STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
21 STATE HOUSE STATION
AUGUSTA, MAINE
04333-0021

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August 08, 2025

Laura Paye, Hydropower Coordinator
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017

Subject: MDMR Comments on 401 Water Quality Certification Application for the Ellsworth Hydroelectric Project (P-2727)

Dear Ms. Paye:

On July 9, 2025, the Maine Department of Environmental Protection (DEP) published their Notification of Project Review for Water Quality Certifications pursuant to Section 401 of the Clean Water Act, 33 U.S.C. §§ 1251 *et. seq*. for the federal relicensing and continued operation of the Ellsworth Hydroelectric Project (P-2727). The application was submitted by Black Bear Hydro Partners LLC, a subsidiary of Brookfield Renewable (Brookfield or Applicant). Since the initial relicensing efforts, Maine Department of Marine Resources has developed and updated recommendations and river specific goals based on the best available information and utilization of new studies and tools. The Maine Department of Marine Resources (MDMR) continues to be an active participant in federal licensing and relicensing activities through the Federal Energy Regulatory Commission (FERC) for these projects. We provide the following comments and recommendations to assist MDEP in their review of the Water Quality Certification application for the project.

Please contact Casey Clark (casey.clark@maine.gov; 207-350-9791) or Lars Hammer (lars.hammer@maine.gov; 207-557-1564) if you have any questions.

Sincerely,

Sean Ledwin

Sean Ledwin
Director, Bureau of Sea-Run Fisheries and Habitat

Cc:

Executive Summary

The Union River represents a critical watershed for expanding access to historically occupied habitat for Alewife (*Alosa pseudoharengus*), Blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), American eel (*Anguilla rostrata*), Sea lamprey (*Petromyzon marinus*) and Atlantic salmon (*Salmo salar*). Restoration of these species has not progressed on the Union River, primarily because of the lack of upstream fish passage. Since 2018, the State of Maine has updated its diadromous fish restoration priorities for the Union River, including inclusion of all indigenous sea-run species, the development of new river-specific population targets, and increased protection efforts for endangered Atlantic salmon under the Gulf of Maine DPS. Given the expected license term and need for permanent solutions to fish passage, it was anticipated that previous interim goals and recommendations would have "significant modifications" in response to FERC relicensing[1]. Diadromous fish species require safe, timely, and effective access to high quality habitats at different life stages to successfully survive and reproduce. The waters above Ellsworth and Graham Lake Dams are historic spawning and rearing habitat and/or a migratory corridor for six indigenous fish species. No upstream passage for American eel, blueback herring, American shad, and sea-lamprey has occurred and only limited trucking of alewife and Atlantic salmon captured at the Ellsworth fish trap has occurred since the construction of the interim fish trapping facility in 1974. All indigenous diadromous fish species are likely present below the Ellsworth dam including threatened Atlantic sturgeon. These upstream aquatic habitats are extremely important for diadromous fish and have been designated as Critical Habitat for Atlantic salmon under the Endangered Species Act (ESA) and Essential Fish Habitat (EFH) under the Magnuson Stevens Act (MSA) for several species based on the location and characteristics of habitats required to support healthy fish populations. Almost 100% of high-quality spawning and rearing habitat for these native anadromous species is above the Ellsworth Dam. MDMR believes fish passage solutions need to go beyond trap-and-truck with intermittent access and continued downstream fish kills[2][3] need to be addressed at these projects.

The applicant's proposal for fish passage measures described in the Water Quality Certification application and FERC's Final Environmental Assessment (FEA) [4] will not provide effective fish passage to all indigenous diadromous fish species and life stages without additional measures. The proposal will continue to have significant adverse impacts on these indigenous fish species and their habitat. These adverse impacts include, but are not limited to, no volitional passage of target species, mortality and injury to upstream and downstream migrating diadromous fish, impaired in-stream habitat, significant delays in passage, and cumulative effects. When taken cumulatively, the lack of effective upstream and downstream passage measures will prevent meaningful restoration of any diadromous fish species above the projects and would prevent the achievement of MDMR's management goals for the Union River. MDMR's recommendations are necessary to ensure that final license conditions incorporate site-specific measures that will achieve fish passage goals over the license term.

For upstream passage, the applicant's proposal does not include provision of a timely volitional upstream fish passage plan for all species. This approach cannot achieve adequate passage success for

[1] Accession No. 20150227-5321.
[2] Accession No. 20181121-3012. FERC Draft Environmental Assessment. Table 22 at page 160.
[3] Conservation group says dam operations caused the death of thousands of alewives in Ellsworth | Maine Public
[4] Accession No. 20190729-3018.

meaningful restoration[5]. In addition, downstream passage measures included in the applicant's proposal will not provide adequate protection for all diadromous species and life stages, and MDMR supports the installation of 0.75-inch angled racks at the Ellsworth powerhouse. Numerous incidents of mass fish mortality have occurred at this project, including eight fish kill events between 2014 and 2018[6] and filings and media reports documenting fish mortality at the project in many years [7,8]. Thus, it is paramount to keep fish out of the project turbines. Appropriately spaced angled racks are a comprehensive, long-term measure to exclude or guide the majority of species and life stages away from the turbines and to effective dedicated downstream passage facilities. Given our concerns with upstream and downstream passage, MDMR believes that the current proposal is highly unlikely to achieve the passage performance standards included in the proposal for Atlantic salmon (90% US, 90% DS cumulative standard for Ellsworth and Graham Lake dams, which equals 95% per project), without additional measures and accountable adaptive management. Furthermore, recent modeling and reviews of studies and best management practices conducted by MDMR suggests that upstream passage must be high for American shad (77%), blueback herring (85%; interim), alewife (92%), American eel (90%), and sea-lamprey (80%) at every dam in order to achieve management goals in the Union River. Population modeling of the cumulative impacts of upstream and downstream passage has shown that efficient downstream and upstream fish passage with minimal delays are critical to support these fish species' life history needs. Unless fish passage facilities meet MDMR's proposed performance standards the project waters will likely be of insufficient quality to support robust self-sustaining runs of these important indigenous species. To determine achievement of passage performance standards, each facility must be tested using robust and scientifically supported passage studies for each species and life stage. If, based on appropriate testing, performance standards are not achieved, there must be a robust adaptive management plan with clear measures and timelines in place for curing passage deficiencies. Since the time of the 2018 filing by MDMR, the U.S. Fish and Wildlife Service finalized its Fish Passage Engineering Design Criteria (2019) [9]. These criteria establish minimum performance expectations for volitional upstream and downstream passage, including; 24-hour availability of upstream fishways; maximum allowable approach velocities and minimum entrance flow ratios; and performance-based standards for safe and timely downstream bypasses. The current facilities at Ellsworth and Graham Lake, and Brookfield's proposed designs, do not meet these criteria. DMR is making recommendations to ensure alignment with accepted interagency standards and to support enforceable licensing conditions.

In summary, since 2018, new scientific tools, federal standards, and watershed-specific goals have emerged that warrant substantial updates to MDMR's recommendations for the Ellsworth Project. MDMR has expanded its diadromous fish restoration priorities and developed species-specific performance standards using life history models like *anadrofish*. These models demonstrate that high passage efficiency and minimal delay at both Ellsworth and Graham Lake dams are essential to meet restoration targets.

The current trap-and-truck system is outdated, biologically ineffective, and inconsistent with the U.S. Fish and Wildlife Service's 2019 Fish Passage Engineering Design Criteria. Ongoing fish mortality

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[5]Brown, J.J., Limburg, K.E., Waldman, J.R., Stephenson, K., Glenn, E.P., Juanes, F. and Jordaan, A., 2013. Fish and hydropower on the US Atlantic coast: failed fisheries policies from half-way technologies. Conservation letters, 6(4), pp.280-286.

[6] Accession No. 20181121-3012. FERC Draft Environmental Assessment. Table 22 at page 160.[7]Accession Nos. 20150127-3032; 20201008-5111; 20211013-3005; 20241028-5022; 20250610-5012

[7]Accession Nos. 20150127-3032; 20201008-5111; 20211013-3005; 20241028-5022; 20250610-5012

[8] Conservation group says dam operations caused the death of thousands of alewives in Ellsworth | Maine Public

[9] USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.

events and delayed access to habitat threaten the survival of multiple species, including endangered Atlantic salmon. Climate change and new federal recovery plans further highlight the urgency of enabling rapid access to upstream cold-water habitats. Federal agencies, including NOAA and FERC, have acknowledged that the applicant's proposed measures are likely insufficient without timely adaptive improvements.

MDMR does not consider it appropriate or scientifically defensible to delay construction of volitional upstream fish passage at the Ellsworth Project until year 15 of the new license as proposed, with fishways just focused on Atlantic salmon as the target species. Such a delay would postpone meaningful access to over 90% of the watershed's historical spawning and rearing habitat for multiple species, including endangered Atlantic salmon. During that time, current facilities will continue to cause delay, injury, or mortality, and deny fish timely access to high-quality habitat necessary for successful reproduction. Delayed passage implementation also prevents timely monitoring and adaptive management, deferring corrective actions. Given the history of fish kills, the known limitations of the current trap-and-truck system, and the immediate availability of feasible design solutions, construction of a modern volitional fishway within five years of license issuance is both reasonable and necessary to achieve Clean Water Act standards and MDMR's fish restoration goals. Comparable facilities have already been designed and implemented on similarly sized rivers in Maine, including the Penobscot and Kennebec, and therefore there are no technical or practical barriers to timely implementation at Ellsworth. A five-year implementation timeline for permanent improvements to upstream and downstream passage is both reasonable and necessary, aligning with other Maine relicensing efforts and ensuring prompt access to over 90% of the Union River's historic habitat for all six indigenous species.

Below we provide a series of recommendations to DEP related to specific Water Quality Certification conditions that would provide meaningful restoration for indigenous sea-run fish species. In addition, we have provided a list of relevant documents on the FERC record (Appendix 1).

