UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930-2276

May 21, 2024

Debbie-Anne Reese
Acting Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

RE: Administrative Record Filing for our Preliminary Fishway Prescriptions for the Turners Falls Hydroelectric Project (P-1889-085) and Northfield Mountain Pumped Storage Project (P-2485-071)

Dear Acting Secretary Reese,

We filed our preliminary fishway prescription on May 21, 2024 for the Turners Falls Project (P-1889) and Northfield Mountain Pumped Storage Project (P-2485) located on the Connecticut River, Massachusetts (Accession # 20240521-5074) . As part of that filing, we hereby submit our administrative record by mail on a CD. If you have any questions or need additional information, please contact Bill McDavitt (978-675-2156 or william.mcdavitt@noaa.gov).

Sincerely,

Christopher Boelke
Chief, New England Branch
Habitat and Ecosystem Services Division

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

May 20, 2024

Debbie-Anne Reese, Acting Secretary
Federal Energy Regulatory Division
888 First Street, N.E.
Washington, D.C. 20426

RE: Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Prescription for Fishways; FirstLight, LLC, Turners Falls Hydroelectric Project (P- 1889-085) and Northfield Mountain Pumped Storage Project (P-2485-071)

Dear Acting Secretary Reese,

We have reviewed the Federal Energy Regulatory Commission's (Commission and FERC) *Notice of Application Accepted for Filing, Soliciting Motions to Intervene and Protests, Ready for Environmental Analysis and Soliciting Comments, Recommendations, Preliminary Terms and Conditions, and Prescriptions*, dated February 22, 2024, for the Turners Falls Hydroelectric Project (P-1889) and the Northfield Mountain Pumped Storage Project (P-2485) on the Connecticut River, Massachusetts[1]. In response to the Notice, we provide the attached comments, recommendations, preliminary terms and conditions, and preliminary prescriptions for the Projects pursuant to Section 18 [16 USC §811], Section 10(a) [16 USC §803(a)] and Section 10(j) [16 USC §803(j)], of the Federal Power Act (Attachment A). Through this filing, we act to preserve, protect, and restore diadromous fish and avoid and minimize effects to endangered species, consistent with management goals established by federal and state resource agencies.

The Connecticut River is the largest river in New England. The river supports twelve diadromous fish species including species listed under the Endangered Species Act (ESA) (five Distinct Population Segments of Atlantic sturgeon and shortnose sturgeon). Each of these species serve unique and important ecological functions by connecting the marine environment to freshwater and terrestrial ecosystems. Industrial development, dams, and overfishing have heavily affected these species over the past 250 years, leading to historical declines in their stocks.

The *NOAA Fisheries Strategic Plan 2022-2025* calls for adaptively managing fisheries for sustainability and economic competitiveness, and for the safeguarding of protected species[2].

[1] Accession # 20240222-3011
[2] https://media.fisheries.noaa.gov/2022-12/NOAA-Fisheries-2022-25-StrategicPlan.pdf

Furthermore, our *New England and Mid-Atlantic Geographic Strategic Plan 2020-2023* includes goals for amplifying the economic value of commercial and recreational fisheries while ensuring their sustainability, and conserving and recovering protected species while supporting responsible fishing and resource development[3]. These goals reflect the societal priorities recognized in congressionally authorized mandates of the Fish and Wildlife Coordination Act, Magnuson-Stevens Fishery Conservation and Management Act, ESA, Federal Power Act (FPA), and Atlantic Coastal Fisheries Cooperative Management Act. These mandates highlight diadromous fish as public trust resources with significant ecological, recreational, and commercial value. Restoring diadromous fish populations and protecting fish habitat throughout their historical range within the Connecticut River is a priority action to meeting our congressionally mandated public trust obligations, as well as our stated agency resource goals.

Settlement discussions with FirstLight were initiated in late 2016 and a signed Flow and Fish Passage Settlement Agreement (FFP agreement) was submitted to FERC on March 31, 2023[4]. This FFP agreement focused on improving existing fish passage for diadromous species, including American shad, blueback herring, sea lamprey, and American eel, and for an improved flow regime for the benefit of these species, as well as to avoid and minimize effects of operations on ESA-listed shortnose sturgeon. These agreed upon measures are incorporated into our FPA 10(j) recommendations and FPA Section 18 Mandatory Terms and Conditions.

By this letter, we provide notice pursuant to 18 CFR §385.214(a), as amended, that we are intervening in this proceeding. We have a federal statutory responsibility for protection, mitigation, and enhancement of diadromous fish and their habitats affected by the results of this proceeding. We intervene for the purposes of becoming a party to represent our interests and those of the public in this proceeding. Service of process and other communications concerning this proceeding should be made to:

Regional Administrator
National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office
55 Great Republic Drive
Gloucester, MA 01930

If you have questions or need additional information, please contact Bill McDavitt (william.mcdavitt@noaa.gov or 978-675-2156).

Sincerely,

Michael Pentony
Regional Administrator

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[3] https://media.fisheries.noaa.gov/dam-migration/ne- ma_geographic_strategic_plan_implementation_plan.pdf
[4] Accession # 20230331-5600

cc: Service List

Attachment A: United States Department of Commerce's Recommended Terms and Conditions and Preliminary Prescription for Fishways for the FirstLight, LLC Turners Falls Hydroelectric Project (P-1889) and Northfield Mountain Pumped Storage Project (P-2485)

Attachment B: Species Life History Summaries

Attachment A

United States Department of Commerce's Preliminary Prescription for Fishways for the Turners Falls Hydroelectric Project (P-1889) and Northfield Mountain Pumped Storage Project (P-2485)

BEFORE THE

UNITED STATES OF AMERICA

FEDERAL ENERGY REGULATORY COMMISSION

FirstLight Hydro Generating Company	**Turners Falls Hydroelectric Project** **Connecticut River** **Franklin County** **Turners Falls, Massachusetts** **FERC No. 1889-085**
	Northfield Mountain Pumped Storage Project **Connecticut River** **Franklin County** **Northfield, Massachusetts** **FERC No. 2485-071**

UNITED STATES DEPARTMENT OF COMMERCE'S PRELIMINARY PRESCRIPTION FOR FISHWAYS PURSUANT TO SECTION 18 OF THE FEDERAL POWER ACT

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Michael Pentony, Regional Administrator

Greater Atlantic Regional Fisheries Office

United States Department of Commerce

National Marine Fisheries Service

55 Great Republic Drive

Gloucester, MA 01930

Table of Contents

1 INTRODUCTION

The U.S. Department of Commerce, through the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS), hereby submits our Recommended Terms, Conditions, and Preliminary Prescriptions for Fishways for FirstLight LLC's Turners Falls Hydroelectric Project (P- 1889) and Northfield Mountain Pumped Storage Project (P-2485) in response to the Federal Energy Regulatory Commission's (FERC or Commission) February 22, 2024, Notice of Application Ready for Environmental Analysis. Comments, terms, and conditions included here are supported by congressional mandates and our agency mission for protecting and conserving diadromous fish species and their associated habitat. We are submitting this document to the Commission with an index to our Administrative Record. Documents not currently in the record will be filed under separate cover. We developed this preliminary prescription for fishways, as well as the recommended conditions, through a review process that included consultation with the U.S. Fish and Wildlife Service, Massachusetts Division of Fisheries and Wildlife, non-governmental organizations, and the Licensee. These mandatory conditions and recommendations are intended to be consistent with the settlement agreement.

FirstLight, LLC (FirstLight or Licensee) is seeking a new license from the Commission for the continued operation of the Turners Falls Hydroelectric Project and the Northfield Mountain Pumped Storage Project. We have worked directly with FirstLight throughout the licensing process providing input on resource management needs. Furthermore, we provided comments and recommendations throughout the licensing process, including on the Pre-Application Document, Proposed Study Plan, and on studies filed with the Commission. We were fully engaged with FirstLight and other resource agencies to develop the Flows and Fish Passage Settlement Agreement (FFP agreement) in 2023.[5] Included in the FFP agreement are new facilities, modifications to existing facilities, and modifications to flow regimes intended to mitigate Project effects on resources under our jurisdiction. The purpose of our Section 18 preliminary fishway prescription is to identify the engineered facilities, and operations and maintenance of such facilities, necessary to achieve safe, timely, and effective fish passage conditions and flows for our trust resources.

At this filing, our prescriptions for fishways are preliminary. We developed these prescriptions using the best available scientific information. We include specific prescriptive measures that allow amendments through adaptive management in order to develop final design plans or to correct observed deficiencies. Our preliminary prescriptions require the Licensee to develop elements of the prescriptions in consultation with the resource agencies to ensure fishways are designed, constructed, and operated as intended.

2 ADMINISTRATIVE PROCESS, HEARING RIGHTS, AND SUBMISSION OF ALTERNATIVES

This preliminary prescription was prepared, and will be processed, in accordance with our regulations at 50 CFR 221 et seq. These regulations provide that any party to a license

[5] Accession # 20230331-5600

proceeding before the Commission in which the Department of Commerce exercises mandatory authority has both the right to a trial-type hearing on issues of material fact and the opportunity to propose alternatives to the terms contained in the preliminary prescription.

Any party to the proceeding may challenge the facts upon which our section 18 prescription is based by requesting a trial-type hearing within 30 days (50 CFR 221.4). The challenge is limited solely to the facts; the party may not use this process to contest the weight accorded to the facts or the opinions drawn from these facts by the agency. Agency expertise in forming its opinions and conclusions is entitled to deference under the law and the Commission lacks the authority to modify the Secretary of Commerce's prescription. The prescription, however, including the opinions and conclusions upon which it is based, may be challenged in the Court of Appeals after the Commission issues its license.

Although a party may not use the trial-type hearing process to challenge the agency's prescriptive opinions and conclusions – in other words, the Licensee cannot challenge the deliberative choices made by the agency in the preliminary prescriptive process – a party may submit alternative prescriptions according to agency regulations at 50 CFR 221.70 et seq. Requests for a trial-type hearing or alternatives to the terms contained in this preliminary prescription must be submitted within 30 days of this filing to the following address:

Chief, Habitat Protection Division
NMFS Office of Habitat Conservation
1315 East-West Highway, F/HC2
Silver Spring, MD 20910

Modified prescriptions, conditions, and other recommendations are due within 60 days of the close of the Commission's National Environmental Policy Act (NEPA) comment period or in accordance with a schedule otherwise established by the parties to the licensing. We will file our analysis of any alternative prescriptions with the Commission at that time.

If the Commission considers a Section 10(j) recommendation inconsistent with the purposes of relicensing, the Commission shall attempt to resolve the inconsistency, giving due weight to the recommendations, expertise and statutory responsibilities of the agency (10 USC 803(j)). If after such an attempt, the Commission does not adopt in whole or in part a recommendation, the Commission must detail in writing how the recommendation is inconsistent with the purposes of the licensing and how the condition ultimately selected by the Commission protects, mitigates damages to, and enhances fish and wildlife (including related spawning grounds and habitat). In such circumstances, we request the Commission set forth such details in its NEPA document.

