample size to each table.*

Response 2: As requested, Tables 4-3, 4-4 and 4-6 have been updated to include a column for sample size.

Question 3: *Please include the reach-specific survival estimate from station M8 to M9 in Table 4-9 and Table 4-11.*

Response 3: Language related to the reach-specific survival estimate from Station M8 to M9 has been added to Section 4.3.6 of the final report.

Question 4: *Please add clarification in the descriptions for Table 4-9 and 4-11. The report states that Station M1 was not functioning from 1700 on 10/15 to 1000 on 10/16 and that Stations M2, M3, or M4 were used as surrogates for "arrival time." However, the reaches in Table 4-9 and 4-11 only list Station M1.*

Response 4: Row labels in Tables 4-9 and 4-11 have been edited to reflect general descriptions of eel locations.

Question 5: *Were any of the tagged study animals detected at the West Enfield, Stillwater, Orono, or Milford facilities?*

Response 5: As discussed at the March 18, 2020 study plan meeting and described in Appendix B of the Medway eel study plan, downstream progress of radio-tagged individuals was monitored from the release site upstream of Medway, through passage at Medway, and until detection at the upstream face of Weldon Dam. No stationary receivers were installed to monitor passage of adult eels at Projects in the lower portion of the Penobscot River.

Question 6: *Maine DMR comments on the study plan, dated 3/30/2020, suggested that the time limit for study fish to be determined as dead was 8.7 hours from passing the Medway project to arrival at the Mattaceunk project. MDMR calculated a live, healthy adult American eel could make it to the Mattaceunk facility in 8.7 hours, not including the increased rate of* *travel due to water currents. Can you explain how this number fits into the data from your dead drift study, and why it was not used to determine which study fish were indeed deceased?*

Response 6: As described in the study plan, the use of a desktop calculated "travel" speed for an eel released downstream of Medway to reach Station M9 at Weldon Dam was passed over in favor of drift data for freshly-dead radio-tagged adult eels released immediately downstream of Medway and in river conditions comparable to those being experienced by test fish released upstream of Medway. The use of empirical data related to drift duration and magnitude was considered to be a more accurate estimate than the desktop approach, which assumed a fixed rate of travel in a straight line from point A to point B.

Question 7: *Is it possible to determine potential injury of study fish based on their time of travel to the Mattaceunk project, or other projects downstream, and then consider them as a delayed mortality as the goal of safe passage at the Medway facility was not realized?*

Response 7: The adjusted and modified-adjusted survival estimates (Section 4.3.6) are attempts to quantify latent estimates of project passage success for adult eels at Medway. These modifications assumed variance in observed rates of travel to a downstream monitoring station are representative of eel condition, and eels failing to reach the downstream location within a defined threshold of time are considered "mortalities".

Appendix F. PowerPoint presentation slides from the January 27, 2021 resource agency and PIN study discussion meeting.

Evaluation of Downstream Passage Effectiveness for Adult American Eel

Medway Hydroelectric Project (FERC No. 2666)

Prepared For:
Black Bear Hydro Partners, LLC
1 Bridge Street
Milford, ME 04461

Prepared By:
Normandeau Associates, Inc.
30 International Drive
Portsmouth, NH 03801

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

Study Development and Objectives

- As specified in the current FERC License, Black Bear required to conduct a post-construction study to evaluate effectiveness of existing downstream passage facility at Medway for eel passage
- Multiple sampling years to identify source for collection of test fish in the basin were unsuccessful
- Out-of-basin eels utilized for passage studies at Lower Penobscot locations
- Draft plan distributed to resource agencies for review and final version filed with FERC June 15, 2020

Study Objectives:
- Evaluate residence time from arrival until downstream passage for radio-tagged adult American eels at Medway;
- Determine the proportional downstream passage route selection of radio-tagged adult American eels at Medway; and
- Estimate the downstream passage survival for radio-tagged adult American eels from the point 200 m upstream of Medway dam to the first stationary receiver downstream of Medway