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Minimum Species Goals for the Union River

MDMR's goal is to restore diadromous fish populations in Maine to their historic habitat. Diadromous fish species require safe, timely, and effective access to high quality habitats at different life stages to successfully survive and reproduce. Hydroelectric projects often prevent or delay fish migrations or cause injury or mortality that contribute to population declines. These adverse impacts can be mitigated by properly designed fishways.[10] When there are a series of fishways within a migration corridor for diadromous species, such as in the Union River, the risks increase that one or more underperforming fishways will result in significant cumulative negative impacts to these fish populations. The potential for cumulative impacts creates the need for highly effective fish passage at each of the dams that meet agency design and performance standards. The Union River has historically been managed as six river reaches, each with its own objectives for sea-run and resident species. Below, we present each river reach as presented in the 2015-2017 Comprehensive Fisheries Management Plan for the Union River.[11]

Reach I: Mouth of the river to Ellsworth Dam; includes Upper and Lower Patten Pond, Patten Stream, and Meadow Brook in Surry, which flow into Union River Bay, and Card Brook, which joins the river in Ellsworth.
Reach II: Ellsworth Dam to Graham Lake Dam, including Branch Lake sub-drainage.
Reach III: Graham Lake Dam to confluence of West and East Branch of the Union River and tributaries.

[10] USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts..
[11] Accession No. 20150227-5321.

Reach IV: West Branch of the Union River.
Reach V: Middle Branch of the Union River.
Reach VI: East Branch of the Union River.

The 2015 Comprehensive Plan referenced above expired in 2017 with the expiration of the FERC license for the Ellsworth Project. Since then, MDMR has updated its goals for the watershed to include additional historical habitat for alosines and sea-lamprey. Tables of habitats considered under this Water Quality Certification for alewife, blueback herring, and American shad are available in Appendix 2.

The minimum goal for **Atlantic Salmon** is to provide safe, timely, and effective upstream and downstream passage in order to achieve a minimum annual return of 500 naturally-reared adults to historic spawning/rearing habitat in the Downeast Salmon Habitat Recovery Unit (SHRU) for Endangered Species Act (ESA) downlisting and a minimum annual return of 2,000 naturally-reared adults to historic spawning/rearing habitat in the Downeast SHRU for reclassification based on the NOAA and USFWS Recovery Plan (2019)[12]. The Union River contains 14,090 Atlantic salmon habitat recovery units, approximately 25% of the 57,563 units in the Downeast SHRU. Thus, we anticipate that the Union should pass at least 125 naturally-reared adult Atlantic salmon to contribute to downlisting and at least 500 for reclassification. To reach spawning/rearing habitat in the Union River, all returning adults must annually pass upstream at the Ellsworth Dam.

The minimum goal for **American Shad** is to provide safe, timely, and effective upstream and downstream passage in order to achieve a minimum annual return of 82 adult American shad per acre of habitat. This would equate to at least 60,598 American shad passing the Ellsworth project and at least 54,530 passing into Graham Lake.

The minimum goal for **Blueback Herring** is to provide safe, timely, and effective upstream and downstream passage in order to achieve a minimum annual return of 484 blueback herring per acre of habitat. This would equate to at least 357,676 blueback herring passing the Ellsworth project and at least 321,860 into Graham Lake.

The minimum goal for **Alewife** is to provide safe, timely, and effective upstream and downstream passage in order to achieve a minimum annual return of 235 adult alewife per acre of habitat. This would equate to at least 6,893,490 alewife passing the Ellsworth project, at least 6,174,860 into Graham Lake.

The minimum goal for **Sea Lamprey and American Eel** is to provide safe, timely, and effective upstream and downstream passage throughout the historically accessible habitat of these two species. Sea lamprey likely occupied similar habitats to those of Atlantic salmon and American eel likely had access to the entire watershed historically.

Recommendations

Recommendation 1: Atlantic salmon performance standard

[12] USFWS and NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service. 2019. Recovery plan for the Gulf of Maine Distinct Population Segment of Atlantic salmon (Salmo salar). 74 pp.

Achieve an upstream performance standard of at least 95% within 48 hours for adult Atlantic salmon and downstream performance standard of at least 95% within 24 hours for Atlantic salmon smolts and kelts at each dam.

Justification: Historical records document that Atlantic salmon ascended the Union River and spawned in tributaries to Graham Lake, including the East Branch and Middle Branch, prior to the construction of dams. Atkins (1869)[13], in his report to the U.S. Commissioner of Fisheries, listed the Union River among several eastern Maine rivers that formerly supported natural salmon runs. Additional documentation from the U.S. Fish Commission's Bulletin (Kendall 1930)[14] confirmed that the Union River contained suitable spawning and nursery habitat upstream of Ellsworth, with historical runs likely extending throughout the system prior to the construction of the Ellsworth Dam in 1907. These runs were likely extirpated shortly thereafter due to complete blockage of upstream migration. Recognition of the Union River's restoration potential has remained consistent across multiple generations of state planning. In 1961, Havey of the Maine Department of Inland Fisheries and Game emphasized the importance of fish management and restoration opportunities in the watershed[15]. The 1982 *Statewide River Fisheries Management Plan*[16] and the *Union and Minor Coastal Drainages East of the Penobscot*[17] both prioritized the Union River for restoration of anadromous fish, highlighting both the historical record and the biological potential of the system. These priorities were reaffirmed in the *Union River Anadromous Fish Restoration and Management Plan* developed in 2000 by the Maine Atlantic Salmon Commission and Maine Department of Marine Resources.[18]

The Union River has the second-most Atlantic salmon habitat units in the Downeast SHRU with 14,090 of those habitat units upstream of Ellsworth Dam[19]. Nearly all the high-quality habitat in the Union River is above the Ellsworth and Graham Lake dams. The attainment of NMFS and USFWS recovery downlisting goals for connectivity in the Downeast SHRU and associated productivity requires passage at the Ellsworth Project and further delays prevent meeting the goals of the recovery plan.
The Union River is currently stocked with Atlantic salmon fry and an April 2025 multi-agency plan[20] calls for the development of a stock rebuilding and management plan for the Union River and use of the West Branch Union River as a Genetic Refuge Area (GRA) to both increase the distribution and abundance of a selected stock and as a way to spatially separate lifestages within the stock. To reach this

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[13] Atkins, C.G. (1869). "On the salmon of eastern North America and its artificial propagation." *U.S. Commission of Fish and Fisheries, Report of the Commissioner*, 1868: 1–20.
[14] Kendall, W.C. (1930). "The Fishes of the Union River, Maine." *Bulletin of the U.S. Bureau of Fisheries*, 46(1): (1930). 247–265.
[15] Havey, Keith A. (1961). *Union River Fish Management and Restoration*. Maine Department of Inland Fisheries and Game.
[16] State of Maine (1982). *Statewide River Fisheries Management Plan*. Departments of Inland Fisheries and Wildlife, Marine Resources, and Atlantic Sea Run Salmon Commission.
[17] Atlantic Sea-Run Salmon Commission (1982). *Union and Minor Coastal Drainages East of the Penobscot: A River Management Report*.
[18] Maine Atlantic Salmon Commission and Maine Department of Marine Resources (2000). *Union River Anadromous Fish Restoration and Management Plan*.
[19] Wright, J., Sweka, J., Abbott, A., & Trinko, T. (2008). *GIS-Based Atlantic Salmon Habitat Model*. Appendix C in: National Marine Fisheries Service & U.S. Fish and Wildlife Service. (2009). *Biological valuation of Atlantic salmon habitat within the Gulf of Maine Distinct Population Segment*. Appendix supporting the September 2009 Critical Habitat Final Rule (74 FR 29300)
[20] Atlantic Salmon Recovery Work Plan for the Downeast Coastal Salmon Habitat Recovery Unit (2025 to 2030). NOAA, USFWS, Maine DMR, Penobscot Indian Nation. April 2025

habitat Atlantic salmon will need to successfully ascend both dams in a timely way. Rapid passage is becoming even more important as climate change is causing Atlantic salmon rivers to warm and increasing variability in the hydrograph, both of which increase the need for salmon to reach cold water refuges before the onset of heat waves[21]. Ensuring that salmon can reach the climatically resilient habitat present in the upper Union River watershed and other cold water reaches of the Union will be essential for meeting the recovery goals laid out in the recovery plan[22]. To meet those recovery goals and restore this indigenous species to its habitat, MDMR is recommending performance standards for Atlantic salmon. A population viability analysis (Dam Impacts Analysis model[23]) could be used in the future specifically for the development of performance standards for Atlantic salmon passage that consider the effects of dams on the survival and recovery of Atlantic salmon in the Union River. If a river specific standard that is focused on meeting ESA delisting criteria is developed and standards are set higher, performance standards could be updated accordingly.

It is feasible to achieve high performance for Atlantic Salmon. For example, Keefer et al. (2021) [24] found that the passage efficiency for Pacific salmonids at eight dams on the Columbia River were regularly among the highest recorded for any migratory species, averaging 96.6%, which the study attributed to a "sustained adaptive management approach to fishway design, maintenance, and improvement" where many of the dams have more than one fishway. DMR expects a 95% upstream passage standard could be achievable, particularly with a robust adaptive management plan in place, potential for two fishways at each project, and appropriate water management (i.e., at minimum 5% of station capacity used as attraction for each fishway and directing spill near fishway entrances to be used as additional attraction). Delay standards are more difficult to achieve, but MDMR believes with robust measures and continued improvements, it may be possible.

Recommendation 2: American shad Performance Standard

Achieve an upstream passage performance standard of 77% within 48 hours for American shad and downstream performance standard of at least 95% within 24 hours for American shad at each dam.

Justification: Atkins (1869)[25], in his report to the U.S. Commissioner of Fisheries, listed the Union River among several eastern Maine rivers that formerly supported shad runs, stating "No river fisheries now exist here, though formerly salmon, shad, and alewives abounded." According to the 2015-2017 Comprehensive Fisheries Management Plan for the Union River, American shad historically were able to access riverine spawning and rearing habitat in the Union River watershed, including habitat above the Ellsworth and Graham Lake dams[26]. Adults ascended the Union River and accessed the East and

[21] Gillis, C.A., Ouellet, V., Breau, C., Frechette, D. and Bergeron, N., 2023. Assessing climate change impacts on North American freshwater habitat of wild Atlantic salmon-urgent needs for collaborative research. *Canadian Water Resources Journal/Revue canadienne des ressources hydriques*, *48*(2),.222-246.
[22] National Oceanographic and Atmospheric Administration and United States Fish and Wildlife 661 Service. (2019). Recovery plan for the Gulf of Maine distinct population segment of 662 Atlantic salmon (Salmo salar): Final plan for the 2009 ESA listing.
[23] Nieland JL, Sheehan TF, Saunders R, Murphy JS, Trinko Lake TR, Stevens JR (2013). Dam Impact Analysis Model for Atlantic Salmon in the Penobscot River, Maine. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 13-09; 524 p.
[24] Keefer, M. L., Jepson, M. A., Clabough, T. S., & Caudill, C. C. (2021). Technical fishway passage structures provide high passage efficiency and effective passage for adult Pacific salmonids at eight large dams. PLoS One, 16(9), e0256805.
[25] Atkins, C.G. (1869). "On the salmon of eastern North America and its artificial propagation." *U.S. Commission of Fish and Fisheries, Report of the Commissioner*, 1868: 1–20.
[26] Accession No. 20150227-5321.