We will consider any comments on the preliminary prescription filed by any member of the public, state or federal agency, the Licensee, or other entity or person. Comments must be filed within 30 days of the filing of this preliminary prescription to the following address:

Regional Administrator
NMFS Greater Atlantic Regional Fisheries Office
55 Great Republic Drive
Gloucester, MA 01930.

As with trial-type hearing requests, we encourage timely electronic comment submissions (in addition to hard-copy comments), these should be directed to William McDavitt (william.mcdavitt@noaa.gov).

3 NATIONAL MARINE FISHERIES SERVICESTATUTORY AUTHORITY

The National Marine Fisheries Service (NOAA Fisheries) has statutory authority for protecting and managing a variety of living marine resources that may be affected by the proposed relicensing, including alewife, Blueback herring, American shad, Sea lamprey, American eel, and Shortnose sturgeon in accordance with the following statutes:

3.1 The Magnuson-Stevens Fishery Conservation and Management Act

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act set forth a number of mandates for the National Marine Fisheries Service (NMFS), regional fishery management councils, and other federal agencies to identify and protect important marine and anadromous fish habitats. Fishery management councils, with assistance from us, are required to designate EFH for all federally-managed species. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." Federal action agencies that fund, permit, or carry out activities that may adversely affect EFH are required to consult with us regarding the potential effects of their actions on EFH, and to respond in writing to our recommendations. In addition, we may comment on any state agency activities that would affect EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH.

3.2 The Endangered Species Act (as amended) (ESA) (16 USC §§1531, et seq.).

Section 7(a)(1) of the ESA requires federal agencies to use their authorities to further the conservation of listed species. ESA section 7(a)(2) states that each federal agency shall, in consultation with the Secretary of Commerce or Interior, as appropriate, ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Any discretionary federal action that may affect a listed species or its critical habitat must undergo ESA section 7 consultation. Issuance of a hydroelectric project license by the Commission is an action that requires ESA section 7 consultation if it may affect any ESA listed species or designated critical habitat.

3.3 The Atlantic Coastal Fisheries Cooperative Management Act (as amended) (ACFCMA)

The purpose of the Atlantic Coastal Fisheries Cooperative Management Act is to provide for more effective conservation of coastal fish species that are distributed across the jurisdictional boundaries of the Atlantic states and the federal government. These coastal fish species, including Blueback herring and alewife (collectively, "river herring"), American shad, and American eel, are managed by various boards of the Atlantic States Marine Fisheries Commission (ASMFC). The ASMFC creates fishery management plans and recommends management action to the states and NMFS.

3.4 The Fish and Wildlife Coordination Act (as amended) (FWCA) (16 USC 661, et seq.).

The Fish and Wildlife Coordination Act provides that wildlife conservation shall receive equal consideration and be coordinated with other features of water resource development programs. A federal action agency, such as FERC, must consult with us and consider the conservation of wildlife resources by preventing loss and damage to such resources. In addition, action agencies must consider providing for the development and improvement of wildlife resources in connection with such water resource development. We may provide recommendations to the federal action agency; the action agency is required to give these recommendations full consideration.

3.5 The National Environmental Policy Act (as amended) (NEPA) (42 USC §§4321, et seq.).

NEPA and its implementing regulations require federal action agencies to analyze the direct and indirect environmental effects and cumulative impacts of project alternatives and connected actions. NEPA requires the federal action agency to conduct a comparative evaluation of the environmental benefits, costs, and risks of the proposed action, and alternatives to the proposed action.

3.6 The Federal Power Act (as amended)(16 USC §§791a, et seq.).

3.6.1 Section 10(a)(1) of the Federal Power Act (FPA)

Under Section 10(a) of the FPA, the Commission must consider a project's consistency with federal and state comprehensive plans for improving, developing, or conserving a waterway. Comprehensive plans include management and restoration of fish and habitat resources. The Commission must ensure that hydropower projects are consistent with a comprehensive plan for improving or developing a waterway and for other beneficial public use. Under Section 10(a)(1), a project in a river basin must serve the public interest, not just power generation. Section 10(a) requires the Commission to solicit recommendations from resource agencies and Indian tribes (if affected by the project) on how to make a project more consistent with federal or state comprehensive plans. The Commission will give consideration to a plan which a federal or state agency has adopted under its own authority, if the plan: (1) is a comprehensive study of one or more of the beneficial uses of the river; (2) specifies the standards, data, and methodology used; and, (3) is filed with the Commission's Secretary before Section 10(a) conditions are established for a given project.

3.6.2 Section 10(j) of the FPA

Under section 10(j) of the FPA, licenses for hydroelectric projects must include conditions to protect, mitigate damages to, and enhance fish and wildlife resources, including related spawning grounds and habitat. Recommendations received from federal and state fish and wildlife agencies form the basis of these conditions. The Commission is required to include such recommendations in the license unless it finds that they are inconsistent with Part I of the FPA or other applicable law, and that alternative conditions adequately address fish and wildlife issues. Before rejecting an agency recommendation, the Commission must attempt to resolve the inconsistency, giving due weight to the agency's recommendations, expertise, and statutory authority. If the Commission does not adopt a section 10(j) recommendation, in whole or in part, it must publish findings that adoption of the recommendation is inconsistent with the purposes and requirements of Part 1 of the FPA or other applicable provisions of law, and that conditions selected by the Commission adequately and equitably protect, mitigate damages to, and enhance fish and wildlife and their habitats.

3.6.3 Section 18 of the FPA

Section 18 of the FPA grants to the Department of Commerce and the Department of the Interior unilateral authority to prescribe fishways. Section 18 states that the Commission must require construction, maintenance, and operation by a Licensee, at the Licensee's own expense, of such fishways, as may be prescribed by the Secretary of Commerce or the Secretary of the Interior. Within the Department of Commerce, the authority to prescribe fishways is delegated to each NMFS Regional Administrator.

4 MANAGEMENT GOALS AND OBJECTIVES

4.1 <u>NOAA/National Marine Fisheries Service</u>

We are responsible for the stewardship of the nation's living marine resources and their habitats. The NOAA Strategic Plan 2022-2026, NOAA Fisheries Strategic Plan 2019-2022 and the New England/Mid-Atlantic Geographic Strategic Plans 2020-2023 (NMFS 2019, 2020, NOAA 2022) each include long-term goals for resilient coastal ecosystems and conserving habitat for protected resources. Our agency goals are for aquatic habitats and the species that inhabit them to be sustainable into the future. Working toward the long-term sustainability of all species will help ensure: commercial, recreational, and cultural access for present and future generations; non-consumptive uses of living marine resources continuing to support vibrant coastal communities and economies; and, sustaining species of cultural and economic value. Objectives include: recovered and healthy marine and coastal species; healthy habitats that sustain resilient and thriving marine resources and communities; improved understanding of ecosystems to inform resource management decisions; and, sustainable fisheries and safe seafood for healthy populations and vibrant communities.

Anadromous fish species, including American shad, alewife, and Blueback herring, are historically important prey items for commercially important groundfish species (e.g., Atlantic cod, haddock) in Long Island Sound (Ames 2004). The decline of nearshore groundfish stocks may have been hastened by the loss of prey. Large-scale restoration efforts in the Connecticut River system, and elsewhere, are anticipated to enhance the abundance of anadromous fish species, and may, in turn, aid in the restoration of cod and other groundfish species.

A goal of the NOAA Fisheries Strategic Plan is to safeguard protected species and propel their recovery (NOAA Fisheries 2022). Preventing the extinction and promoting the recovery of Shortnose sturgeon is a priority for the agency and is mandated under the ESA. We are charged with conserving and recovering species listed as threatened or endangered under the ESA. Recovery is the process of restoring listed species and the ecosystems upon which they depend to the point they no longer require the protections of the ESA. Our goals and objectives as stated below are based on our statutory authority and derived from our long-term agency goals and objectives as well as NMFS' Recovery Plan for Shortnose sturgeon (NMFS 1998).

4.2 Connecticut River Migratory Fish Cooperative

The fisheries resources of the Connecticut River are collaboratively managed through the Connecticut River Migratory Fish Cooperative (Cooperative). This entity was previously referred to as the Connecticut River Atlantic Salmon Commission (CRASC) that Congress established in 1983, and reauthorized in 2002 through the Connecticut River Atlantic Salmon Compact (Public Law 98-138). The Cooperative is currently composed of ten Commissioners including representatives from NMFS, the U.S. Fish and Wildlife Service, four state agencies, and the public[6]. The Cooperative's policy members evaluate methods and provide guidance on restoring migratory fish species in the Connecticut River and its tributaries

This agency and public commitment, and recognition by Congress reflects the historical and cultural value of a restored anadromous fishery in the Connecticut River. Below is a summary of the goals and objectives for American shad and American eel identified by the Cooperative.

4.2.1 American shad (Alosa sapidissima)

In 2017, the CRASC approved an updated Connecticut River American shad Management Plan with the goals "To restore and maintain a naturally reproducing American shad population to its historic range in the Connecticut River basin at targeted management levels of both abundance and stock structure, to provide and maintain recreational fisheries in the four basin states and the traditional in-river commercial fisheries for the species in Connecticut, and provide for the diverse ecological benefits derived from all life stages of shad in freshwater, estuarine, and marine habitats." In March of 2020, CRASC amended that Plan with fish passage performance objectives[7]. FERC replaced the previously approved 2017 CRASC shad Management Plan with the amended plan on July 6, 2020[8]. The first population objective is to "achieve and sustain a minimum population of 1.7 million adult American shad annually entering the mouth." Using an annual adult return rate of 203 adult shad per hectare in the mainstem Connecticut River, this yields a minimum adult passage target of 397,000 adult American shad at the Turners Falls Dam, based on described upstream habitat[9]. Strategies to achieve Plan objectives include increasing access to spawning and nursery habitat, adherence to the fish passage performance measures defined in the Fish Passage Addendum, and developing corrective action plans, as needed[10]. Since 2012, recreational fisheries have been closed to the taking of shad in both New Hampshire and Vermont, with annual adult passage (and subsequent juvenile production) commonly an order of magnitude lower than the defined minimum in the CRASC Plan. Achieving CRASC management goals and objectives would represent significant restoration gains for American shad within basin (particularly for New Hampshire and Vermont) and coast wide (ASMFC 2010, 2020, Limburg et al. 2003, Limburg and Waldman 2009). As noted above, the 2020 CRASC Addendum to the American shad Management Plan includes performance standards for upstream and downstream migrating American shad at hydroelectric projects in the Connecticut River

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[6] https://www.fws.gov/r5crc/partnerships/public_law_98_138.html
[7] Accession # 20200302-5300
[8] Accession # 20200706-3007
[9] Accession # 20200302-5300
[10] Accession # 20200302-5300

basin. These standards were established based on a suite of information including cited publications, available data, and professional opinions of fisheries biologists to ensure the fishways are operating as intended to effectively mitigate project related impacts. Based on the results of population and passage modeling and data, upstream and downstream passage facilities for American shad must provide high levels of survival with minimal delay to address cumulative impacts to achieve restoration goals for the Connecticut River (ASMFC 2020)[11].