Methodology: Tagging and Release

- Eel tagging:
  - Individuals imported from St. Croix River, Maine and transported to holding facility established at West Enfield (October 12)
  - Surgically tagged following standard procedures
  - Held for a 24-hr period post tagging to visually evaluate prior to release
- Eel releases:
  - Transported by truck to shoreline ~0.5 miles downstream of East Millinocket Dam
  - Downstream releases into discharge of DS bypass or active turbine
  - Conducted during evening hours

Methodology: Monitoring at Medway

- Installed and maintained nine receivers
  - Approach
  - Downstream bypass
  - Forebay sluice
  - Intake
  - Tailrace
  - Spillway
  - Downstream locations (x2)

Methodology: Data Analysis

Data Analysis – Downstream:

- *Upstream Residence Duration:* calculated as differential between release at point upstream of Medway and arrival at the Project (i.e., "approach")
- *Project Residence Duration:* calculated as differential arrival at the Project (i.e., "approach") and downstream passage
- *Downstream Passage Route:* based on evaluation of the spatial and temporal distribution of time-stamped detections from final, filtered data set (coupled with operations data)
- *Downstream Passage Survival:* estimated using Cormack-Jolly Seber model run in Program MARK (eels only)

- CJS models: all eels; adjusted eels; route-specific

*This approach resulted in estimates that included background mortality (i.e., natural mortality, such as predation) along with any tagging-related mortalities or tag regurgitations for eels within 200 m upstream of the Project, as well as the reach downstream of the dam to the first downstream receiver. This resulted in minimum estimates of total project survival (i.e., attributable to project effects) for adult eels.

Study Results: Tagging and Release

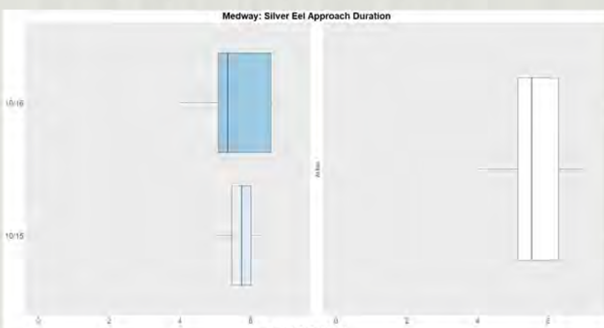
- A total of 60 adult eels radio-tagged and released at one of three release locations
- Two release dates: October 15 & 16
- Upper end of the Medway impoundment (n = 50)
- Downstream/Drift Assessment (n = 10)
  - Whole-body, dead at bypass (n = 2)
  - Whole-body, dead in turbine discharge (n = 2)
  - Partially severed, dead in turbine discharge (n = 2)
  - Live at bypass (n = 2)
  - Live at turbine discharge (n = 2)
  - Rate of travel and downstream extent of dead drift monitored to help inform estimates of passage survival

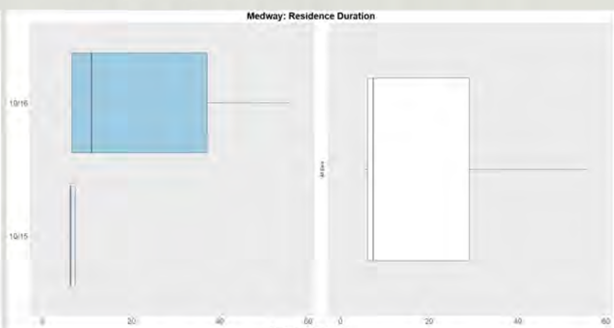
Study Results: River & Operational Conditions

- Study ran from October 15 to November 15
- Downstream bypass open (~15 cfs) and available throughout study period (closed Nov. 15 per operations plan)
  - ~7 fps, 3'depth, 2.5' in front
- Turbines operated throughout study
- No significant spill events
- Limited precipitation events >0.25"
  - Oct 16-17, Nov 1-3, Nov 15
- River temperature declined over the course of the monitoring period