West Branches. Most of the 916 acres[27] of habitat (72.6%; 665 acres) lies above the Graham Lake dam, and is not freely accessible. Impedance of migration at the dams has the potential to restrict access to habitat, decrease the efficacy of spawners, and reduce the probability of post-spawn survival.

MDMR has utilized a life-history model (anadrofish) to develop performance standards for American shad at the Ellsworth and Graham Lake Dams on the Union River. This tool uses the best available scientific information to model population responses to a range of upstream and downstream passage performance at dams within a river system. These modeling efforts determined that upstream passage needed to meet or exceed 77% (combined with at least 95% downstream passage) to meet the department's management goal for American shad in the river. Migration delay is considered an additional limitation for population growth and limiting such delay is necessary to meet population goals. A peer-reviewed manuscript detailing the utility of this model for Maine Rivers is in prep and is supported by MDMR, NOAA, and SUNY Oneonta.

It is feasible to achieve high performance for American Shad. For example, the average effectiveness of upstream passage at the Safe Harbor Project on the Susquehanna River is 76% from 1997-2019 with a single fishway, and many years exceeding 85% passage efficiency[28]. Large numbers of American Shad also pass the Columbia River dams each year, suggesting that those fishways may provide efficient Shad passage. MDMR expects a 77% upstream passage standard could be achievable, particularly with a robust adaptive management plan in place, potential for two fishways at each project, and appropriate water management (i.e., at minimum 5% of station capacity used as attraction for each fishway and directing spill near fishway entrances to be used as additional attraction).

Recommendation 3: Alewife Performance Standard

Achieve an upstream passage performance standard of 92% within 48 hours for alewives and downstream performance standard of at least 95% within 24 hours for alewives at each dam.

Justification: Atkins (1869)[29], in his report to the U.S. Commissioner of Fisheries, listed the Union River among several eastern Maine rivers that formerly supported alewife runs, stating "No river fisheries now exist here, though formerly salmon, shad, and alewives abounded." The 2000 *Union River Atlantic Salmon and Anadromous Fish Management Plan* explicitly identifies alewife as among the anadromous species that historically used the river. Adult Alewife historically ascended the mainstem Union River and the East, West, and Middle Branches and accessed 30,520 acres of habitat. The majority of that habitat (75.8%; 23,144 acres) is located above the Graham Lake dam. Alewives require timely access to lakes or slow moving river habitat to spawn, which may necessitate migration of over 50 kilometers in the Union. Migration delays impact their reproductive success through expenditure of energy and mismatch of environmental conditions as seen with American shad[30]. Similarly, their iteroparous life history requires safe downstream routes at dams for adults after spawning to allow for repeated spawning migrations in following years. MDMR's goal (235 alewives/acre) ensures that a fishery can

[27] Maine Atlantic Salmon Commission and Maine Department of Marine Resources (2000). *Union River Anadromous Fish Restoration and Management Plan*.
[28] https://www.fws.gov/project/susquehanna-river-fish-passage#:~:text
[29] Atkins, C.G. (1869). "On the salmon of eastern North America and its artificial propagation." *U.S. Commission of Fish and Fisheries, Report of the Commissioner*, 1868: 1–20.
[30] Stich, D.S., Sheehan, T.F. and Zydlewski, J.D., 2019. A dam passage performance standard model for American shad. *Canadian Journal of Fisheries and Aquatic Sciences*, *76*(5), pp.762-779.

be maintained, while promoting fish restoration that provides additional ecosystem services to Maine's people, environment, and wildlife.

A 2021 radio telemetry study[28] at the Milford fish lift documented 86.1% passage effectiveness for river herring. Given the lessons learned at Milford since commencement of operations, and increased understanding in the field of fish passage engineering since ~2012, MDMR expects a 92% upstream passage standard could be achievable, particularly with a robust adaptive management plan in place, potential for two fishways at each project, and appropriate water management (i.e., at minimum 5% of station capacity used as attraction for each fishway and directing spill near fishway entrances to be used as additional attraction). Achievement of this standard has been made in other systems for other species (Keefer et al. (2021)[31].

Recommendation 4: Blueback Herring Performance Standard

Achieve an upstream passage performance standard of 85% within 48 hours for blueback herring and downstream performance standard of at least 95% within 24 hours for blueback herring at each dam.

Justification: Blueback herring likely accessed the same areas as Alewife and American Shad considering their comparable swimming abilities and spawning habitat requirements. The 2000 *Union River Atlantic Salmon and Anadromous Fish Management Plan* explicitly identifies blueback herring as among the anadromous species that historically used the river. Adult Blueback Herring historically ascended the mainstem Union River and accessed the East and West Branches. Most of the habitat (72.6%) lies above Graham Lake dam. There are 665 acres of spawning/rearing habitat in the Union River above the Graham Lake Dam that are not freely accessible and the licensee annually transports blueback herring. Impedance of migration at the dams has the potential to restrict access to habitat, decrease the efficacy of spawners, and reduce the probability of post-spawn survival.

MDMR has utilized a life-history model (anadrofish) to develop performance standards for American shad and alewife at the Ellsworth and Graham Lake Dams on the Union River. This tool uses the best available scientific information to model population responses to a range of upstream and downstream passage performance at dams within a river system. Migration delay is considered an additional limitation for population growth and limiting such delay is necessary to meet population goals. A peer-reviewed manuscript detailing the utility of this model for Maine Rivers is in prep and is supported by MDMR, NOAA, and SUNY Oneonta. These modeling efforts determined that upstream passage needed to meet or exceed 77% (American shad) or 92% (alewife; combined with at least 95% downstream passage) to meet the department's management goal for each species in the river. MDMR's preliminary modeling for blueback herring suggests that blueback herring passage will need to be comparable to that of the other alosines to meet management goals for the river. Thus, MDMR recommends an interim performance standard of 85% upstream passage within 48 hours and 95% downstream passage within 24 hours for blueback herring. MDMR will submit a short memo to DEP updating the interim performance standard for blueback herring once modeling has been completed.

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[31]Keefer, M. L., Jepson, M. A., Clabough, T. S., & Caudill, C. C. (2021). Technical fishway passage structures provide high passage efficiency and effective passage for adult Pacific salmonids at eight large dams. PLoS One, 16(9), e0256805.

A 2021 radio telemetry study at the Milford fish lift documented 86.1% passage effectiveness for river herring[32]. Given the lessons learned at Milford since commencement of operations, and increased understanding in the field of fish passage engineering since ~2012, MDMR expects a 85% upstream passage standard could be achievable, particularly with a robust adaptive management plan in place, potential for two fishways at each project, and appropriate water management (i.e., at minimum 5% of station capacity used as attraction for each fishway and directing spill near fishway entrances to be used as additional attraction).

Recommendation 5: American eel Performance Standard

Achieve an upstream passage performance standard of 90% and a downstream standard of at least 95% malady-free[34] passage within 24 hours for American eel at each dam.

Justification: American eels are present within the Union River and likely had access to the entire watershed historically. The 2000 *Union River Atlantic Salmon and Anadromous Fish Management Plan* explicitly identifies American eels as among the anadromous species that historically used the river. Like anadromous species, the abundance of American Eel has declined from historic levels due in part to dams, overfishing, and poor water quality. The species has been considered for listing under the ESA twice, but the USFWS determined in both cases that listing was not warranted at the time. States manage their American Eel fisheries collaboratively through the Atlantic States Marine Fisheries Commission (ASMFC), which periodically conducts stock assessments or stock updates on all managed species. According to the 2023 stock assessment, the American eel population remains depleted in U.S. waters[33]. The stock is at or near historically low levels due to a combination of factors including turbine mortality, a direct project impact. The stock assessment also points to predation and disease as additional impacts that contribute to near historically low levels. Specific to hydro project, reduction or delay in upstream passage of American eels has been shown to lead to reduced growth and condition, increased parasite loads and mortality due to competition and predation[34,35].

MDMR recommends an upstream performance standard of 90% passage within 24 hours. This criterion has been developed by USFWS and MDMR and has been used to assess multiple eelways in Maine, River[36]. A 90% upstream passage standard is incorporated into the license for the Mattaceunk Project on the Penobscot River, and the Anson and Abenaki licenses on the Kennebec River[37]. A similar standard (95%) is also included in the Connecticut River American Eel Management Plan[38]. Thus, this standard is consistent with eelway performance and evaluation on many river systems in the region.

MDMR recommends a downstream performance standard of 95% based on USFWS recommendations[39] and several similar standards at other projects throughout the New England and mid-Atlantic regions of

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[32] Accession Number. 20220118-5295

[33] Atlantic States Marine Fisheries Commission. (2023). American Eel benchmark stock assessment and peer review report. Atlantic States Marine Fisheries Commission.

[34]Machut, L.S. 2006. Population dynamics, Anguillicola crassus infection, and feeding selectivity of American Eel (Anguilla rostrata) in tributaries of the Hudson River, New York. M.Sc. Thesis, State University of New York, College of Environmental Science and Forestry, Syracuse, NY. 177 pp.

[35] Machut, L.S., K.E. Limburg, R.E. Schmidt, and D. Dittman. 2007. Anthropogenic impacts on American Eel demographics in Hudson River tributaries, New York.

[36] FERC No's. 2555, 2556, 2364, 2365, 2611, 2574, 2322, 2325, 5073, 2942, 2984, 2931, and 2932

[37] Accession No. 20210226-3016

[38] CRASC. 2023. Connecticut River American Eel Management Plan.