The CRASC shad passage performance standards reflect the behavior and life history (iteroparous) of American shad and the benefits to the population for maintaining a component of repeat spawners annually (ASMFC 2020, Leggett and Carscadden 1978). The CRASC shad management plan seeks to address sources of mortality from either turbine passage or other facility passage routes (e/g., dam spill) on down running adult and juvenile shad in river to address CRASC goals and objectives[12].

4.2.2 *American eel (Anguilla rostrata)*

The CRASC has identified adequate upstream and downstream passage for the Connecticut River watershed's American eel population as one of the objectives in its American eel Management Plan[13]. With site specific locations and entrance/trap configurations, current conventional designs for eel passes can provide safe, timely, and effective passage upstream of the project. Likewise, providing safe, timely, and effective downstream passage will avoid or minimize mortality of eels that would otherwise occur as a result of downstream dam passage during their lengthy freshwater residency period and while adults are migrating to the sea to spawn.

4.3 Atlantic States Marine Fisheries Commission

The ASMFC acts to coordinate the conservation and management of 26 fish species or species groups (e.g., shad and river herring). Commissioners, representatives of the state's marine fisheries management agency, legislators, and appointed stakeholder representatives for each state constitute the ASMFC. The commissioners deliberate policy regarding interstate fisheries management, fisheries science, habitat conservation, and law enforcement. In furtherance of their mission for sustainable and healthy fisheries and fish population restoration, the states work closely with their federal partners, including NMFS. Through this forum, the states collaborate to ensure the sound management and conservation of shared coastal resources and the associated fishing and non-fishing public benefits. We are a member of the ASMFC Interstate Fishery Management Program Policy Board. In addition, agency representatives serve as members and participate on several ASMFC Technical Committees, Stock Assessment Subcommittees, and Management Boards, including the Sturgeon Technical Committee and Management Board, Shad and River Herring Technical Committee, Stock Assessment Subcommittee, and Management Board, Fish Passage Working Group, Assessment Science Committee, and Habitat Committee.

[11] Accession # 20200302-5300
[12] Accession # 20200302-5300
[13] Accession # 20230630-5046

Management authority for American shad, Blueback herring, alewife, and American eel lies with the coastal states the United States Fish and Wildlife Service (USFWS) and NMFS, and is coordinated through the ASMFC. The ASMFC developed Interstate Fishery Management Plans (FMP) for these species under the authority of the Atlantic Coastal Fisheries Cooperative Management Act. Each FMP recognizes the depletion of stocks from overfishing, habitat loss (including the presence of dams), inconsistent management actions, and lack of data.

The goals and objectives of the following ASMFC FMPs are consistent with our agency's objectives for restoring runs of American shad and American eel to historical habitat within the Connecticut River watershed. Implementing fish passage enhancement and protection measures at the Turners Falls and Northfield Mountain Pumped Storage projects is a critical step toward achieving the restoration goals and objectives of the ASMFC and the member state and federal agencies, including NMFS.

4.3.1 American shad

The stated goal of Amendment 3 to the Interstate Fishery Management Plan (FMP) for Shad and River Herring (2010) is to, " Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats.". This amendment goes on to identify strategies including restoring and maintaining access to historical spawning and nursery habitat and achieving river specific restoration targets for shad populations as specified in existing stock specific restoration plans (ASMFC 2010). The protection, restoration, and enhancement of river herring habitat is deemed critical for preventing further declines in river herring abundance and to restore healthy, self-sustaining populations to the East Coast of the United States.

The goal of Amendment 1 to the Interstate FMP for Shad and River Herring is to protect, enhance, and restore the East Coast migratory spawning stock of American shad and river herring in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass (ASMFC 1999). The American shad Benchmark Stock Assessment and Peer Review Report stated that effective fish passage is needed to provide access to historical spawning and nursery habitats, without which American shad will not be able to achieve the abundance, size and age structure are needed in order to achieve the ASMFC goal of providing for sustainable fisheries (ASMFC 2020).

4.3.2 American eel

The decline of eels and the ecological services they provide is a widely held concern among Atlantic Coast states in the Northeast. ASMFC Management objectives for American eel are outlined in the Interstate FMP for American eel (ASMFC 2000). The FMP's goals are to maintain and enhance the abundance of American eels in inland coastal waters and to contribute to the viability of the adult American eel spawning population at sea.

Since its development in 2000, the ASMFC has modified the FMP four times. Addendum II (approved in 2008) made recommendations for improving upstream and downstream passage for American eels. The ASMFC recommended special considerations for American eels in Commission hydropower licensing proceedings. These considerations include, but are not limited to, improving upstream passage and downstream passage, and collecting data on both means of passage (ASMFC 2008). In addition, the 2012 Benchmark Stock Assessment found that the American eel population in U.S. waters is at or near historically low levels due to a combination of historical overfishing, habitat loss and alteration, productivity and food web alterations, predation, turbine mortality, changing climatic and oceanic conditions, toxins and contaminants, and disease (ASMFC 2012).

4.4 Massachusetts, Vermont, New Hampshire, and Connecticut Wildlife Action Plans

Each of the four river basin states have approved (USFWS) State Wildlife Action Plans that identify elements (e.g., threats, recommendations) to identify and address Species of Greatest Conservation Need (SGCN) and their habitats (CTDEEP 2015, Kart et al. 2005, MADFW 2015, NHF&G 2015). Shortnose sturgeon are listed as a Massachusetts species of greatest conservation need[14]. State wildlife action plans identify multiple threats related to diadromous fish and hydropower, including disturbance from dams that block species from spawning areas or other important habitat, mortality from hydropower turbines, disturbance from dams causing delayed migration and fish movement, and habitat fragmentation. In order to address these threats, state plans highlight actions including removing barriers to migration, improving fish passage at dams, restoring natural hydrologic flow regimes, and maintaining and restoring aquatic organism passage and habitat connectivity at barriers.

5 CONSIDERATION OF CLIMATE CHANGE

The NOAA Fisheries strategic plan acknowledges the effects of climate change and its influence on our science-based conservation and management mission. This plan highlights specific strategies to advance climate science and ecosystem-based fishery management, to mitigate and adapt to climate-driven changes in fisheries habitat, and to model and predict the effects of climate change on protected marine species to improve conservation outcomes (NOAA 2022). Measures within this prescription document are consistent with the strategic plan, in that they provide American shad and American eel safe and timely access to climate resilient habitat upstream of the Project.

5.1 Climate Change Effects to Habitat for Diadromous Species

Alterations in stream temperatures, volume, velocity, and other abiotic characteristics affected by climate change and the presence of dams can influence larval and juvenile fish development, as well as the ecology and biota of the river (Hare et al. 2016, Spence et al. 1996). Dalton et al. (2022) found that winter sea surface temperature, spring and fall transition dates, and annual run size were the strongest predictors of run initiation. These authors found that the spring migration timing of alosines from marine habitats into freshwater rivers was correlated with several seasonal climate drivers including more severe winter conditions. Hare et al. (2016) report that Alewife and American shad have shown some of the greatest shift in their distribution of their habitat ranges due to temperature changes in the ocean.

Dams can exacerbate the effects of climate change by altering streamflow temperature via increased water residence times and decreased daily temperature fluctuations (Bergkamp et al. 2000). When droughts occur, migratory fish experience both temperature and oxygen stress and become crowded with predators into smaller areas as habitat disappears (Lennox et al. 2019). Changes in the magnitude and duration of future summer and fall low flows in the Northeast U.S. have been documented and intensified drought conditions are likely (Demaria et al. 2016).

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[14] https://www.mass.gov/info-details/massachusetts-species-of-greatest-conservation-need-sgcn#fishes

Dams concentrate migratory fish and increase bird or fish predation on downstream of a dam. Reduced flows and associated reduced volumes of water may also concentrate fish and increase predation and competition among species (Kennedy et al. 2016, Larinier 2000, Spence et al. 1996). Thermally stressed fish may also become more susceptible to mortality from disease (Clews et al. 2010).

5.2 Potential Effects of Climate Change in the Project Area

The global mean temperature has risen 0.85°C from 1880 to 2012; the linear trend over the last 50 years is nearly twice that for the last 100 years (IPCC 2014, 2023). Precipitation has increased nationally by 5 centimeters, associated with an increased frequency of heavy downpours(Melillo et al. 2014). Observed changes in marine systems thought to be associated with global climate change; these changes include ocean acidification, decreased productivity, altered food web dynamics, shifting species distributions, among others (Hoegh-Guldberg and Bruno 2010).

Empirical data indicate that air temperatures in Massachusetts since 1900 have already risen by 3.5°C[15]. Using the Intergovernmental Panel on Climate Change (IPCC) medium to high pathways for future greenhouse emissions, these models predict that the upper Connecticut River watershed's annual temperature will increase another maximum temperatures in Massachusetts could increase by 1.4–3.7 °C by 2050[16]. Since 2004, the rate of increase in sea surface temperature in the in the Atlantic Ocean where migratory fish grow to adult size has accelerated to 0.23 °C per year; a rate faster than 99 percent of the world's oceans (Fernandez et al. 2015). Siddique and Palmer (2020) tested Representative Concentration Pathway (RCP) 4.5 and 8.5 to estimate 100-year, 24-hour extreme precipitation events. These were then used to estimate 100-year, 24-hour flow estimates whereby the results suggested that for the Connecticut River, median model results suggested an increase of 2.9% to 13.7%.

Beyond the general information on model predictions for the Northeast U.S. and the Connecticut River watershed, fine scale predictions on how climate change will impact the Turners Falls and Northfield Mountain Pumped Storage Project area are not available. As there is significant uncertainty in the rate and timing of change as well as the effect of any changes experienced in the project area due to climate change, it is difficult to predict the impact of these changes on any particular species. However, based on the IPCC model information, it is possible that changing seasonal temperature regimes could result in changes to the timing of seasonal migrations for all diadromous fish in the Connecticut River watershed. Ensuring access to a diversity of suitable habitat, including climate resilient habitats, is essential for the continued survival and recovery potential of diadromous species. Safe, timely, and effective passage at the Turners Falls Project will support our restoration goals by promoting access to a greater expanse and diversity of spawning, rearing, and nursery habitat that is expected to support population resiliency in light of changing conditions.