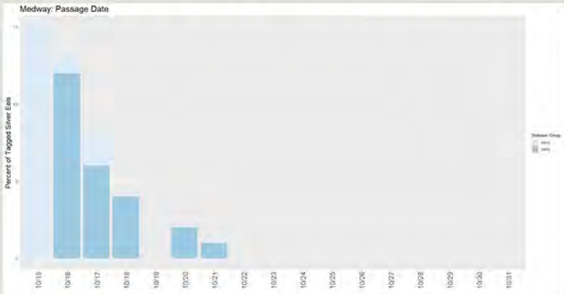
Study Results: Medway Eels

- 100% of tagged eels moved DS and approached the dam
- Median approach duration = 5.5 hrs (P25-P75 = 5.1-6.3 hrs)
- Relied on stations M2-M4 for initial detection of eels from release 1 due to issue with approach receiver
- Median residence = 7.4 hrs (P25-P75 = 6.1-29.1 hrs)
- 62% passed within 24 hours of initial detection
- 16% took longer than 48 hours to pass downstream following their initial detection

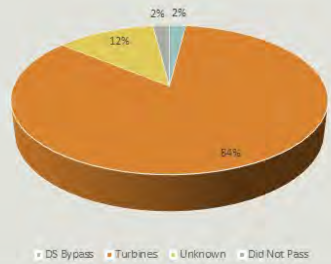




Study Results: Medway Eels



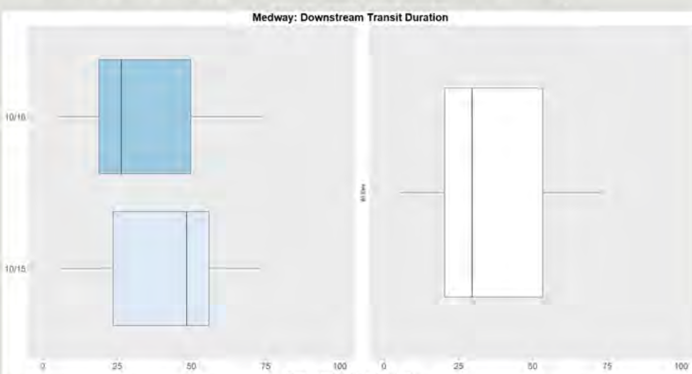
- Passage events recorded from October 15 through October 21
- Primarily evening/night hours - 1900-0200
- Majority utilized turbines for downstream passage (84%)
- Single individual used DS bypass
- One eel had not passed at end of monitoring (Nov 15)



Study Results: Medway Eels

Downstream Detection (Test):

- 90% detected 12 km downstream at M9 (Weldon)
- Median travel to M9 = 11.4 hrs (P25-P75 = 4.0-24.4 hrs)



Downstream Detection (Tailrace group):

- Four of ten detected at M9 (Weldon)
  - 3 live, 1 dead (partially severed)
- Seven of ten detected at M8
  - 4 live, 3 dead (bypass, tailrace (whole), tailrace (partially severed))
- Median drift time for dead eels to M8 = 38.7 hours
- 12 test eels had a travel time > median drift to reach M8

Study Results: Medway Eels

Downstream Passage Effectiveness:

- Estimates include project effects, background mortality or any other losses from the "approach" receiver 200 m upstream of Medway to Station M8 located ~5 km downstream of Medway

Model	S_1	S_2	S	75% CI
All Eels	98.0%	93.9%	92.0%	88.0-96.0%
Adjusted	98.0%	69.4%	68.0%	60.0-76.0%
Turbine only	100.0%	92.8%	92.8%	88.1-97.6%

- Adjusted estimate assumed mortality for 12 individuals at passage (based on time to reach M8)
  - Of those 12 eels – 8 had a transit time from M8 to Weldon within the set of values bracketed by P25-P75 (3.9-25.9 hrs) observed for eels reaching M8 in less time than drift fish (7 of the 8 less than median of 15 hrs)
  - Single dead eel reaching Weldon took 64 hours to "travel" from M8 to M9
  - Only 4 individuals with long duration to reach M8 exhibited a prolonged duration (or failed) to reach Weldon