[39] Accession No. 20240603-5215

the U.S. These include: (1) 95% project survival for eels in the Connecticut River[40]; (2) 95% downstream passage survival for each project on the Merrimack River[41]; and (3) 95% downstream survival for dams on the Naugatuck River in Connecticut[42]. The USFWS has also noted that numerous other FERC-licensed projects require downstream passage standards for eels[43,44,45,46,47,48].

<u>Recommendation 6</u>: Sea lamprey Performance Standard

Achieve an upstream passage performance standard of 80% for sea lamprey within 48 hours.

Justification: Sea lamprey are native anadromous fish that historically ranged along the Atlantic coast from Newfoundland to the Gulf of Mexico and utilized medium to large rivers throughout New England for spawning and larval development[49]. The Union River lies well within this native range and historically provided suitable habitat, including gravel riffles and depositional areas for ammocoetes upstream of the Ellsworth Dam[50]. The 2000 *Union River Atlantic Salmon and Anadromous Fish Management Plan* explicitly identifies sea lamprey as among the anadromous species that historically used the river. Sea lamprey are recognized as an important indigenous species in Maine and serve a uniquely important role in community structure and community function in freshwater habitats in the Union River and its tributaries. Sea lamprey have similar upstream migration behavior and spawning habitat to that of Atlantic salmon, and therefore it is assumed that sea lamprey had a similar historic extent to that of Atlantic salmon in all Maine rivers[47,48,51]. Thus, MDMR assumes a historic range that includes the mainstem Union River as well as the East, West, and Middle Branches.

Sea lamprey can reach small, high-gradient, headwater streams. They spawn in gravel-cobble substrate, and the spawning process results in streambed modification and sediment transport. A life history-based modeling framework does not exist to assist in development of performance standards for sea lamprey. However, information from tagging studies of modern fishways can serve as a proxy for how new fishways on the Union River may perform for sea lamprey. A University of Maine study conducted at the Milford fishway, a modern fish lift on the Penobscot River, is the best approximation of conditions for passage at Union River dams[52]. During the first year of the study, 41 of 50 (82%) of tagged sea lamprey that approached the project were successfully passed[53]. Given that each of the Union River

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[40] CRASC. 2023. Connecticut River American Eel Management Plan.
[41] Merrimack Technical Committee. 2021. Merrimack River Comprehensive Plan for Diadromous Fishes. The Technical Committee for the Anadromous Fishery Management of the Merrimack River Basin. 180 pp.
[42] CTDEEP. 2022. The plan to restore diadromous fishes to the Naugatuck River watershed. Connecticut Department of Energy and Environmental Protection, Bureau of Natural Resources, Fisheries Division. October 2022.
[43] Muddy Run FERC No. 2355
[44] York Haven FERC No. 1888
[45] Wyre Wynd FERC No. 3472
[46] , Normanskill FERC No. 2955
[47] SRAFRC. 2013. American Eel Restoration Plan for the Susquehanna River Basin.
[48] Accession Number: 20030729-3001 and 20030807-0326. Article 406 requires a 90% standard for permanent facilities.
[49] Haro, A., & Kynard, B. (1997). Migration of sea lamprey in the Connecticut River. *North American Journal of Fisheries Management*, 17(1), 100–105.
[50] Moser, M.L., et al. (2020). *Biology and Conservation of Sea Lamprey*. American Fisheries Society Symposium.
[51] Nislow,K.H. and Kynard,B.E. 2009. The role of anadromous sea lamprey in nutrient and material transport between marine and freshwater environments. Am.Fish.Soc.Symp. 69: 485-494.
[52] Peterson E, R Thors, D Frechette, and JD Zydlewski. 2023. Adult sea lamprey approach and passage at the Milford dam fishway, Penobscot River, Maine, United States. North American Journal of Fisheries Management 43(4): 1052-1065.
[53] Accession Number: 20250228-3002.

projects is recommended by MDMR to have a fish passage that will operate 24 hours per day during the sea lamprey passage season, MDMR expects that each facility will be able to achieve 80% upstream passage effectiveness. More information or new modeling frameworks may be available in the future, but for now, MDMR relies upon available tagging data as the basis for this passage standard.

Recommendation 7: Upstream Anadromous Fish Passage

Design, construct, operate, and maintain new upstream anadromous fish passage facilities at the Ellsworth and Graham Lake Dams. Upstream fishways shall meet or exceed USFWS design criteria (2019 or current version), and shall be designed to pass at least 932 Atlantic salmon, 357,676 blueback herring, and 82,029 American shad. MDMR estimates that habitat upstream of Ellsworth could support up to 23,613,870 alewives and therefore fishways should be designed and sized to accommodate large, peak season runs of target sea-run species, particularly river herring, of equal or greater capacity to existing or planned projects at Milford (Penobscot River), Hydro-Kennebec (Kennebec River), and the planned lift at Woodland Dam (St. Croix River). For example, the Milford fish lift includes a 4,000-gallon hopper capable of lifting over 1,000 fish per cycle, with a design capacity of more than 20,000 fish per day to support expected seasonal totals in the millions. Hydro-Kennebec's lift includes a similarly sized hopper and attraction flow system designed for upstream passage under variable flow conditions. At Woodland Dam, the planned lift incorporates the most contemporary design items for high capacity. These systems are characterized by high-capacity hoppers, strong attraction flows (often exceeding 100 cfs), redundant lifting systems, and sufficient crowding and holding space to prevent delays or fallback. Given the Union River's comparable habitat potential, the Ellsworth Project must include fish passage facilities of equal or greater capacity to ensure timely, volitional, and effective passage for expected future runs of river herring, American shad, and other diadromous species. Designs for the new upstream fishway at the Ellsworth project shall be compatible with the facilitation of a continued municipal river herring harvest, and shall include designs for interim fish passage to be operational during construction of the new fishway. Final fishway designs shall be complete and approved within 2 years of license issuance at each project. New fishways and passage infrastructure shall be constructed and operational prior to the 5th upstream passage season after license issuance. Interim fish passage shall be provided throughout the first 4 passage seasons through either the existing fishway or interim fish passage developed by Brookfield.

Justification: The Ellsworth Hydroelectric Project is the lowermost barrier on the Union River and a critical point for the restoration of native diadromous species, including endangered Atlantic salmon (*Salmo salar*), American shad (*Alosa sapidissima*), river herring (*Alosa pseudoharengus* and *Alosa aestivalis*), and sea lamprey (*Petromyzon marinus*). However, the Project's existing upstream fish passage infrastructure, composed of a 1972 terminal vertical-slot fishway, a fish trap, and truck transport, does not meet modern biological or regulatory performance standards and cannot support the long-term recovery of these species.

The current facilities are limited by a combination of structural constraints, biological inefficiencies, and operational gaps. The upstream trap-and-truck system introduces significant stress, migration delays, and misallocation of fish. This system is not available 24 hours per day and depends heavily on staff availability. In prior years, the trap operated only one to two days per week for a few hours each day, leaving fish delayed downstream for up to a week, during which they are exposed to elevated predation, fallback, and straying risks.

During warm water periods (above 23–24.5°C), federal and state protocols prohibit handling adult Atlantic salmon, further restricting trap operations during the summer migration window. Between 2015 and 2018, approximately 22–25% of the nearby Penobscot River's adult salmon run arrived during this period, demonstrating the critical importance of operating passage facilities continuously during peak migration.

The vertical-slot fishway also likely fails to perform as intended. Fish routinely refuse to enter the trap, often requiring the structure to be dewatered for manual netting. The U.S. Atlantic Salmon Assessment Committee has estimated that upstream passage effectiveness at Ellsworth is approximately 50%, consistent with salmon return data from the Union and Penobscot Rivers[54]. For sea lamprey and other nocturnal migrants, the fishway cannot currently operate 24 hours per day when trap-and-truck activities are paused for logistical and safety reasons, further reducing passage success for these species at night[55]

Brookfield Renewable already provides 24-hour operation at other fishways such as Milford Dam on the Penobscot River in an attempt to reduce delay for Atlantic salmon[56] and will be required to provide 24-hour operation on the Kennebec Rivers indicating that continuous passage at Ellsworth is both technically feasible and a reasonable standard of performance. However, achieving such operation at Ellsworth will require the construction of a swim-through facility and flume connection to the headpond to circumvent the logistical and safety limitations of the existing trap-and-haul system.

Fish holding capacity within the current trap facility is also inadequate to support larger runs expected under improved passage conditions. Once fish tanks are full and staff are unavailable to transport or harvest fish, river herring and other species are sluiced back downstream of the dam. This contributes to significant delays, increased energy expenditure, and thermal stress, even for fish that successfully located the passageway.

Fish passage data from comparable projects reinforce the consequences of such bottlenecks. Between 2016 and 2024 at the Lockwood Project, the difference between fish captured and those actually transported upstream averaged 15.7% for river herring and 44% for American shad (Table 1a and 1b). In some years, 100% of captured shad were returned downstream. Without a continuous swim-through facility, similar outcomes will persist at Ellsworth, undermining any restoration gains made by increasing run sizes.

Table 1a and 1b. Comparison of fish captured (lifted in fish lift), trucked upstream, and returned to the river downstream at the Lockwood project from 2016 to 2024.

1a. Lockwood River Herring (Alewife and Blueback Herring)

Year	# Captured	# Trucked	# Returned	% Returned
2016	220,727	207,771	12,956	5.87%
2017	289,172	238,493	50,679	17.53%

[54]USASAC. (1991). Annual report of the U.S. Atlantic Salmon Assessment Committee. Report No. 03 1990 Activities. Prepared for U.S. section to NASCO. January 1991.

[55] Grote, A. B. , M. M. Bailey, J. D. Zydlewski, and J. E. Hightower. 2014. Multibeam sonar (DIDSON) assessment of American Shad (Alosa sapidissima) approaching a hydroelectric dam. Canadian Journal of Fisheries and Aquatic Sciences. 71: 545-558.