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[15] https://statesummaries.ncics.org/chapter/ma/

[16] https://resilient.mass.gov/changes/rising-temperatures

6 FACTUAL BACKGROUND

6.1 Project Specifics

The following description is from the Final License Applications for the Turners Falls Project and Northfield Mountain Pumped Storage Project[17].

6.1.1 Turners Falls - Project Description

The Turners Falls Project consists of two individual concrete gravity dams, referred to as the Gill Dam and Montague Dam connected by a natural rock island known as Great Island. Additionally, the project consists of a gatehouse that controls flow to the power canal, the main power canal and a short branch canal, two hydroelectric powerhouses referred to as Station No 1 and Cabot Station, and a reservoir referred to as the Turners Falls Impoundment[18]. The Amended Final License Application (Amended FLA), Exhibit A, provides a detailed description of the Project and project operations[19].

6.1.2 Turners Falls - Proposed Mitigation Measures

FirstLight proposed mitigation and enhancement measures for the benefit of fisheries and aquatic habitat. These measures include installation of upstream fish passage facilities at the spillway, improvements to downstream passage protection facilities at the spillway, and enhanced seasonal flows in the bypass channel. A detailed description of these proposed mitigation and enhancement measures is included in the final license application, Exhibit E[20].

6.1.3 Northfield Mountain - Project Description

The Northfield Mountain Project is a pumped-storage facility located on the Connecticut River in Massachusetts that uses the Turners Falls Impoundment (TFI) as its lower reservoir. The Northfield Mountain Project Boundary overlaps with Turners Falls Project Boundary along nearly the entire perimeter of the TFI, but it does not include the Turners Falls Dam. The TFI is a shared project feature with the Turners Falls Hydroelectric Project (FERC No. 1889). The tailrace of the Northfield Mountain Project is located approximately 5.2 miles upstream of Turners Falls Dam, on the east side of the TFI. The Northfield Mountain Project's Upper Reservoir is situated atop Northfield Mountain. During pumping operations, water is pumped from the TFI to the Upper Reservoir. When the Northfield Mountain Project is generating, water flows from the Upper Reservoir back to the TFI. The Northfield Mountain Project consists of the Upper Reservoir dam/dikes; an intake channel; pressure shaft; an underground powerhouse; a tailrace tunnel and the TFI. A detailed description of the Project and its operations is included in the final license application, Exhibit A[21].

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[17] Accession # 20160429-5414
[18] Accession # 20121031-5247
[19] Accession # 20201204-5120
[20] Accession # 20201204-5120
[21] Accession #20201204-5120

6.1.4 Northfield Mountain - Proposed Mitigation Measures

FirstLight proposes to install a barrier net downstream of the Northfield Mountain Project tailrace to prevent the entrainment of migratory fish when the Northfield Mountain Project is pumping. The net will be parallel with the river shoreline. The net will be anchored at each end at the shoreline with additional anchoring along the base of the net to prevent migrants from passing under the net. The barrier net will be deployed during the dates specified in Section 8.1.5. A detailed description of these proposed mitigation measures is included in the final license application, Exhibit E[22].

6.2 Connecticut River Watershed

Section 4 of FirstLight's Pre-Application Document provides an extensive background on the Connecticut River Watershed[23].The Connecticut River and its tributaries drain an area of approximately 11,250 mi^2. At the Turners Falls Dam, the total watershed drainage area is 7,163 mi^2. Major tributaries to the Turners Fall Impoundment include the Ashuelot River in New Hampshire, which drains 420 mi^2 from the east and enters the Connecticut River just below Vernon Dam, and the Millers River, which drains 392 mi^2 from the east and enters downstream of the Northfield Mountain tailrace. Additionally, the Deerfield River, which drains 665 mi^2 from the west, enters the Connecticut River just downstream of the Cabot Station tailrace.

There are 12 hydropower dams along the mainstem Connecticut River, including the Turners Falls Dam. The upstream boundary of the Turners Falls Project and Northfield Mountain Project is the base of Vernon Dam, approximately 20 miles upstream of the Turners Falls Dam. The next hydropower project downstream of the Turners Falls Dam is the Holyoke Project (P-2004), approximately 35 miles downstream. The next hydropower dam upstream of the Turners Falls Dam is the Vernon Project (P-1893). Both of these mainstem projects provide upstream and downstream passage for species under our jurisdiction.

State resource agencies have monitored the Connecticut River in order to make water quality designations. Both New Hampshire and Massachusetts have designated the entire Connecticut River as Class B waters.

6.3 Fisheries Resources - Historical

Historically, the Connecticut River Basin was accessible to several species of sea-run migratory fish from Long Island Sound. Adult anadromous fish live in the estuary or ocean and migrate to freshwater rivers to spawn. Juvenile anadromous fish stay in freshwater habitats for several months to many years before they migrate to the estuary or ocean and grow to maturity. Catadromy is the reverse life history, whereby a fish spends most of its life rearing in estuarine or fresh water before migrating out to sea to spawn. Of the sea-run migratory fish historically present in the Connecticut River Basin, Atlantic salmon (*Salmo salar*), striped bass (*Morone saxatilis*), Atlantic sturgeon (*Acipenser oxyrinchus*), Shortnose sturgeon (*A. brevirostrum*), Sea lamprey (*Petromyzon marinus*), American shad (*Alosa sapidissima*), alewife (*A. pseudoharengus*), and Blueback herring (*A. aestivalis*) are anadromous and the American eel (*Anguilla rostrata*) is catadromous. The historical range of Atlantic sturgeon in the Connecticut River is thought to extend to Hadley Falls (current location of the Holyoke Dam); the Turners Falls and Northfield project areas are outside the historic and current range of Atlantic sturgeon

[22] Accession # 20201204-5120
[23] Accession # 20121031-5247

in the Connecticut River. Atlantic sturgeon are currently not present at either project and are not be passed upstream of the Holyoke Dam. Alewife are currently not present at Turners Falls. The Atlantic Salmon Restoration Program (sea-run) was ended in 2012 by the cooperating agencies under the Connecticut River Atlantic Salmon Commission (CRASC). A final stocking of fry for restoration purposes occurred in the spring of 2012 in Massachusetts, New Hampshire, and Vermont. Atlantic salmon are currently do not reach the Turners Falls project.

A number of these sea-run species were known to ascend the mainstem Connecticut upstream of the Hadley Falls, Massachusetts, with Turner Falls being the next major natural waterfall. Moss (1946) describes historic accounts of American shad being an important food source and how they were caught and sold in the vicinity of Bellow Falls. This report goes on to mention that in the mid-20th century, two canneries on the Connecticut River received a little over a million pounds of alewives.

American shad, Shortnose sturgeon, Blueback herring, Sea lamprey, Atlantic salmon, and American eel historically occurred in the vicinity of the Turners Falls Project. The historical upstream limit of the range of Shortnose sturgeon in the Connecticut River is considered to be Turners Falls. With the exception of the Shortnose sturgeon, all the other species noted here were abundant in mainstem and tributaries upstream of the Turners Falls project, providing important ecological roles and fisheries for Native Americans and early settlers, before dam constructions excluded access to migratory fish (Gephard and McMenemy 2004, Noon 2003). Sea lamprey populations most likely were established in all watercourses with access to the ocean prior to the building of dams. On the Connecticut River, Sea lamprey historically ranged to Bellows Falls, Vermont, if not farther (Scarola 1987).

6.4 Fisheries Resources - Present Day

Presently, some sea-run migratory fish are able to ascend the Connecticut River as far as the Wilder Project that spans the Vermont and New Hampshire borders. The Bellows Falls Project's fishway is operated to facilitate Sea lamprey upstream passage. The fish ladders at the Bellows Falls and Wilder projects were designed and originally intended to only operate to pass sea-run Atlantic Salmon per a pre-CRASC multi agency agreement (Policy Committee for the Connecticut River). Sea lamprey as well as smaller numbers of American shad (historic upstream extent of main range) and American eel (known to have migrated to the Connecticut Lakes in Pittsburg, New Hampshire) annually use the Bellows Falls ladder. American shad, Sea lamprey, American eel, Shortnose sturgeon and Blueback herring are passed upstream at the Holyoke Project's fishways and can access the Turners Falls project. Attachment B provides the life histories for American shad, Blueback herring, Sea lamprey, American eel, and Shortnose sturgeon.

As noted above, since 1995, the Holyoke Project has passed anadromous fish, including Shortnose sturgeon in some years, to facilitate access to spawning and rearing habitat upstream of the project, primarily in the mainstem Connecticut River. Passage at Turners Falls provides access to an additional 1,883 acres of main stem spawning and rearing habitat for American shad (CRASC 2004). The Turners Falls project currently provides upstream anadromous fish passage at the Cabot Station fish ladder, the Spillway fish ladder and the Gatehouse fish ladder. Designated downstream passage is provided via a bypass sluice that is just south of the Cabot Station powerhouse.

6.4.1 American shad

American shad are an important forage stock for many marine species (Hall et al. 2012, Walter III et al. 2003). Depleted stocks of forage fish have negatively impacted other ocean fisheries (Ames 2004, Essington et al. 2015, Hall et al. 2012, Nelson et al. 2003). Historically, American shad supported important commercial and recreational fisheries[24]. The decline of American shad and the ecological services they provide is a widely held concern among Atlantic Coast states in the Northeast (Brown et al. 2013). Due to declines in stock abundance, many states have implemented bans or significant restrictions on the harvest of these species (ASMFC 2020).

The ASMFC's Amendment 3 (2010) required all member states and jurisdictions to submit American shad Habitat Plans by August 2013. The CRASC developed the required ASMFC Plan for the Connecticut River basin; it was approved in February 2014 and an updated plan was approved in May 2021. The CRASC Technical Committee reviewed the ASMFC Habitat Plan for the Connecticut River in 2022 and supported its adoption[25].

The ASMFC American shad Habitat Plan details the locations of barriers, existing or planned passage measures, and status of barriers. The Plan's Threats Assessment section provides details that cover the impacts from instream barriers and poor passage. The information in this Plan provided the rationale for agency Study Requests in the relicensing processes for both the Turners Falls and Northfield Mountain Pumped Storage projects. The evolving stream of information cited extensively in the CRASC 2020 Plan/Addendum, played a role in getting the ASMFC's 2022 Habitat Plan. [26].

6.4.2 American eel

American eel are an important resource for preserving biodiversity and for human needs. American eel also serve as a prey species for aquatic mammals and fish-eating birds. While current recreational and commercial catches of this species are significantly reduced from historic highs, this fishery is still an important resource to the region[27]. The ASMFC's 2023 stock assessment indicated that the stock remains depleted and that the stock has decreased over the period of time for which monitoring data exist.