Summary

- Medway eel passage study was conducted using out of basin eels from the St. Croix (similar to previous Licensee studies at West Enfield, Milford, Stillwater and Orono
- Tagged eels approached and passed downstream relatively quickly following release
- Downstream passage options during 2020 study were limited to turbine or DS bypass
  - Majority of eels passing downstream utilized turbine units
- Downstream passage survival estimated at 92% based on detection at first DS receiver
- Applicability of dead drift duration to first station to "adjust" survival estimate?
  - Criteria may have overestimated losses for the reach from passage to first DS receiver based on review of continued rates of DS movement to Weldon

Attachment C

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

JANET T. MILLS
GOVERNOR

PATRICK C. KELIHER
COMMISSIONER

Stillwater

MDMR recommends that LIHI certification for Orono be delayed or be contingent on committing to a prudent timeline to complete the additional studies of downstream passage as identified in our responses to your questions below.

Orono

MDMR recommends that LIHI certification for Orono be delayed or be contingent on A) carrying out the below recommendations for upstream passage, in addition to B) committing to a prudent timeline to complete the additional studies as identified in our responses to your questions below.

In addition, any documentation of the Orono project impact should include an acknowledgement of the presence of American eel and Sea lamprey within Zone 1, 2, and 3 of the Project.

Medway

MDMR recommends that LIHI certification for Medway be delayed or be contingent on completion of improvements to downstream passage for eels.

For further questions regarding these projects or our comments, please contact Casey.Clark@maine.gov and Gail.Wippelhauser@maine.gov.

MDMR responses to Pat McIlvaine's Questions dated December 14th, 2020

Finding a passage facility is safe and effective
BBHP stated in their application that the approach being used at this time to evaluate passage success is to conduct requested monitoring and then, based on stakeholder consultation, make the improvements recommended by you to enhance either up or downstream migratory passage. In your opinion, has BBHP been accommodating in making modifications to the various passage facilities or project operations that you have been suggesting?

It is our opinion that BBHP has been accommodating in making modifications at some, but not all, passage facilities or project operations. It is also important to note that while BBHP has been accommodating in carrying out the required monitoring at most projects, the pace of monitoring studies has been very slow as BBHP have chosen an iterative approach. This approach has resulted in monitoring for one aspect (E.g. route of passage or survival) for often only one species, lifestage, and direction of migration in a given year (E.g. downstream juvenile alewife route of passage). Due the slow pace of monitoring studies, BBHP lacks the required information to determine if fish passage is safe, timely, and effective for many species and lifestages and the Orono, and Stillwater projects. This also means that MDMR and other resource agencies lack the required information to inform recommendations for modification of passage facilities or project operations for many species and lifestages and the Medway, Orono, and Stillwater projects. In addition, some of the monitoring completed by BBHP has been under non-normal project operations (E.g. spill at a project during a downstream study in a year with exceptionally low flow that was below station capacity), which makes the result irrelevant to normal operational conditions.

I also understand that to date, specific numerical standards for determining "safe and effective" passage have not been developed, except for downstream passage of Atlantic salmon (and these standards have not yet been met.) From your perspective, will these be required for all other designated species? Can you tell me if there is a target date for establishment of these standards for the other target species?

BBHP has stated that they do not intend to develop numerical standards for their projects. MDMR and other resource agencies are developing specific numerical standards for determining safe, effective, and timely passage for all diadromous species that occur in Maine. We anticipate these numeric standards will be established in the next five years.

Medway

In 2020, the effectiveness of the downstream passage facility at the Medway Project was tested for American eel. The agencies have just commented on the draft study report.
Major findings of the study were not encouraging.

1) 84% (42/50) of the eels passed through the turbines;
2) 12% (6/50) of the eels passed by an unknown route, but turbine passage seems likely since rack spacing is 2.25-inch clear spacing;
3) 2% (1/50) of the eels used the bypass;
4) 2% (1/50) of the eels did not pass; and
5) When adjusted for transit time > 38.7 hours, 61-76% (75% CI) of the eels survived from passage to Station M8.