[56] Accession No. 20250425-5193

2018	300,390	236,311	64,079	21.33%
2019	240,487	204,975	35,512	14.77%
2020	143,529	133,170	10,359	7.22%
2021	66,008	52,830	13,178	19.96%
2022	83,978	74,819	9,121	10.86%
2023	136,752	103,436	33,316	24.36%
2024	86,467	69,669	16,798	19.43%
Average	174,168	146,830	27,333	15.70%

1b. Lockwood American Shad

Year	*# Captured*	*# Trucked*	*# Returned*	*% Returned*
2016	*836*	*827*	*9*	*1.08%*
2017	*213*	*201*	*12*	*5.63%*
2018	*401*	*272*	*129*	*32.17%*
2019	*187*	*22*	*165*	*88.24%*
2020	*180*	*134*	*46*	*25.56%*
2021	*99*	*64*	*35*	*35.35%*
2022	*5*	*0*	*5*	*100%*
2023	*4*	*0*	*4*	*100%*
2024	*23*	*21*	*2*	*8.70%*
Average	*216*	*171*	*45*	*44.08%*

Operational risks extend to both Atlantic salmon and river herring. Thousands of river herring are harvested at the trap, and no reliably safe method exists to separate them from salmon. Salmon are identified visually among thousands of alewives in the hopper, increasing the chance of injury, misplacement, or accidental harvest. The use of a dry hopper during river herring harvest further increases injury risks. A terminal fishway cannot indefinitely support the fish restoration goals. It is both reasonable and prudent to construct the flume and swim-through fishway at the Ellsworth Project to address these longstanding passage failures and achieve modern performance expectations.

While the existing requirements include the development of a state of the art swim-through fishway *no later than year 15* of any new license, this timeline has no biological basis and the continuous impacts are too significant for this amount of delay, particularly given the delays since expected relicensing. The focus on Atlantic salmon as the only target species and timeframe is not supportive of all indigenous species and DMR's goals for the watershed. Current passage conditions are neither safe nor timely, and they fail to support long-term goals. Given the significant delay in implementing volitional fish passage and the immediate risks to ESA-listed species, requiring final design approval within two years and full facility implementation within five upstream passage seasons is both reasonable and essential. This timeline aligns with implementation schedules used in other hydropower relicensing processes where anadromous fish passage is a primary concern in the lower watershed below the majority of historic habitats.

Recommendation 8: Downstream Fish Passage

Brookfield will design, construct, operate, and maintain a 0.75-inch or less, full depth, angled or inclined rack structure upstream of the forebay, new surface bypass systems at the Ellsworth Dam and low level (multiple entrances) bypass systems at the Ellsworth and Graham Lake dams within five years of license issuance. The structures should be designed such that normal velocities do not exceed two feet per second as measured at an upstream location where velocities are not influenced by the local acceleration around guidance structures. The structures shall include low level entrances to a downstream bypass system and provide guidance to a surface bypass location or locations. In the interim four years before this requirement, Brookfield shall perform targeted shutdowns for American eel and alosines at the Ellsworth Project. For eels, Brookfield shall shut down the project at night (½ hour before dusk to ½ hour before dawn) from August 15 to November 15. In addition, Brookfield shall shut down the project immediately following a storm event that results in ≥ 15% of the average monthly rainfall during the downstream alosine passage season (June 1 to November 30). The project shall be shut down for 5 consecutive days following the storm.

Justification: Brookfield has proposed or is required to construct or maintain fish guidance boom systems and overlays that are intended to preclude downstream migrating fish from entrainment. However, many anadromous species may pass downstream at depth. A 1990 paper reported that adult American Shad were captured in the lower half of the water column 83% of the time when migrating upstream and downstream, and a 1987 and 1990 paper reported that adult Blueback Herring migrated at mid-water depth[57,58]. In addition, a 1982 paper that compared surface and bottom trawls for juvenile alosines found that the majority of alewife (98.5%) and American Shad (76.8%) and a large portion of Blueback herring (33%) were captured in bottom trawls[59]. In addition, downstream passage studies performed at West Enfield with Atlantic salmon smolts, adult river herring, adult American shad, and juvenile river herring demonstrate that these fish either approach the project at depth or sound down more than 15 feet to reach the submerged entrance of the entrance rack, which starts at 15 feet below normal headpond. The results of these studies are as follows: 2016: 49.4% of smolts were entrained; 2017: 57% of smolts were entrained; 2018: 26% percent of smolts, 16% of adult river herring, and 13% of adult American shad were entrained[60]; 2019: 99% of juvenile river herring were entrained.

Data provided by Brookfield on the Kennebec River (SPP, Table 5-1) demonstrates that the guidance booms used at the Lockwood, Hydro-Kennebec, and Weston Projects do not guide 14.3-30.6% of the migrating smolts away from the turbines[61]. Data provided by Brookfield (FLA, Table 4-22) shows that 32.7% of the downstream migrating smolts were entrained into the turbines at the Shawmut Project and the instantaneous survival was 7% lower when fish went through the turbines compared to spill routes at Shawmut[62]. This grossly underestimates the sublethal effects, including injury and disorientation, that would result in higher mortality in the estuary (latent mortality). Furthermore, this analysis does not account for all causes of mortality through a hydroelectric project, including mechanical damage,

[57] Witherall, D. B. and B. Kynard. 1990. Vertical distribution of adult American shad in the Connecticut River. Transactions of the American Fisheries Society. 119: 151-155.
[58] Witherall, D. B. 1987. Vertical distributions of adult American shad and blueback herring during riverine movement. Master's thesis. University of Massachusetts, Amherst.
[59] Loesch, J. G., W, H. Kriete, Jr., and E. J. Foell. 1982. Effects of light intensity on the catchability of juvenile anadromous Alosa species. Transactions of the American Fisheries Society 111:41-77.
[60] These entrainment values would have likely been higher but flashboard damage during the study period caused spill conditions that don't normally occur.
[61] Brookfield Renewable. 2021. Lockwood (FERC No. 2574), Hydro Kennebec (FERC No. 2611), and Weston (FERC No. 2325); Lower Kennebec Species Protection Plan and Draft
Biological Assessment
[62] Accession No. 20200131-5356

pressure-induced damage, shearing action damage, and cavitation damage[63]. Studies at the Ellsworth dam assessing injury to salmon showed that 22-30% of fish that went through the turbines had injuries compared to 3.8% that went through spill routes, demonstrating that impact quantitatively[64]. The 2015 Evaluation of Downstream Passage for Adult and Juvenile River Herring on the Kennebec River demonstrated that 53 percent of the study fish went through the Lockwood turbines, rather than being guided by the boom to the downstream bypass, and survival was lowest for those fish passing Lockwood via the units (i.e., 77.4-81.7% survival) [65]. In their comments on the proposed downstream alternatives for the West Enfield project (P-2600), USFWS summarized effectiveness of guidance booms on the Kennebec River, at the Lockwood and Weston projects (both project had the bypass operating at greater than 5% of station capacity and the panels of the booms are rigid and extend 10 feet below the water surface), and concluded "the boom does not provide safe, timely, and effective passage for the Service's trust species and does not comport with our most up to date design criteria"[66]. They noted that inefficiencies associated with guidance booms may be due to downward velocities that are produced by the panels themselves, as presented by Mulligan et al. 2017[67].

The anticipated guidance structures at the project are unlikely to prevent or significantly reduce entrainment of adult river herring, juvenile alosines, and juvenile sea lamprey. Adult river herring are more likely to migrate downstream past the Ellsworth and Graham Lake Projects during the summer months (July-September) when average flows are not likely to result in spill at the project. During this time the majority of river flow would be going through the turbines in a typical year. Adult river herring would typically migrate downstream in proportion to the ratio of flow provided at each passage route. With an ineffective boom system (see previous paragraph) and large spaced trash rack overlays that do not provide further guidance, these fish will fit right through the trash racks and pass through the turbines resulting in continued large-scale fish kills at the project[68,69]. This issue is even more pronounced for smaller juvenile alosines, which have decreased swimming abilities and are even more likely to follow proportional flow paths at the project. Thus, under the current proposal, there is minimal to no protection for these fish to prevent them from being entrained in the project turbines, which have been documented as the passage route with the highest mortality. Even fish that cannot pass through the trash rack overlays (i.e., adult American shad) may experience severe impingement due to relatively high intake velocities associated with current infrastructure (> 2 fps at all units)[70] and no additional guidance to downstream passage routes once they have passed downstream of the guidance boom. A 2020 study found that Juvenile American shad were more susceptible to both fluid shear and rapid decompression associated with passage through hydropower turbines than Chinook salmon with injuries

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[63] Pflugrath BD, RK Saylor, K Engbrecht, RP Mueller, JR Stephenson, M Bevelhimer, BM Pracheil, and AH Colotelo. 2020. Biological Response Models: Predicting injury and mortality of fish during downstream passage through hydropower facilities. PNNL-30893.
[64] BBHP. (2017a). Ellsworth Project, FERC No. 2727, Evaluation of Atlantic salmon smolt passage, Spring 2017. Prepared by Normandeau Associates, Inc. for Black Bear Hydro Partners, LLC. FERC Accession # 20171229-5079.
[65] Accession Number. 20160331-5144
[66] Accession Number: 20211217-5213.
[67] Kevin Brian Mulligan, Brett Towler, Alex Haro, David P. Ahlfeld, A computational fluid dynamics modeling study of guide walls for downstream fish passage, Ecological Engineering, Volume 99, 2017, Pages 324-332, ISSN 0925-8574, https://doi.org/10.1016/j.ecoleng.2016.11.025.
[68] Accession No. 20181121-3012. FERC Draft Environmental Assessment. Table 22 at page 160.
[69] Conservation group says dam operations caused the death of thousands of alewives in Ellsworth | Maine Public
[70] Accession No. 20151230-5275

such as scale loss, damage to the eyes and operculum, and damage or rupture of the swim bladder[71]. The authors go on to say, "When compared to other fish species, American shad are highly susceptible to fluid shear and rapid decompression."

The current proposal would also be ineffective for American eel. American eels typically approach hydroelectric projects in the lower portion of the water column and therefore would not be effectively guided by floating booms. The USFWS Fish Passage Design Criteria provides very specific guidance around floating booms:

> "A floating guidance system for downstream fish passage is constructed as a series of partial depth panels or screens anchored across a river channel, reservoir, or power canal. These structures are designed for pelagic fish which commonly approach the guidance system near the upper levels of the water column. While full-depth guidance systems are strongly preferred, partial-depth guidance systems may be acceptable at some sites (e.g., for protection of salmonids, but not eels)"[72].