In 2018, Holyoke Gas and Electric compiled their American eel monitoring data and provided annual count data, including collection location from 2006 through 2018[28]. American eel passage has changed over the monitoring period with traps being deployed at several different locations at the project site and with various types of substrate and designs. The monitoring data at Holyoke shows a great deal of seasonal variation as well as annual variation (Table 1).

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[24] Accession # 19990608-0472
[25] http://www.asmfc.org/files/ShadHabitatPlans/CRASC_CT_RiverAmShadHabitatPlan_May2022.pdf
[26] Accession # 20200302-5300
[27] https://asmfc.org/species/american-eel
[28] Accession # 20190228-5028

Table 1. Annual American eel catch based on the summed totals from each eelway deployed at the Holyoke project (Source: Connecticut River Coordinator's office, MS Access database).

Year	Annual Eel Catch
2006	5,339
2007	5,145
2008	13,864
2009	6,427
2010	4,253
2011	9,734
2012	39,423
2013	13,584
2014	50,410
2015	20,038
2016	38,449
2017	19,438
2018	8,562
2019	27,505
2020	17,689
2021	12,469
2022	7,841
2023	11,039

6.4.3 Shortnose sturgeon

Shortnose sturgeon are listed as endangered throughout their range, inclusive of the Connecticut River population. There is no current total population estimate for Shortnose sturgeon range wide. Population size throughout the species' range is considered to be stable; however, most riverine populations are below the historic population sizes and most likely are below the carrying capacity of the river (Kynard 1996).

There are 19 documented populations of Shortnose sturgeon ranging from the St. Johns River, Florida (possibly extirpated from this system) to the Saint John River in New Brunswick, Canada. There is a large gap in the middle of the species range with individuals present in the Chesapeake Bay separated from populations in the Carolinas by a distance of more than 400 km. In general, populations in the Northeast are larger and more stable than those in the Southeast (SSSRT 2010).

Recent developments in genetic research as well as differences in life history support the grouping of Shortnose sturgeon into five genetically distinct groups, all of which have unique geographic adaptations (Grunwald et al. 2002, King et al. 2001, SSSRT 2010, Waldman et al. 2002, Walsh et al. 2001, Wirgin et al. 2010, Wirgin et al. 2002). These groups are: 1) Gulf of Maine; 2) Connecticut and Housatonic Rivers; 3) Hudson River; 4) Delaware River and Chesapeake Bay; and 5) Southeast. The Gulf of Maine, Delaware/Chesapeake Bay and Southeast groups function as metapopulations[29]. The other two groups (Connecticut/Housatonic and the Hudson River) function as independent populations.

While there is migration within each metapopulation (i.e., between rivers in the Gulf of Maine and between rivers in the Southeast) and occasional migration between populations (e.g., Connecticut and Hudson), interbreeding between river populations is limited to very few individuals per generation; this results in morphological and genetic variation between most river populations (Grunwald et al. 2002, Waldman et al. 2002, Walsh et al. 2001, Wirgin et al. 2005)). Indirect gene flow estimates from mitochondrial DNA (mtDNA) indicate an effective migration rate of less than two individuals per generation. This means that while individual Shortnose sturgeon may move between rivers, very few sturgeon are spawning outside their natal river; it is important to remember that the result of physical movement of individuals is rarely genetic exchange. Information specific to the Connecticut River is presented below.

Connecticut River Population

As described in SSSRT (2010), Shortnose sturgeon in the Connecticut River inhabit a reach downstream of the Turners Falls Dam to Long Island Sound. Construction of the Turners Falls Dam was completed in 1798 and built on a natural falls-rapids. Turners Falls is considered to be the historic upstream boundary of Shortnose sturgeon in the Connecticut River; however, there have been anecdotal sightings of sturgeon upstream of the dam and in the summer of 2017 an angler reported a catch of a Shortnose sturgeon upstream of the Turners Falls Dam. This information suggests that occasional Shortnose sturgeon are present upstream of the dam; however, we have no information on how Shortnose sturgeon accessed this reach or how many sturgeon may be present in this area. At this time there is no information to indicate that there is spawning occurring upstream of the Turners Falls Dam. Targeted sampling by the USGS Conte Lab and environmental DNA (eDNA) studies upstream of the Turners Falls Dam have not resulted in the detection of any Shortnose sturgeon between Turners Falls and Bellows Falls.

For many years, few, if any, Shortnose sturgeon passed upstream of the Holyoke Dam. Despite this separation, the populations are not genetically distinct (Kynard 1997, Kynard et al. 2012b, Wirgin et al. 2005). However, significant improvements to the Holyoke fishway in 2015 have resulted in the safe upstream and downstream passage of many Shortnose sturgeon. The most recent estimate of the number of Shortnose sturgeon upstream of the dam, based on captures and tagging from 1990-2005 is approximately 328 adults (CI = 188–1,264 adults; B. Kynard, USGS, unpubl. Data in SSSRT 2010); this compares to a previous Peterson mark-recapture estimate of 370–714 adults (Taubert 1980). Using four mark-recapture methodologies, the long term population estimate (1989-2002) for the lower Connecticut River ranges from 1,042-1,580 (Savoy 2004). Comparing 1989-1994 to 1996-2002, the population exhibits growth on the order of 65-138%. The population in the Connecticut River is thought to be stable, but at a small size. Recent collections of larvae below the Holyoke Dam support a conclusion that limited spawning

[29] A metapopulation is a group of populations in which distinct populations occupy separate patches of habitat separated by unoccupied areas (Levins 1969). Low rates of connectivity through dispersal, with little to no effective movement, allow individual populations to remain distinct as the rate of migration between local populations is low enough not to have an impact on local dynamics or evolutionary lineages (Hastings and Harrison 1994). This interbreeding between populations, while limited, is consistent, and distinguishes metapopulations from other patchy populations.

occurs at least occasionally below the Holyoke Dam. However, the primary spawning location is located upstream of the Holyoke Dam.

Overwintering and foraging occur in both the upper and lower portions of the river. Occasionally, sturgeon have been captured in tributaries to the Connecticut River including the Deerfield River and Westfield River.

Because sturgeon are long-lived and slow growing, stock productivity is relatively low; this can make the species vulnerable to rapid decline and slow recovery (Musick 1999). In well studied rivers (e.g., Hudson, upper Connecticut), researchers have documented significant year to year recruitment variability (up to 10 fold over 20 years in the Hudson and years with no recruitment in the CT). However, this pattern is not unexpected given the life history characteristics of the species and natural variability in hydrogeologic cues relied on for spawning.

The small amount of effective movement between populations means recolonization of currently extirpated river populations is expected to be very slow and any future recolonization of any rivers that experience significant losses of individuals would also be expected to be very slow. Despite the significant decline in population sizes over the last century, gene diversity in Shortnose sturgeon is moderately high in both mtDNA (Quattro et al. 2002, Wirgin et al. 2005, Wirgin et al. 2000) and nuclear DNA (nDNA) (King et al. 2001) genomes.

All Shortnose sturgeon populations are highly sensitive to increases in juvenile mortality that would result in chronic reductions in the number of sub-adults as this leads to reductions in the number of adult spawners (Anders et al. 2001, Gross et al. 2002, Secor et al. 2002). Populations of Shortnose sturgeon that do not have reliable natural recruitment are at increased risk of experiencing population decline leading to extinction (Secor et al. 2002). Elasticity studies of Shortnose sturgeon indicate that the highest potential for increased population size and stability comes from YOY and juveniles as compared to adults (Gross et al. 2002); that is, increasing the number of YOY and juveniles has a more significant long term impact to the population than does increasing the number of adults or the fecundity of adults.

The Shortnose sturgeon Recovery Plan (NMFS 1998) and the Shortnose sturgeon Status Review Team's Biological Assessment of Shortnose sturgeon identify habitat degradation or loss and direct mortality as principal threats to the species' survival (SSSRT 2010). Natural and anthropogenic factors continue to threaten the recovery of Shortnose sturgeon and include: poaching, bycatch in riverine fisheries, habitat alteration resulting from the presence of dams, in-water and shoreline construction, including dredging; degraded water quality which can impact habitat suitability and result in physiological effects to individuals including impacts on reproductive success; direct mortality resulting from dredging as well as impingement and entrainment at water intakes; and, loss of historical range due to the presence of dams. Shortnose sturgeon are also occasionally killed as a result of research activities. The total number of sturgeon affected by these various threats is not known. Climate change, particularly shifts in seasonal temperature regimes and changes in the location of the salt wedge, may impact Shortnose sturgeon in the future.

6.5 Turners Falls Project Impacts

The relicensing studies, the Amended FLA, as well as other authoritative data sources have documented several project impacts to migratory fish[30].

6.5.1 Upstream Anadromous Fish Passage - Turners Falls – American shad

The number of available American shad that the Turners Falls project can pass upstream is constrained by the number of American shad that pass the Holyoke project (FERC No. 2004). In 1992, CRASC established that Turners Falls should pass 40 to 60% of the American shad that pass Holyoke, however the Turners Falls project never met that management goal (Table 2). In 2017, CRASC commissioners voted to approve an updated version of the shad management plan that established a minimum annual passage goal of 397,000 American shad passing the project (CRASC, 2017).

In May 2017, FirstLight filed an Addendum 1 to Relicensing Study 3.3.2 that included a meta-analysis of five previously conducted upstream passage studies the project[31]. Table 2.9-5 from this report indicated that the passage efficiency at the Cabot Station ladder ranged from a low of 2% to a high of 25%, which demonstrates inadequate passage efficiency to meet management goals. The historical count data, the relicensing studies and published papers indicate that the Turners Falls project has negative impacts on migrating American shad.