MDMR and USFWS requested some additional analysis, and the USFWS recommended consultation to discuss next steps (i.e., proposed operational changes, structural changes, etc.).

MDMR recommends that LIHI certification for Medway be delayed or be contingent on completion of improvements to downstream passage for eels.

Upstream passage at Orono:

1) BBHP informed us that that no further upstream passage studies for Atlantic salmon beyond that conducted in 2014 and 2015 will be needed at Orono as "We were only required to conduct an upstream passage study to determine whether salmon that were attracted to the Orono bypass reach during times of spill or generation flows were delayed in making their way to the Milford facility and the 2015 study showed they were not."

   Do you agree that no further studies are needed as a result of the 2015 study findings?

   MDMR has reviewed the study reports and we do not agree that the 2015 study findings are sufficient to prove that upstream passage for Atlantic salmon at Orono is safe, timely, and effective. The 2014 and 2015 studies were not designed to explicitly assess fish passage at the Orono Project.

The studies were assessments of the Milford fishway, which used fish that were captured at the top of the Milford fishway and placed them downstream in order to re-approach the Milford fishway. Due to the study design the results of the study are biased towards fish that had already approached Milford and therefore are a biased assessment of the Orono Project as fish were unlikely to be motivated to pass the project. MDMR recommends further studies to determine passage is safe, timely, and effective for Atlantic salmon at Orono.

2) At this time, can you comment on whether or not upstream passage performance standards for river herring and American shad will be likely be developed and testing required, or given the fact that fisheries restoration is focused on the Penobscot River mainstem rather than the Stillwater Branch, is it more likely that such standards will never be established?

   MDMR may develop upstream performance standards for river herring and American shad for the Orono Project during the 5-year LIHI certification, and require additional testing.

3) Would you also agree that based on the 2016 upstream American eel passage studies, that no further studies for eels will be required, as reported to us by BBHP? (BBHP has noted to LIHI that additional upstream passage studies for eel however will likely be required at Stillwater.) Or will possible future studies be requested if numerical standards for passage effectiveness are established?

   Future upstream American eel studies will likely be requested to ensure the Orono project meets numerical standards for passage effectiveness, once they are established.

Downstream Eel Passage at Stillwater and Orono

1. From your perspective, have sufficient studies been conducted to determine that downstream eel passage has been shown to be safe and effective at these sites or will numerical standards still be developed in the future and new studies required to make this determination?

   Downstream eel passage was studied at the Stillwater and Orono projects in 2016. At Orono, all eels went over the spillway or through the lower level bypass, but the Orono project also spilled water for all but ten days of the study even though river flows were below station capacity. Spill at Orono is not normal given the river flows during the study period and thus the study results are not relevant for normal operations. At Stillwater most eels went over the spillway or through the bypasses, but 12% went through turbine A. MDMR requested examination of the rack, but there is no record if BBHP carried out this examination. In summary, the estimated survival rates were high, but operations at Orono were not normal and survival to a downstream receiver was not adjusted for excessive time to reach the receiver as was done in the 2020 Medway study (see below).

   In the Medway study, the median time for freshly-dead tagged eels to drift from the release site (below the powerhouse) to a downstream receiver (M8) was determined. Tagged live eels that reached M8 in a period of time exceeding the median drift time were classified as a project mortality.

   MDMR may develop downstream performance standards for American eel during the 5-year LIHI certification, and require additional testing.

MDMR recommendations for Orono upstream operations:

Upstream Passage at Orono

The number of river herring returning to the Penobscot River has increased dramatically since the completion of the Penobscot Restoration project. Due in part to the increased river herring return, the Orono Fishway has been overwhelmed by river herring and resulted in a fish kill during the 2018 season. As a result of this fish kill event, BBHP convened a meeting with resources agencies. In the 2019 and 2020 seasons, BBHP committed more staff time to the trucking effort at the Orono project.

In response the fish kill event and the meeting with resources agencies, MDMR developed the following recommendations that BBHP complete in order to improve upstream passage at Orono.