American eels are also highly likely to fit through the currently proposed trash rack overlays. In addition to these issues, the current proposal does not provide any new low-level bypasses, which will result in increased delay (i.e., time spent searching for downstream passage) and increase the likelihood of entrainment. Providing effective low-level bypass facilities would reduce delay and promote passage effectiveness for this bottom-oriented species. Downstream passage facilities such as weirs (surface or bottom opening) and flumes have been incorporated at many dams to mitigate the effects of turbine mortality[73]. A 2003 paper found that eels presented with surface and bottom opening bypass weirs preferred the bottom bypass (94%)[74]. A study in 2008 of silver eel passage at a hydroelectric project on the Magaguadavic River in New Brunswick found only 21% of tagged eels used a new surface bypass weir, 11 percent passed safely by other routes and the remaining silver eels entered the turbines soon after encountering this route and died, as evidenced by cessation of movement[75].

Broadly, the current proposal will result in adverse impacts to these species and will not be conducive to producing self-sustaining runs above these projects if further measures are not required. USFWS has summarized passage data on guidance booms in a filing[76]. The data in their summary demonstrates that guidance booms do not meet current USFWS design criteria, nor do they provide safe, timely, and effective passage for many species. The recent FERC FEIS analysis and assumptions on the Kennebec River demonstrate that turbine passage would be significantly higher with the current action compared to MDMR's recommendation of full depth 0.75-inch angled racks and appropriate bypass facilities

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[71] Pflugrath, B. D., Harnish, R. A., Rhode, B., Engbrecht, K., Beirao, B., Mueller, R. P., ... & Colotelo, A. H. (2020). The susceptibility of Juvenile American shad to rapid decompression and fluid shear exposure associated with simulated hydroturbine passage. *Water*, *12*(2), 586.
[72] USFWS (U.S. Fish and Wildlife Service). 2019. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.
[73] Shepard, S.L. 2015. American eel biological species report. Supplement to: Endangered and Threatened Wildlife and Plants; 12-Month Petition Finding for the American Eel (Anguilla rostrata) Docket Number FWS-HQ-ES-2015-0143. U.S. Fish and Wildlife Service, Hadley, Massachusetts. xii +120 pages.
[74] Durif, C., P. Elie, C. Gosset, J. Rives, and F. Travade. 2003. Behavioral study of downstream migrating eels by radio-telemetry at a small hydroelectric power plant. Pages 343–356 in D.A. Dixon, editor. Biology, management, and protection of catadromous eels. American Fisheries Society Symposium 33. Page 350.
[75] Carr, J. W., and F. G. Whoriskey. 2008. Migration of silver American eels past a hydroelectric dam and through a coastal zone. Fisheries Management and Ecology 15(5– 6):393–400. Page 396–398.
[76] Accession Number: 2021217-5213

(including low-level bypasses for eels) at the Ellsworth dam project[77]. FERC's analysis on the Kennebec estimated that 0.75-inch full depth screening would eliminate turbine entrainment for Atlantic salmon kelts, adult river herring, and American eels and significantly reduce entrainment for Atlantic salmon smolts and juvenile alosines compared to the proposed action. While trash rack overlays with 1-inch clear spacing or less have been installed at some projects, testing has shown that those measures do not adequately reduce entrainment. For example, 1-inch clear spaced racks were installed at the Mattaceunk Project on the Penobscot River in 2023 and tested in 2024. Testing found the majority of eels used the roll gate to pass the project during the daily shutdown times, however all eels that passed outside of the daily shutdown times passed via the turbines and were therefore not deterred by 1" racks[78].

Previous recommendations for 1" racks and other measures were based on old guidance and are now out of date. The USFWS updated their design criteria in 2019 and MDMR continues to recommend that all project passage measures comport with that guidance or updated versions as they become available. Based on current criteria, we recommend screening all operating turbines with angled, full-depth bar racks with a clear space less than or equal to 0.75-inches along with appropriately designed surface and low-level bypasses.

In addition to these permanent measures, we also recommend interim measures to keep eels and alosines out of the project turbines. As stated previously, there are multiple reports of mass fish kills because of turbine passage at the project. Beyond these isolated reports, MDMR has analyzed age structure and repeat spawner data for the Union River going back to 2008 that indicates that the alewife population in the Union is dominated by age-3 and age-4 fish with very few repeat spawners, suggesting that adults do not survive downstream migration. These data, coupled with fish kill reports, and the likelihood of fish passing via turbine passage necessitate immediate protective measures at the project. Shutting down the turbines is the best way to protect fish in the interim (i.e., prior to appropriate guidance and exclusion measures). Adult American eels typically migrate downstream at night, so MDMR recommends nighttime shutdowns from dusk (1/2 hour after sunset) to dawn (1/2 before sunrise) during the downstream eel passage season, defined here as August 15 – November 15 (Appendix 3). This measure should protect some downstream migrating river herring and American shad as well, but extended shutdown periods for these species is warranted as well. FERC summarized fish kills that had occurred to date in their DEA[79]. All of the documented fish kills between 2014 and 2018 occurred within 5 days of a storm event that dropped ≥ 17% of the average monthly rainfall. This finding suggests that shutting down the project for 5 days following large storm events would reduce the occurrence of large fish kills at the project. MDMR believes such an approach is appropriate in the interim.

Recommendation 9: Adaptative Management Plan.

A. Effectiveness testing to assess survival, injury, and delay in upstream and downstream passage shall be implemented by Brookfield in the first downstream fish passage season and the second upstream fish passage season following installation of MDMR's recommended fish passage measures. Atlantic salmon testing will be coordinated with federal agencies. Brookfield will prepare study plans for effectiveness testing for Atlantic salmon, shad, alewife, blueback herring,

[77] Federal Energy Regulatory Commission. (2022). Final Environmental Impact Statement for the Lower Kennebec River Projects. Washington, DC.
[78] Accession Number: 20250331-5471.
[79] Accession No. 20181121-3012

American eel, and sea lamprey and distribute draft plans to MDMR and DEP for review and for approval by DEP no later than one year prior to the start of the passage season in which the study will be conducted. The study plans will include appropriate measures for testing to determine if the project meets the applicable performance standards.

   a. These initial studies may be limited to specific species and life stages, with approval from DEP, to prevent delay of potential modifications. However, the facilities will need to be tested for all species and life stages on a timeline approved by DEP

B. No later than 8 months after the initiation of effectiveness testing, Brookfield shall distribute a draft study report to MDMR and DEP.
C. If performance standards have not been achieved after one year of testing, Brookfield will consult with MDMR and DEP within 30 days of distribution of the effectiveness testing report to review study results and identify areas of deficiency. Deficiencies will be addressed as described in Sections d, e, f, and g below prior to initiation of a subsequent study. Addressing deficiencies in upstream eel passage shall follow the process outlined in Recommendation 10.
D. If performance standards have not been achieved, but the results are close (within 10% of performance standard criteria for passage effectiveness or timing for the tested species), Brookfield can implement minor operational or structural modifications to address the deficiency as approve by DEP and retest the facility as described in section A or as determined by DEP. Structural modifications could include:
   a. Modifications to the upstream fishway entrance gates, internal infrastructure, and/or attraction water system and, modifications to the spillway, downstream fishway, or downstream ledges.
E. If upstream performance standards have not been achieved, and the results are not close (within 10% of performance standard criteria for passage effectiveness or timing for tested species), Brookfield shall construct the following measure no later than 4 years after the distribution of the effectiveness testing report:
   a. Design, construct, operate, and maintain attraction flow channel(s) capable of conveying 20% of station capacity to provide additional attraction
F. If downstream performance standards have not been achieved and the results are not close (within 10% of performance standard criteria for passage effectiveness or timing for the tested species), Brookfield shall construct a comprehensive measure no later than 4 years after the distribution of the effectiveness testing report. Measures could include:
   a. Construction of a new downstream fish bypass facility with low level and surface entrances
   b. Construction of additional crest gates or other spillway gates
G. Once Brookfield has implemented DEP's required measures, Brookfield will repeat the study and implementation timeline and process as outlined in steps A-F of this adaptive management plan until deficiencies have been addressed. However, subsequent adaptive management measures will be developed in consultation with DMR and approved by DEP. If Brookfield is still not close to achieving performance standards (within 10% of performance standard criteria for passage effectiveness of timing), Brookfield will design and implement a new or replacement fishway

that could achieve performance standards. This second or replacement fishway shall meet or exceed USFWS design criteria (2019 or current version), and shall be of comparable size to the fishway built in Year 5 of the license or larger, and shall include components or be designed to allow opportunity for continued municipal harvest and interim fish passage. Final fishway designs shall be complete, approved, and submitted to FERC within 2 years of failure to achieve the performance standard a second time at each project. New fishways and passage infrastructure shall be constructed and operational within 3 years of the submission of final fishway designs to FERC.

Justification: Effectiveness testing and adaptive management are essential to ensuring that upstream and downstream fish passage measures at the Ellsworth and Graham Lake Projects meet designated uses under the Clean Water Act and support the restoration goals of the Maine Department of Marine Resources (MDMR) for native diadromous fish. The performance of fish passage systems cannot be assumed at the time of construction; instead, it must be verified through monitoring. If the facilities fail to meet biological performance standards, adaptive management provides a structured process to make timely and necessary improvements to achieve those standards over the license term.

Performance standards may not be achieved immediately following construction and additional modifications, such as increasing attraction flow, adjusting fishway entrances, or adding new fishways can improve effectiveness. NOAA's Biological Opinion for the Ellsworth Hydroelectric Project is explicit in its expectation that initial fish passage measures may fail and that adaptive modifications are necessary. NOAA anticipates that even well-engineered designs may not meet performance targets at the outset, stating that: "additional structural or operational modifications—such as enhanced attraction flow, additional entrances, or new fishways—may be required if monitoring reveals deficiencies in passage effectiveness." In the FLA, Brookfield has committed to "implement additional adaptive management measures in consultation with the resource agencies" in relation to meeting a 90 percent cumulative performance standard (95% per project) for Atlantic salmon. However, this proposed measure is not specific, does not include the other diadromous fish species, and does not include a clear timeline for implementation. MDMR's recommended adaptive management program for all species is more specific and provides clear timelines.