[30] Accession # 20201204-5120
[31] Accession # 20170501-5353

Table 2 Percent of American shad that passed Holyoke Hydroelectric Project (P-2004) that also passed the Turners Falls Hydroelectric Project (P-1889) from 1983-2020. Sources: Holyoke Gas and Electric, FirstLight Power

Year	Gatehouse	Holyoke	Gatehouse as % of Holyoke
1983	12,705	528,185	2%
1984	4,333	496,884	1%
1985	3,885	487,158	1%
1986	17,858	352,122	5%
1987	18,959	276,835	7%
1988	15,787	294,158	5%
1989	9,511	354,180	3%
1990	27,908	363,725	8%
1991	54,656	523,153	10%
1992	60,089	721,764	8%
1993	10,248	340,431	3%
1994	3,729	181,038	2%
1995	18,369	190,295	10%
1996	16,193	276,289	6%
1997	9,216	299,448	3%
1998	10,527	315,810	3%
1999	6,751	193,780	3%
2000	2,591	225,042	1%
2001	1,540	273,206	1%
2002	2,870	374,534	1%
2003		286,814	0%
2004	2,235	191,555	1%
2005	1,581	116,511	1%
2006	1,810	154,745	1%
2007	2,248	158,807	1%
2008	3,995	153,109	3%
2009	3,947	160,649	2%
2010	16,768	164,439	10%
2011	16,798	244,177	7%
2012	26,727	490,431	5%
2013	35,494	392,967	9%
2014	39,914	370,506	11%
2015	58,079	412,656	14%
2016	54,760	385,930	14%
2017	48,727	536,670	9%
2018	43,146	275,232	16%
2019	22,649	314,361	7%
2020	41,252	362,423	11%
2021	21,052	237,306	9%
2022	23,576	190,352	12%
2023	33,782	277,376	12%

6.5.1.1 Cabot Ladder and Spillway Ladder efficiency and delay

Sullivan (2004) examined the internal efficiency of the Cabot Station and Spillway fish ladders. His data indicated that internal passage efficiency for American shad ranged from a low of 2% to a high of 19.2% for the Cabot ladder and a low of 8.2 % to a high of 31.9% for the Spillway ladder for the years 1999 through 2002 (Table 3). This indicates an overall internal efficiency of 13% efficiency for the Cabot Ladder and an overall internal efficiency of 16.4%. In addition, Sullivan (2004) examined the length of delay for these same years and determined that the median delay inside the ladder ranged from 6.3 to 24.6 hours for the Cabot ladder and from 4.5 to 8.8 hours for the Spillway ladder. Some fish end up dropping back from the pools they have ascended to, especially at higher temperatures. Castro-Santos and Haro (2011) studied cohorts of shad based on where they were released and found the percent of fish that passed the Cabot Ladder relative to the number of fish that entered the Cabot Ladder ranged from 20 to 63%.

Table 3. Internal efficiency and delay inside the Cabot ladder. Source: (Sullivan 2004)) Table 2-1 & Table 2-2)

Year	Cabot Internal Efficiency (%)	Cabot Median Transit Time (hrs)	Spillway Internal efficiency (%)	Spillway Median Transit Time (hrs)
1999	19.2	24.6	16.7	4.5
2000	17.5	9.3	8.2	6.4
2001	15.7	10.0	31.9	7.8
2002	2.0	6.3	14.3	8.8
Overall	13.0	10.2	16.4	7.0

Castro-Santos and Letcher (2010) ran a simulation model using distribution data from Sullivan 2004 and it took into account the total number of attempts a fish makes into the ladder. Their model results reported that shad needed 2.3 days to pass the ladder. These data demonstrate that migrating American shad that want to reach spawning habitat upstream of the Turners Falls project are delayed at the Project.

Relicensing Study 3.3.2 used the Cormack-Jolly Seber model that multiplies internal ladder efficiency by attraction efficiency. Using this this metric, the overall Cabot ladder efficiency was low at 10.2%[32]. When evaluating the Spillway ladder, this study determined that entrance efficiency, internal efficiency and overall ladder efficiency was 91.5%, 35.7% and 32.7%[33].

6.5.1.2 Canal and Gatehouse Passage

Castro-Santos and Haro (2012) compiled data from 2008 through 2012 looking at American shad movement throughout the Turners Falls project . While the authors acknowledged that handling and tagging fish likely increases delay and decreases the number of fish that successfully pass through the project, the data also suggested that the project induces delay on these fish and overall had low levels of successful passage. Data from 2008 through 2012 suggested that 50%

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[32] Accession # 20201204-5120 (Amended FLA, Exhibit E part 2 of 4)

[33] Accession # 20161014-5112 (page 4-70)

of the study fish took little under 1 day to as much as 7 days to arrive at the Gatehouse Approach Zone after being released.

Castro-Santos (2010) reviewed window count data at the Cabot, Spillway and Gatehouse ladders from 1980 to 2010. Using a 60% passage success of shad passing the Spillway ladder, which the author calculated the percent of fish that ascended the Cabot ladder and successfully passed the Gatehouse ladder, estimated number of fish that successfully exited the Gatehouse ladder and originated from the Cabot ladder using total annual window count numbers. The results ranged from a low of 0% to a high of 78.5% in 1990. In addition, for upstream migrating adult shad, this paper reported a median upstream delay of 2.3 days in the power canal. These data indicate that very high percentages of fish that ascend either the Cabot Ladder or Spillway Ladder never successfully reach the Turners Falls headpond.

With respect to the Gatehouse ladder specifically, Castro-Santos and Haro (2012) reported that of the 91 PIT-tagged shad that entered the Gatehouse ladder, 79 of these fish passed into the Turners Falls impoundment for an 87% internal efficiency.

The Amended FLA reported on the canal passage efficiency. This filing combined fish that were released either at Holyoke or into the canal and reported that the overall upstream passage through the canal for these fish was 40.7%.[34] The Amended FLA reported the internal gatehouse ladder efficiency at 76.9%, which is a 10% lower than what Castro-Santos and Haro (2012a) reported[35]. With respect to Relicensing Study 3.3.2 and delay, this tracked upstream migrating shad under differing flow conditions in the canal. Under the 75th percentile flow (a relatively high flow condition),half of the study fish reached the upper portion of the canal in 365 hours (15.2 days) indicating a substantial amount of delay and vastly exceeding the CRASC shad upstream delay performance standard[36].

6.5.2 Upstream American eel passage – Turners Falls

The degree to which a given dam is an impediment to the upstream movement of juvenile eels depends on a number of factors, including the height of the dam, the characteristics of its surface, whether the surface is wetted or not, and the size of the eels trying to ascend it[37]. Some upstream barriers may be size-selective, as the ability of juvenile eels to scale obstacles decreases as they grow in size (Hitt et al. 2012). In general, a high dam with a dry, vertical surface represents the greatest barrier. While some portion of eels trying to ascend a given barrier may be successful, studies have shown that the density of eels tends to be higher downstream of a dam and lower upstream of a dam. On the Merrimack River, (Hoover 1938) reported a great discrepancy in American eel abundance above and below the Amoskeag Dam in Manchester, New Hampshire, with much higher densities just below the dam, and Sprankle (2005) reported similar findings with much higher catch rates downstream of the Essex Dam in Lawrence, Massachusetts, than upstream. High densities below barriers due to limited passage success have the negative effects of altering natural sex ratios, increasing the transmission of parasites and diseases, and increasing

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[34] Accession # 20201204-5120 (Amended FLA, Exhibit E part 2 of 4)
[35] Accession # 20201204-5120 (Amended FLA, Exhibit E part 2 of 4)
[36] Accession # 20161014-5112 (page *ii*)
[37] Accession # 20210617-5089 (USFWS Preliminary Fishway Prescription for the Pejepscot Project P-4748)

intraspecific competition for habitat and food resources (Krueger and Oliveira 1999, Oliveira and McCleave 2000).

As part of Relicensing Study 3.3.4, the evaluation of upstream passage of American eel at the project, traps were deployed during the summer and fall of 2015[38]. The eels collected at the Spillway Fishway Trap accounted for the vast majority of all collected eels at 87.7% (5,235). The trap installed at the Cabot Emergency Spillway collected 7.1% (424) of all fish, and the Cabot Ladder Trap accounted for 5.2% (313) of all collected fish. The trap installed at the Station No. 1 tailrace did not collect any eels at all.

6.5.3 Downstream Fish Passage - Turners Falls (adult and juvenile American shad)

For downstream migration, fish respond to river flow and migrate past dams via different routes, including over dam spillways, down bypass channels, and through hydroelectric turbines (Castro-Santos and Haro 2003, Jansen et al. 2007, Kynard and O'Leary 1993). At hydroelectric dams, large volumes of water can direct out-migrating fish into potential hazards while they attempt to pass the project. Fish may be injured or killed via entrainment through a turbine, discharge through a gate with no adequate plunge pool, impingement on screens and racks, and trauma due to changes in barometric pressure. Mortality caused by passing downstream through turbines at hydroelectric projects can vary greatly depending on species, size, and life stage (adult or juvenile) of fish (e.g., 12 percent mortality for American shad, (Heisey et al. 2008), 100 percent mortality for American eel, (Carr and Whoriskey 2008)) as well as on turbine design, including turbine flow, tip speed, rotational speed, number of blades/buckets, blade spacing, and runner diameter (Franke et al. 1997).

Castro-Santos and Letcher (2010) reported on adult shad that failed to reach the Turners Falls Impoundment. For these fish that remained in the power canal, the median downstream delay for these fish was 14.6 days.

Relicensing study 3.3.2 tracked routes of passage of downstream migrating shad in Turners Falls Impoundment. This study reported that 75% of the fish entered the power canal and 25% passed over the Turners Falls spillway. For the fish that encounter the Cabot Station powerhouse, 32% of these fish were entrained. Of the 86 fish that entered the canal, 67 passed downstream for an overall canal passage rate of 82% indicating that 18% were lost and not counted as successfully passing downstream[39].

6.5.3.1 Mortality & Injury - juvenile shad

In 2015, Relicensing Study 3.3.3 tracked 129 juvenile shad that were released 1.5 miles upstream of Northfield Mountain and 54 juvenile shad released 1.25 miles upstream of the Turners Falls Dam with Lotek NanoTag Series Model NTQ-1 tags used for tracking purposes. Survival over the Bascule 1 and 4 was studied under three test flow conditions. Survival at each test flow and overall survival is summarized in Table 4. The report states "the boulder and concrete sill structures immediately downstream of Bascule Gates 1 and 4 likely contributed to lower survival of the passed juvenile American shad under the lower flow conditions"[40].

[38] Accession # 20160301-5504
[39] Accession # 20161014-5112 (pages 5-3 & 5-4)
[40] Accession # 20161014-5114

Table 4. Juvenile shad downstream passage 1 hour direct survival (%)

Flow	Bascule 1	Bascule 4
1,500 cfs	69.4	64.2
2,500 cfs	47.7	59.0
5,000 cfs	75.6	73.6
Overall	63.0	64.8

This same study also examined juvenile shad that passed the project downstream via the Bascules, Station 1 and at Cabot Station. The fish were recaptured downstream of each of these routes of egress and were examined for injuries. The results from the examination suggest that the rate of visible passage injuries range from 9% to 22% of the fish that pass via either powerhouse. The visible injury rate for fish that pass via either bascule ranged from 21% to 45% (Table 5). These data indicate that no studied routes of egress are providing safe passage for downstream migrating shad.