BBHP stated that BBHP staff devoted:

1) Multiple full or partial days assisting with passage studies; namely shad and river herring tagging;
2) Multiple full or partial days on fish cleanup efforts after fish kill; and
3) Multiple full or partial days looking for and recovering stranded fish after drawdowns at the Orono, Stillwater, and Milford Facilities;
4) Partial/most of a day handling a sturgeon captured at the Milford facility.

All these activities occurred during the river herring run. Much of the time that could have been spent trapping and trucking river herring from the Orono facility was lost due to these activities. The lost time due to the lack of dedicated full time Orono staff decreased the number of fish transported, and therefore successfully passed the project, for that season.

MDMR recommends that BBHP Dedicate full time staff (3-4 persons) to the Orono Facility during the trapping and transport season and use additional staff for activities required at their other projects.

BBHP stated that at times, the river herring did not start running until late morning/early afternoon and that much staff time was spent waiting for fish to enter the trap. Similar run timing is observed at Milford.

MDMR recommends that BBHP coordinate their crew hours with river herring run timing to maximize efficiency in moving fish. This could be accomplished by daily observations at the Orono Facility. If crew observations confirm that the river herring are not moving until afternoon, staff starting times could be shifted to later in the day.

BBHP stated that they do not always operate the Orono fishway with the attraction water operational. It was mentioned that this was to prevent overcrowding of the hopper.

At other facilities like Benton Falls, which also struggles at times to handle the numbers of fish present at the facility, MDMR/Benton Falls Hydro has had success by raising the entrance gate to create a velocity barrier to restrict fish passage. This provides a method for metering the rate of fish entering the trap facility while still maintaining attraction flow to attract other species such as Atlantic salmon and shad. Operating with no attraction flow will limit other fish species from being attracted to the fishway entrance. MDMR recommends that BBHP investigate varying entrance gate settings as an alternative to current practice and report results to DMR for further discussion. MDMR recognizes that there may still be times which attraction water must be operated at a reduced level or off if necessary.

BBHP staff have also state verbally that fish are able to access the hopper area even with the V gates closed, to the point of overcrowding the hopper, and for this reason attraction water is not run over night.

If fish access to the hopper is due to damage or malfunction of the V-gates, MDMR would request that repairs be made. If this is due to improper engineering, many of the gates at the Milford facility had to be lined with lobster wire to prevent fish from passing through the gates. MDMR would like to see this issue addressed such that attraction water can be run overnight and throughout the day for the following reasons:

1) It has been observed at the Milford facility, that salmon tend to move when alewives are not running hard. At Milford, salmon are typically captured in the morning prior to heavy alewife movements. Having the attraction water running overnight at the Orono Facility would attract salmon to the facility throughout the night and in the early morning, such that they should be at the gates waiting when staff arrive in the morning. This is standard practice at other projects.

2) Running attraction flow over night would provide attraction for river herring to help maximize earlier lifts. MDMR understands that when Orono staff arrive on site, they turn on the attraction water to the fishlift. Fish below the dam must then "reorient" to the new flow regime, which creates lost hours for attracting fish during the early morning. This is missed opportunity with respect to trapping and trucking fish. There are always fish more driven than others. This will also increase efficiency and the numbers of fish that BBHP can move.

In summary MDMR recommends:

1) Dedicated staff (3-4 persons) specific to the Orono Facility utilized for trap and transport of river herring and salmon during the river herring season
2) Staff time optimized to match river herring daily run timing during the season
3) Repairs and/or modifications to the trap/V-gates to eliminate fish entering the hopper area while the V-gates are closed:
4) Investigate varying entrance gate settings in attempts to optimize hopper lifts and to limit overcrowding the hopper;
5) Run attraction water 24 hours per day as prescribed by designs.
6) Provide weekly reports for the site that document the following metrics: fish passage numbers, fish passage operations and changes in fish passage operations at the facility, project operations and changes in operations at the facility, number of staff and numbers of hours per staff dedicated to fish passage operations, and flow conditions.