In cases where passage standards are not met, adaptive management should include improvements to nearfield attraction at fishway entrances. Effective attraction flow is essential for guiding fish to the entrance of the fishway and can be improved by modifying flow conditions, relocating entrances, or adjusting entrance hydraulics. The U.S. Fish and Wildlife Service (USFWS) Design Criteria recommend that at least five percent of station capacity be allocated to attraction flow, with higher flows generally resulting in improved entrance location by fish[80]. FERC Staff and Interior's Section 18 prescriptions identify attraction flow as a pivotal adaptive management measure. In describing adaptive obligations, the DEA requires that: "implement adaptive management measure(s) in consultation with resource agencies, as necessary to improve downstream fish passage effectiveness … including … increasing flows over the spillway … to meet the 90 percent performance standard." At Ellsworth, MDMR recommends construction of an attraction flow channel capable of passing up to 20 percent of station

[80] U.S. Fish and Wildlife Service. (2019). Fish Passage Engineering Design Criteria. Hadley, MA: USFWS Northeast Region.

capacity to improve fish attraction under high spill conditions, particularly when flow is otherwise diverted away from the fishway entrance.

There is strong evidence from other Northeast projects that the construction of secondary fishways is a highly effective strategy to improve upstream passage. For example, the FEIS for the Lower Kennebec River Projects suggested that cumulative American shad passage through four projects would increase from 0.5 percent under the Proposed Action to 6.2 percent with the addition of secondary fishways. For river herring, passage would increase from 13.6 percent to 55.7 percent, for sea lamprey from 41.7 percent to 82.2 percent, and for Atlantic salmon from 93.5 percent to 99.6 percent[81]. These improvements reflect cumulative increases in passage effectiveness ranging from 97 percent to over 1,100 percent depending on the species. The inclusion of secondary fishways is a well-supported adaptive measure and has already been implemented at other Maine hydroelectric facilities, including the Lockwood Project on the Kennebec, the Milford Project on the Penobscot, and the Woodland Dam on the St. Croix.

The benefits of multiple fishways are further supported by research from the Columbia River Basin. Keefer et al. (2021) found that average passage efficiency for Pacific salmonids at eight large-river dams exceeded 96 percent and attributed this exceptional performance to a sustained commitment to adaptive management, including redundancy in fishway options and continuous refinement of passage systems[82]. Notably, many of the dams in that study operate more than one fishway, offering fish multiple opportunities to pass and reducing the likelihood of delays or failures.

Minimizing passage delay is equally important. Delays at dams can lead to increased energy expenditure, stress, and ultimately reduced reproductive success. Keefer et al. (2004) demonstrated that most Chinook salmon and steelhead successfully passed Columbia River dams within 48 hours[65]. However, recent modeling by Rubenstein et al. (2022) showed that delayed passage across four dams on the Kennebec River could reduce reproductive success for Atlantic salmon to just 30.7 percent[83]. These findings highlight the biological cost of delays and the importance of rapid and efficient fishway performance. Brookfield's decision to operate the secondary Denil fishway at Milford Dam 24 hours per day to reduce migratory delay underscores that similar adaptive operations at Ellsworth would be reasonable and effective[84].

Adaptive measures may also be necessary to address issues with entrance placement, diffuser configuration, attraction water delivery systems, and internal fishway components such as gates and crowders. Telemetry studies and recent evaluations have shown that features like V-gates and poorly placed floor diffusers can inhibit passage, particularly for American shad and other species that require high flow coherence to orient properly[85]. If entrance conditions, internal velocities, or hydraulics fall outside of USFWS guidelines, operational or structural modifications should be made as part of adaptive

[81] Federal Energy Regulatory Commission. (2022). Final Environmental Impact Statement for the Lower Kennebec River Projects. Washington, DC.
[82] Keefer, M. L., Boggs, C. T., Daigle, W. R., & Caudill, C. C. (2021). Sustained high passage efficiency in a large-river fishway network: Lessons from the Columbia River. Fisheries, 46(5), 220–229. https://doi.org/10.1002/fsh.10607
[83] Rubenstein, N., Boucher, T. P., & Perkins, T. (2022). Energy use and reproductive consequences of upstream migration delay in Atlantic salmon. Ecological Applications, 32(3), e2582. https://doi.org/10.1002/eap.2582
[84] Brookfield Renewable. (2022). Milford Dam Fishway Operation and Monitoring Report. Bangor, ME.
[85] Maine Department of Marine Resources. (2023). Telemetry results and design review memos for Union River fish passage. Augusta, ME.

management. Ongoing monitoring will be essential for identifying these needs and ensuring effective solutions are implemented.

Downstream passage must also be adaptively managed to reduce the negative impacts of dams on emigrating fish. Downstream measures must be tailored to site-specific conditions and species behavior and must consider both current design criteria and real-world operational experience. Adjustments to spill timing, bypass location, and turbine operations may all be necessary to achieve safe, timely, and effective downstream passage. The use of regionally supported design principles, including those outlined in the USFWS (2019) criteria, should guide ongoing improvements to these systems[86].

In summary, effectiveness testing and adaptive management are essential components of a successful fish passage strategy for the Ellsworth and Graham Lake Projects. These tools provide the flexibility to respond to site-specific challenges and evolving biological needs. Given the performance standards required under the license and the substantial evidence that adaptive management, especially secondary fishways and improved attraction flows, leads to significantly higher passage success, MDMR strongly supports the implementation of a robust adaptive management framework. This approach ensures that fish passage systems will evolve to meet restoration goals, even if initial construction does not immediately achieve desired biological outcomes.

Recommendation 10: Upstream Eel Passage & Adaptive Management

Design, construct, operate, and maintain interim and permanent upstream eel passage at the Ellsworth and Graham Lake dams. Upstream eelways shall meet or exceed USFWS design criteria (2019 or current version), and multiple eelways may be needed at each dam depending on conditions at the project and as determined by MDMR and DEP. Construction and testing of eelways shall adhere to the following timeline:

A. No later than 2 months after license issuance, Brookfield shall distribute a draft study plan to MDMR and DEP detailing a siting study to be conducted within 1 year of license issuance at the Ellsworth and Graham Lake dams. The study plan must be developed in consultation with MDMR and must be approved by DEP. A second year of study may be required based on study results and environmental conditions, as determined by MDMR and DEP.
B. No later than 6 months after initiation of the above siting study, Brookfield shall distribute a draft study report to MDMR and DEP.
C. Based on the results of the study report and in consultation with MDMR as approved by DEP, Brookfield shall construct, operate, and maintain an interim upstream eelway(s) at the project to be operational for the 2nd upstream passage season following license issuance.
D. No later than 6 months after the construction of new upstream anadromous fishways, Brookfield will submit an additional study plan to MDMR and DEP to reevaluate the location of eelway(s) to determine if eels continue to congregate near and are able to enter the interim eelway(s). Brookfield shall conduct the study 1 year after construction of the new upstream anadromous fishway and may be required to conduct additional years of siting studies dependent on study

[86] U.S. Fish and Wildlife Service. (2019). Fish Passage Engineering Design Criteria. Appendix D: Downstream passage design considerations.

results and environmental conditions. Study plans must be developed in consultation with MDMR and must be approved by DEP

   a. If, based on study results, eels are congregating where eelways are not present, as determined by DEP in consultation with MDMR, Brookfield will develop a plan and, after approval from DEP, construct new permanent eelways that are expected to remedy the issues identified in the report. Unless another timeline is approved by DEP, the new eelways will be constructed within 1 year of the initiation of siting studies.
   b. If, based on study results, the majority of eels are congregating adjacent to existing interim eelways, Brookfield will develop a plan and after approval from DEP, construct permanent eelways in the locations of the interim eelways. Unless another timeline is approved by DEP the new eelways will be constructed within 1 year of the initiation of siting studies.

E. One year after construction of permanent eelways, Brookfield will implement a tag/recapture study in consultation with MDMR and with approval from DEP to demonstrate achievement of the upstream performance standard for American eel (90% within 24 hours). If performance standards are not achieved, Brookfield must implement measures to address upstream passage deficiencies within 1 year based on study results with approval from Maine DEP in Consultation with MDMR. Potential measures could include but are not limited to:
   a. Construction of additional eelways,
   b. Modification of existing eelways,
   c. Modifications to discharge or leakage at project facilities.
F. Once Brookfield has implemented DEP's required measures, Brookfield will repeat the study and implementation timeline and process as outlined above until performance standards have been achieved.

Justification: American eels are currently present in the Union River and likely had access to the entire watershed historically. American eels require unimpeded access to upstream growth habitat. There are no upstream eelways at the Ellsworth, and Graham Lake dams, which severely limits habitat availability and population growth in the system. Thus, safe, timely, and effective upstream passage is needed at these projects to promote population growth and achieve MDMR's management goals for the species. The siting studies proposed by MDMR are the standard methods for siting appropriate eel passage locations and the timeline we recommend will ensure that passage is available soon after license issuance. American eels are already downstream of this project, so passage is needed as soon as possible.

New or existing and untested eelways need to be tested to ensure that they are constructed, operating, and functioning as intended. There are multiple large-scale changes in discharge (amount and location) that are being proposed by Brookfield and MDMR at each project. Many of these changes are likely to result in large amounts of water being discharged in different locations and amounts than they are currently. The USFWS minimum attraction water guidance for eel ramps is a mere 50 gallons per minute (~0.11 cfs), thus even miniscule changes in discharge can render previously constructed eelways ineffective[87]. Further, the recommended studies are needed to confirm that the eelways are indeed passing representative size classes of eels compared to those present below the dam. In addition, an

[87] U.S. Fish and Wildlife Service. (2019). Fish Passage Engineering Design Criteria. Appendix D: Downstream passage design considerations.

independent tag-recapture or PIT study is necessary to determine the proportion of tagged eels that can successfully find (i.e., approach) and pass the eelways to ensure that they are providing safe, timely, and effective passage.

Recommendation 11: Fish Passage Counts

Develop and implement a plan to install, maintain, and report on counts of each species of fish that enter and pass the Ellsworth and Graham Lake Dams each year. The plan shall detail the approach for counting fish at each project, the resolution of data for counts, details on other data that will be provided (E.g. operations data), and shall be submitted to DEP prior to commencement of construction of passage measures. The plan must be approved by DEP and counts must be carried out in the first passage season in which new passage measures are operated at a given project.