Table 5. Daily malady data for recaptured wild juvenile American shad, October 2015.[41]

Study area	Number examined	Visible injuries	Obvious injuries, dead 1 hr	% examined with passage maladies
Cabot Station Unit 2	115	10	0	9%
Station #1, Unit 2/3	65	5	3	12%
Station #1, Unit 1	68	14	1	22%
Bascule 1, 1,500 cfs	42	8	1	21%
Bascule 1, 2,500 cfs	34	12	1	38%
Bascule 1, 5,000 cfs	49	17	0	35%
Bascule 1, combined	125	37	2	31%
Bascule 4, 1,500 cfs	41	18	1	46%
Bascule 4, 2,500 cfs	40	18	0	45%
Bascule 4, 5,000 cfs	41	17	0	41%
Bascule 4, combined	122	53	1	44%

6.5.3.2 Dam Spill Mortality - adult shad

With respect to downstream routes of passage, the results of Study 3.3.2 indicated that of the study fish in the TFI, approximately 18% of the downstream migrating study fish passed over the dam into the bypass reach, 25% of the fish remained in the impoundment with passage through the canal accounting for the remainder of the fish at 57%[42].

Focusing on the 18% of fish that passed via the dam, fish migrating downstream from the headpond that use Bascule Gate Number 1 are subjected to land in shallow water; if the fish pass via Bascule Numbers 2 through 4, they are subjected to landing onto bedrock or concrete. The licensee's data indicated that of the 22 adult shad that were tracked as going over the dam, five were recorded as a mortalities in the pool below the dam for a mortality rate of 23%.[43]

[41] Accession # 20161014-5114 (Table 5-3)
[42] Accession # 20170501-5352 (page 2-92)
[43] Kevin Nebiolo of Kleinschmidt Associates provided the data in Microsoft Access file format. The files were dbRecaptures_V2.accdb and dbRecaptures_V6.accdb

6.5.3.3 Downstream Cabot Station & Station 1 Mortality - adult American shad

Relicensing Study 3.3.19 Ultrasound Array Control and Cabot Station Shad Mortality had a section in the report that focused on downstream shad passage at Cabot Station. One of the methods used to study mortality rates was the Live Recapture Dead Recovery recapture model. In addition, drift rates of dead fish were compared to the rates of travel of live fish.[44] This report states that after removing both live recapture and dead recovery data after the 48-hour mortality window (1 week for mobile tracking), 65% of the fish known to pass via the Cabot powerhouse were expected to survive for 48 hours while 89% of the fish that passed via the Cabot log sluice survived after 48 hours. These results indicate that for either Cabot Station turbine passage or passage via the log sluice, the passage performance standard in the CRASC shad management plan was not met.

6.5.3.4 Station 1 Mortality - adult American eel

Relicensing Study 3.3.5 Downstream Passage of American eel also used HI-Z Turb'N Tag to mark and recapture study fish for fish that passed through the Station No. 1 powerhouse. For fish that passed via Units 2/3 in Station 1 there was a 63% recapture rate. Of the recaptured fish, some of these fish had injuries that included broken bones, hemorrhaging, bruising and cuts. For fish that passed via Units 2/3 the estimated survival rate was 62%.[45] Such a low survival rate demonstrates that mitigation measures are needed in order to significantly decrease the mortality rate at Station 1.

6.5.3.5 Downstream Delay - adult American shad

When studying downstream migratory movement of shad, Relicensing Study 3.3.2 found that some tagged study fish in front of the Cabot Station forebay took as along as 48 hours to leave the forebay area. Some fish were attracted to the Station 1 forebay and took upwards of 15 hours to leave. This report states that approximately 50% of the fish that entered the canal passed downstream within 23 hours, and that a portion remained in the canal up to 10 days.[46] Some study fish were observed to be remain in front of the Cabot Station forebay for 400 hours. These results indicate that the project is imposing significant delay on downstream migrating shad.

With respect to the Turners Falls project, the proportion of the annual spawning run determined to be repeat spawners has declined from 49% in the late 1950s to a mean of 5% for the period 2006-2015[47]. These data indicate that the CRASC shad management plan's goals of 15% repeat spawning is not being met for downstream migrating shad encountering the project.

6.5.4 Downstream adult American eel passage – Turners Falls

Relicensing Study 3.3.5 examined eel passage past the Northfield Mountain Pumped Storage intake, over the Turners Falls Dam, and through the Turners Falls canal. With respect to routes of passage, this study tracked fish in the Turners Falls impoundment and determined their route selection. The study found that 69% of the study fish passed via the gatehouse and entered the

[44] Accession # 20200331-5287 (ES-2)
[45] Accession # 20170301-5222 (page 4-36)
[46] Accession # 20161014-5112 (page 4-89 and page 5-3)
[47] Accession # 20200302-5300

power canal and 10% passed via spill and entered the bypass reach. Of all the escape routes from the canal, the study determined that fish overwhelmingly chose to escape the power canal via Cabot Station powerhouse for all release cohorts. The study found that 83% of migrating eel in the power canal passed via Cabot Station, 8% passed via the downstream bypass and 3% passed via the Station 1 Powerhouse. With respect to delay, for fish that passed via Cabot Station, the median transit time was just over 96 hours (4 days) with the slowest study fish taking 25 days to pass the project.

In addition to radio tagged fish, this study used balloon tags to determine mortality. Station 1 Units 2 and 3 caused the highest mortality with only a 62.1% survival rate. Table 6 summarized the survival rates for balloon-tagged fish that passed at different locations through the Turners Falls project.

Table 6. Summary of 1-hour and 48-hour adult eel mortality at various locations throughout the Turners Falls project

Route of Downstream Egress	Number Released	1-hour Survival Rate (90% CI+/-)	48-hour Survival Rate (90% CI+/-)
Cabot Station Unit 2	50	98 (3.3)	96.0 (4.6)
Station No. 1 Unit 2/3	30	62.1 (14.8)	62.1 (14.8)
Station No. 1 Unit 1	30	90.0 (9.1)	90.0 (9.1)
Bascule Gate 1 (combined)	95	86.8 (5.8)	82.9 (5.9)
1,500 cfs	35	88.2 (4.0)	88.2 (4.0)
2,500 cfs	30	85.7 (7.4)	85.7 (7.4)
5,000 cfs	30	86.2 (10.5)	86.2 (10.5)
Bascule Gate 4 (combined)	95	90.5 (4.9)	88.4 (5.4)
1,500 cfs	35	88.6 (8.7)	82.9 (10.5)
2,500 cfs	30	90.0 (9.1)	90.0 (9.1)
5,000 cfs	30	93.3 (7.6)	93.3 (7.6)
Combined Controls	25	100	100

Heisey et al. (2019) studied downstream American eel passage at Cabot Station and at Station 1 (Unit 1). Their results suggested a 96 ± 4.6% survival rate at Cabot Station and a 90 ± 9.0% survival rate at Station 1. The authors also examined these fish for injuries and found that 4.1% of the fish that passed via Cabot Station were injured. These impacts to downstream migrating American eel at this particular project are an important consideration in a cumulative effects analysis of federally licensed projects up and down the mainstem Connecticut River.

Mueller (2020) considered internal non-visible injuries that can happen to fish when passing hydroelectric projects by taking x-ray images on fish that passed via the turbines and found 36 types of injuries including skeletal injuries, swim bladder anomalies, emphysema, free intraperitoneal gas and hemorrhages. While most fish passage and movement studies do not take x-ray imagery of study fish after they have passed a project, this paper raises an important consideration with respect to the extent of potential effects attendant to downstream passage and the need to ensure it is safe.

6.5.5 Shortnose sturgeon

Manipulation of flow below the Turners Falls Dam has direct effects on spawning and rearing of Shortnose sturgeon, including limiting available habitat, disrupting and displacing spawning adults, and displacing or destroying early life stages. Effects may result from: the magnitude of flow, including low flows, in the bypass reach during the spawning and rearing period; Cabot peaking operations (sudden changes in flow) during the spawning and rearing periods; and, the frequency of Cabot emergency spill releases and bypass flume (log sluice) discharges on spawning and rearing habitat. FirstLight carried out data collection and modeling to assess baseline conditions (inclusive of effects of current operations) and effects of proposed changes to project flows and operations (Relicensing Study 3.8.1, 3.2.2., 3.3.1 and the operations model).

Shortnose sturgeon spawn in the spring at two distinct sites located within a 2-km reach near Montague, MA (rkm 194–193; (Kynard et al. 2012a)). The sites are both located approximately 4km downstream of the Turners Falls Dam (Kynard et al. 2012a). Researchers refer to the main site as "Cabot Station" because it occurs in the tailrace of the Cabot Station Electrical Generation Facility (rkm 193). This site is approximately 2.7 ha in area and receives water from above Turner's Falls Dam that has been diverted through a power canal for the Station. The secondary, smaller site (0.4 ha in area) is located at Rock Dam (rkm 194). Rock Dam is a natural rock barrier located at the end of a natural river reach also flowing from the Turner's Falls Dam.

Analyses of river conditions indicated spawning success was dependent on the timing of habitat suitability windows (Kynard et al. 2012b). No spawning occurred outside the day-length window of 13.9–14.9h of daylight. During this photo-period, Shortnose sturgeon spawned only during daily mean temperatures of 6.5–15.9°C. Spawning was also dependent on a mean daily discharge of 901–121m^3/s, but water levels had to be within this window by 30 April. If reaching this discharge level was delayed even for a few days at the Cabot Station site, spawning failed, even when late-stage females and ripe males were present. Although temperature and discharge appeared to affect spawning, photo period was the dominant factor influencing the timing of spawning (Kynard et al. 2012a)).

Spawning at the Rock Dam site was affected by high discharge levels similar to the Cabot Station site, but was also affected by low discharge (Kynard et al. 2012a)). Because the Rock Dam site is located between the Turners Falls Dam and Cabot Station, flow is significantly reduced when water is diverted from the natural river by the Turners Falls Dam to a power canal serving the Cabot Station. Flow at the Rock Dam all but stops whenever river discharge drops to below ~400m3/s (maximum used for power generation at Cabot Station). Complete diversion typically occurs at some point during the spawning season as the spring floods subside (1 April–27 May). Tracking and early life stage sampling indicate all spawning activity ceases when water is diverted from the Rock Dam site. Even if water returns to the mainstem for brief periods, pre-spawning adults are rarely attracted to the site. Because complete diversion usually occurs in early May, spawning succeeds infrequently at Rock Dam. There was no year when spawning succeeded at Rock Dam but failed at Cabot Station (Kynard et al. 2012a).

6.6 Northfield Mountain Pumped Storage Project Impacts

6.6.1 American shad - ichthyoplankton

Study Report for 3.3.20 filed in late 2016 reports on data collected in 2015 and 2016[48]. Addendum #1 was filed in the summer of 2017 and contains additional analyses.[49] In 2015, with the reduced time frame and sampling effort, a total of just over 3 million shad eggs and 500,000 shad larvae were estimated entrained. In 2016, an estimated 9.5 million shad eggs and 5.4

[48] Accession # 20161228-5079

[49] Accession # 20170728-5035

million shad larvae were entrained by NMPS. FLP applied in-river and marine survival rates to estimate the number of juveniles and adult equivalents from the provided entrainment estimates. Using their application of survival rates to entrained eggs and larvae, they report a projected loss of 694 juveniles and 94 adult American shad in 2015. Similarly in 2016, the report estimates a projected loss of 2,093 juveniles and 578 adult American shad.