Justification: Fish counts are crucial to monitor fish populations throughout the license term, particularly when the applicant is not conducting passage studies. Anomalously low counts could be indicative of changes to operational or structural conditions that have negatively impacted fish passage in a specific year. Any detrimental changes in project conditions may go unnoticed without the information provided by counts.

Recommendation 12: Fishway Operations and Maintenance Plan

Brookfield shall develop a Fishway Operation and Maintenance Plan (FOMP) for the Project (including Ellsworth and Graham Lake Dams and fish passage facilities). The FOMP shall describe detailed plans for 24-hour operation of project fishways during the upstream and downstream fish passage seasons at the Project after construction of new upstream fishways (Appendix 3). Within 12 months of license issuance for the Project, Brookfield shall submit a FOMP to DEP for approval in consultation with MDMR and in coordination with FERC requirements. Brookfield shall keep the FOMP updated on an annual basis to reflect any changes in fish passage operations and maintenance planned for the year. The annual FOMP shall include general schedules and procedures for:

A. Operation and maintenance of existing or anticipated new fishways, including the method and calculations for provision of any required flows;
B. Inspection and monitoring of the fishway facilities, including regular observation of facilities and periodic trash rack inspections;
    i. Standards for temporary suspension or other changes to fishway operations due unplanned (e.g., unusual weather events such as ice conditions) or planned (e.g., maintenance) circumstances upon approval by DEP;
    ii. Replacement of flashboards and limiting leakage within 3 days after river flow is within the hydraulic control of the powerhouse, or within such longer period as is necessary to account for worker safety concerns;
    iii. Brookfield shall conduct an annual inspection of the trash racks to ensure proper spacing and to check for damage and functionality;
    iv. A schedule for routine fishway maintenance to ensure the fishways are ready for operation at the start of the migration season;
    v. Procedures for seasonal upstream and downstream fishway operations;

vi. Procedures for monitoring and reporting on the operation and maintenance of the facilities as they affect fish passage;

vii. If DEP, at its discretion, or in consultation with MDMR, request a modification of the FOMP, Brookfield shall amend the FOMP within 30 days of the request and send a copy of the revised FOMP to the DEP, MDMR, and the Commission. Further, any modifications to the FOMP by Brookfield require the approval of DEP, in consultation with the MDMR, prior to implementation and prior to submitting the revised FOMP to the Commission for its approval; and

viii. Brookfield shall provide information on fish passage operations and project generating operations that may affect fish passage, upon written request to DEP or MDMR. Such information shall be provided within 10 calendar days of the request, or upon a mutually agreed upon schedule.

Brookfield shall prepare a Fishway Operation and Maintenance Report (FOMR) and submit it to the DEP and MDMR by January 31 each year following the completion of fishway construction. The FOMR shall be in letter report format and shall include a summary of the current state of the fishways (structures, flows, etc.), a yearly fishway operation and maintenance report (deviations, issues, timing of installation, etc.), and summary data on the flows (e.g., high flow events) and generation experienced (e.g., non-operational periods) at the Project throughout the year. Additionally, FOMR should include information regarding Brookfield's annual inspection of the trash racks.

Justification: As FERC has held at the four lower Kennebec Projects[88], and as Brookfield operates on the Penobscot River[89] upstream passage facilities need to be operational 24 hours a day to accommodate effective passage for nocturnal migrating alosines[90] and sea lamprey[91]. Fishways need to be operational during the required migratory periods to ensure that they are providing passage when target species are migrating. Migratory periods for the Union River have been adopted from those used at the Milford Project on the nearby Penobscot River (Appendix 3). Given the need for 24-hour operation, passage must be provided without the need for handling, either through an automated fish lift connected to the headpond, or volitional fish passage facility. Trap and haul cannot be used to fulfill 24-hour fish passage operations because it cannot be completed safely[92], in addition to having reduced effectiveness. MDMR also has strict handling protocols for Atlantic salmon[93], which require that no fish are handled when river temperatures exceed 24.5°C. Under a trap and haul approach, Brookfield would be forced to return salmon downstream resulting in significant delay. Prolonged exposure to high temperatures combined

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[88] Accession No. 20250228-3002

[89] Brookfield Renewable Power o/b/o Black Bear Hydro Partners, LLC submits draft Biological Assessment and Species Protection Plan re the Milford Project under P-2534.eLibrary | File List

[90] Grote, A. B. , M. M. Bailey, J. D. Zydlewski, and J. E. Hightower. 2014. Multibeam sonar (DIDSON) assessment of American Shad (Alosa sapidissima) approaching a hydroelectric dam. Canadian Journal of Fisheries and Aquatic Sciences. 71: 545-558.

[91] Peterson E, R Thors, D Frechette, and JD Zydlewski. 2023. Adult sea lamprey approach and passage at the Milford dam fishway, Penobscot River, Maine, United States. North American Journal of Fisheries Management 43(4): 1052-1065.

[92] There are several limitations, drawbacks, and impacts to fish that are inherent to a trap and haul passage approach. For these reasons MDMR believes trap and haul should be precluded from consideration as a permanent solution.

[93] Maine DMR Handling Protocols can be found at https://www.maine.gov/dmr/fisheries/sea-run-fisheries/programs-and-projects/trap-count-statistics. These protocols are being revised, and the new protocol will add the following condition, "Trapping operations will cease at 24.5°C."

with delay will result in increased stress, injury and mortality. Thus, swim-through passage is needed at the site to facilitate 24-hour operations and safe, timely, and effective passage.

Annual documentation of the operation and maintenance at new or existing fishways is needed to ensure they are constructed, operating, and functioning as intended. There are multiple large-scale changes that are being proposed by Brookfield and MDMR at each project. Many of these changes will alter each project's operation and maintenance schedules and therefore passage efficacy and fish survival rates. The recommended annual FOMP and FOMR will help Brookfield reach performance standards and identify issues at each Project.

Recommendation 13: Plunge Pool Evaluation

Within 3 years of license issuance for the Ellsworth and Graham Lake projects, Brookfield shall verify that existing plunge pools meet or exceed USFWS design criteria. If any plunge pool does not meet USFWS design criteria, Brookfield will design appropriately sized plunge pools downstream of bypasses and other outfalls (e.g., spillways) that may provide downstream passage for fish in consultation with DMR and as approved by DEP. Plunge pools should be designed such that plunge pool depths are 25% of the fall height or 3 feet, whichever is greater, with conveyance flows less than or equal to 25 fps, and should meet or exceed other USFWS design criteria. Construction of required plunge pools shall be implemented within 5 years of license issuance. This recommendation should be interpreted in addition to project specific recommendations for downstream passage.

Justification: An important component of safe downstream passage at all projects includes ensuring that the receiving water (or "plunge pool") is appropriate to safely receive fish transported from bypass conduits, flumes, or spillways. USFWS also recommends that plunge pool depths are 25% of the fall height or 3 feet, whichever is greater, and specifies additional requirements for sloped outlets.

Recommendation 14: Design Process for New Infrastructure

Brookfield, following approval from DEP in consultation with MDMR, shall implement the following process for the design of all new fish passage measures at the two projects, which include Ellsworth and Graham Lake. Brookfield shall develop, design, and submit plans to DEP for review and approval, in consultation with MDMR at 30%, 60%, 90% design stages, and final designs. DEP and MDMR shall have 30 days to review and comment on any submitted design drawings. Designs shall be consistent with the USFWS Service's Engineering Criteria (2019 or current version) or other updated versions or guidance, as determined by DEP[94]. Brookfield shall submit final design plans, approved by DEP in consultation with MDMR, to the Commission for approval prior to the commencement of fishway construction activities. Once the fish passage measures are installed, final as-built drawings that accurately reflect the Project as constructed shall be filed with DEP and MDMR, and the Commission.

Justification: Design coordination and approval from DEP is critical through the licensing term to ensure all new fish passage measures will result in safe, timely, and effective fish passage at the Projects. The staged review allows for multiple opportunities for Brookfield, DEP, and MDMR to develop designs to

[94] U.S. Fish and Wildlife Service. (2019). Fish Passage Engineering Design Criteria. Appendix D: Downstream passage design considerations.

meet Project performance standards and follow USFWS Fish Passage Design Criteria (2019 or current version).

Appendices

Appendix 1. List of relevant MDMR comments on the FERC Record.

As evidenced by the Accession No. dates below, the relicensing process for this project has been ongoing for over 10 years. Changes in MDMR's recommendations for the project are the result of updated management goals and restoration timeframes, USFWS design criteria, the development of modeling tools to recommend performance standards, and additional new information.

1. Accession No. 20190122-5112 – MDMR comments on FERC's Draft Environmental Assessment
2. Accession No. 20180327-5112 – MDMR 10(j) Terms and Conditions
3. Accession No. 20151006-5104 – MDMR comments on Draft License Application

Appendix 2. Tables of alosine habitat in the Union River Watershed.

Table 1. Habitat in the Union River Watershed for American shad and blueback herring by river reach. Habitat amounts are from the 2000 Comprehensive Fishery Management Plan for the Union River Drainage.

River Reach	Habitat (acres)
Reach 1	177
Reach 2	74
Reach 3	0
Reach 4	478
Reach 5	0
Reach 6	187

Table 2. Specific lake and pond habitat in the Union River Watershed for alewife by river reach.

River Reach	Lakes/Ponds Included	Habitat (acres)
Reach 1	Lower & Upper Patten	1,186
Reach 2	Leonard, Branch	3,058
Reach 3	Graham, Green, Beech Hill, Mountainy, Floods, Webb, Little Webb, Scammon, Abrams, Molasses, Georges	18,812
Reach 4	Hopkins, Great, Alligator, Brandy	2,875
Reach 5	Lower & Upper Lead Mountain, Middle Branch	2,228
Reach 6	Spectacle, Rocky	2,361

Appendix 3. Migratory periods for Diadromous Species in the Union River

Table 3. Migratory periods for diadromous species in the Union River adopted from the Milford Project on the Penobscot River.

Species	Upstream Migration Period	Downstream Migration Period
Atlantic Salmon	May 1- November 10	April 1-June 15 smolts and kelts; October 15-December 31 kelts
Alewife & Blueback Herring	May 1-July 31	June 1-November 30 adults and juveniles
American Shad	May 15-July 31	June 1-July 31 adults; July 15-November 15 juveniles
American Eel	June 1-September 15	August 15-November 15
Sea Lamprey	May 1- July 30	