A previous study in the 1990s estimated that while NMPS was pumping, 14.4 million shad eggs were entrained (LMS 1993). The study goes on to report a total of 1.175 million American shad eggs, 2.744 million yolk–sac shad larvae, and 10.525 million post yolk-sac larvae were entrained at NMPS. The authors of this report state that in the case of the Northfield Mountain Project, any life stage that is entrained and pumped into the upper reservoir is removed from the river population because they are considered as mortalities.

6.6.2 American shad – juvenile

Relicensing Study 3.3.3 used hydroacoustic split beam sonar equipment at the NMPS intake from August 1 to November 14, 2015[50]. A threshold setting for a fish with a total length of 30mm was applied to the system by using a methodology that Love (1971) developed. The report states the transducer locations at NMPS did not allow for data reduction to accurately estimate the study objective of run timing, duration, or magnitude of juvenile shad outmigration. The analysis of the data led to a report statement indicating a substantial number of targets in a milling behavior, rather than simply moving in a downstream direction. Nearly all fish collected were juvenile shad. Based on the findings reported for Cabot Station, the results that include movement timing, sizes of fish, have substantial inference to the NMPS project located 5.2 miles upstream of the Turners Falls Project. The report also noted that shad sized targets were observed to be entrained at Cabot in all hours of the day but were most prevalent during the afternoon and evening hours, with a peak at 20:00. These results indicate that pump operations create delay for downstream juvenile shad migration.

A radio tagging study with juvenile American shad was also a component of Study 3.3.3 that included the NMPS project area. The Interim Study Report for 3.3.3 states that pre-release evaluations of the nano-sized radio tags were assessed in a control experiment that revealed significant mortality, tag loss, and irregular swimming behavior of tagged shad.

In 2015, six release events of radio tagged shad (20 tagged fish, 30-50 untagged, per group) occurred 1.5 miles upstream of NMPS. Releases occurred from October 12-20, 2015. A total of 129 tagged shad were released upstream of NMPS with 77 (60%) of those detected a short distance upstream (0.5 miles) of NMPS. The analyses uses these identified fish as available to the NMPS area with 32 (41.6%) of the 77 being subsequently detected immediately downstream of the NMPS. This alternatively suggests up to 58.4% of the tagged fish may have been entrained indicating a significant project impact and clear need to mitigate this impact. The study also states that three tagged fish were detected in the NMPS upper reservoir and reports an entrainment rate 3.9% which we consider as a minimum of a 3.9% mortality rate. The report's estimated entrainment rate is a low estimate due to the assumptions that 1) external tags are retained on fish through the pumping process, 2) tagged fish are alive and swimming near surface to allow radio receiver detection, and 3) tag detection is 100%. Factors that would negatively bias this value include 1) no evaluation of the micro tags detection efficiency in the

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[50] Accession # 20161014-5114

upper reservoir and 2) retention rates of the externally applied (with a fly fishing hook) micro tag on a juvenile shad that were subject to the physically intense conditions of velocity acceleration, turbulence and pressures from the 5,000 CFS reverse turbines to the mountain top reservoir. The removal of a micro tag from the dorsal musculature of a juvenile shad would be expected to result in the tag being released (sinking) at substantial depth in the upper reservoir where radio signals would be attenuated due to water depth, particularly with the smaller, weaker signal tags.

Several previous studies have been conducted to examine juvenile shad and ichthyoplankton entrainment at the NMPS project area. The most recent earlier study was the LMS (1993) report that provides study findings that examine potential project operation impacts. Juvenile shad and ichthyoplankton were sampled in the Turners Falls Impoundment from 23 June to 20 October. This study marked 3,187 shad and recovered 8.2% of these fish in the entrainment net indicating that 8.2% of the population was lost due to entrainment. Juvenile shad entrainment sampling using the described net frame structure in the upper reservoir occurred from 9 August to 27 October. The net sampler efficiencies were tested during the study with marked juveniles injected into the turbine pump system and used in the extrapolated entrainment estimates.

The Massachusetts Division of Fisheries and Wildlife and the U.S. Fish and Wildlife Service initiated a juvenile alosine production assessment in the summer and fall of 2017 that has been ongoing (Mattocks et al. 2019). The ongoing study uses a modified random stratified sampling design and boat electrofishing to assess relative abundance and fish length/weight data in areas from the Bellows Falls Dam to the Holyoke Dam. Mattocks et al. (2020) provides data on juvenile shad sampled from August 22 – October 18, 2017 and from August 8 – November 1, 2018. In both years assessment data indicate that density dependent growth dominates in the Holyoke headpond whereas growth, as identified by growth in fish length over time, in the Turners Falls Impoundment does not appear to be limited by density. The authors state that this affect is likely due to the direct result of poor passage at Turners Falls and that this project could support higher passage rates without density limiting growth rates. This report highlights a management need to increase production in these upstream areas and notes the concern with cumulative downstream passage survival mortality as fish encounter hydropower projects.

6.6.3 Adult shad – upstream and downstream delay

Regarding upstream migration through the TFI, Relicensing Study 3.3.2 stated that the majority of transitions occurred when pumping was high and went on to state that as pumping flow increases, fish are more likely attracted to the intake."[51] Relicensing Study 3.3.7 also examined upstream shad movement and stated in the executive summary that 50% of the shad detected at the intake left the area and continued upstream migration within 37.6 hours[52]. These data indicate that shad are being delayed in their upstream migration towards either the Vernon project or the Ashuelot River, both of which are upstream of NMPS.

With respect to downstream passage in the Turners Falls headpond, data from Relicensing study 3.3.2 reported that according to the Kaplan-Meier curve, approximately 50% of the fish reach the

[51] Accession # 20170501-5352 (page 2-86)
[52] Accession # 20161014-5119

area of the impoundment below NMPS intake within 25 hours and 75% of the population passed through the impoundment entirely within 100 hours[53].

6.6.4 American eel

Relicensing study 3.3.5 studied the movement of eels in the Turners Falls headpond. The study used the language of 'transitioning into an unknown state' for fish that were not recaptured at any other receiver; 34 of 91 study fish were categorized this way. The study results suggested as pumping decreased, the eels were less likely to 'transition into the unknown state'. It goes on to report that given that fish are much more likely to transition into the unknown state during nighttime or when NMPS is pumping, the fish transition into the unknown state are likely to be entrained. The results from this study indicated that only 60% of the eel detected at the NMPS intake escaped the impoundment.[54]

7 MANDATORY TERMS AND RECOMMENDED CONDITIONS FOR THE TURNERS FALLS PROJECT (P-1889)

7.1 Section 10(a) Consistency with Comprehensive Plans

Section 10(a)(1) of the FPA requires the project adopted by the Commission to be, in its judgment, the "best adapted to a comprehensive plan for ... beneficial public uses, including … purposes referred to in section 4(e) ..." 16 USC §803(a)(1). This includes consideration of adequate protection, mitigation and enhancement of fish and wildlife, including related spawning grounds and habitat 16 USC §803(a). Section 10(a)(2) requires that, in making this determination, the Commission consider the recommendations of federal agencies exercising jurisdiction over resources of the state in which the project is located (16 USC §803(a)(2)). Our interest at the Project is safe, timely, and effective fish passage for the benefit of American shad, and American eel, as well as habitat considerations for migration, spawning, and rearing for American shad, and American eel and Shortnose sturgeon.

In fulfilling the balancing provisions of section 10(a) of the FPA, FERC guidance states that it must consider the economics of hydropower projects in terms of a project's current operating costs as compared to likely alternative power (72 FERC ¶ 61,027 (1995)). The Project's power benefits are to be evaluated as previously licensed, and under the new license with the mitigation and enhancement measures set forth in the recommendations, prescriptions, and conditions under FPA sections 10(j) and section 18.

Our interests at the Turners Falls and Northfield Mountain Pumped Storage projects are safe, timely, effective fish passage as well as a stabilized flow regime. We address these needs in our 10(j) recommendations and mandatory conditions under Section 18 of the FPA. At this time, we are not providing recommendations under Section 10(a) of the FPA.

7.2 Section 10(j) Protection, Mitigation and Enhancement of Fish and Wildlife

The following Section 10(j) recommendations are for the protection, mitigation of damages to, and enhancement of fish and wildlife resources and their habitat at the Turners Falls Project. These recommendations are consistent with state and federal management goals and objectives for restoring, protecting, and enhancing fish and wildlife resources in the Connecticut River

[53] Accession # 20161014-5112 (page 4-83)
[54] Accession # 20170301-5222

watershed, are based on our assessment of project related impacts on those resources, and are consistent with the FFP agreement filed pursuant to 18 CFR 385.602. Evidentiary support for these recommendations is contained in our administrative record and cited herein. Recommendations submitted by us pursuant to Section 10(j) of the FPA must be accepted by the Commission, as conditions to any license(s) issued, unless, after giving due weight to our subject matter expertise, the Commission finds, based on substantial evidence in the record, that the recommendations are inconsistent with the FPA.

7.2.1 Minimum flows below Cabot Station (FFP agreement proposed license article A130)

Upon license issuance, the Licensee shall maintain Minimum Flows below Cabot Station, or the naturally routed flow (NRF), whichever is less, according to Table 7[55].

Table 7. Flow schedule for minimum flows below Cabot Station

Date	Minimum Flow below Cabot Station
04/01-05/31	8,800 cfs from midnight to 7:00 pm or the NRF, whichever is less and 6,500 cfs from 7:00 pm to midnight or the NRF, whichever is less.
06/01-06/15	6,800 cfs or the NRF, whichever is less
06/16-06/30	5,800 cfs or the NRF, whichever is less

The Minimum Flow below Cabot Station may be temporarily modified if required by equipment malfunction or operating emergencies reasonably beyond the control of the Licensee. If the Minimum Flow below Cabot Station is so modified, the Licensee shall notify the Commission, MDEP, MDFW, NMFS, and USFWS as soon as possible, but no later than 10 days after such incident. The Minimum Flow below Cabot Station may also be temporarily modified for short periods upon mutual agreement with the Licensee for the Northfield Mountain Pumped Storage Project (FERC No. 2485), MDEP, MDFW, NMFS and USFWS, and upon 5 days′ notice to the Commission.

[55] Definition of Naturally Routed Flow: From December 1 through June 30, the NRF is defined as the hourly sum of the discharges from 12 hours previous as reported by the: Vernon Hydroelectric Project (FERC No. 1904), Ashuelot River United States Geological Survey gauge (USGS, Gauge No. 01161000), and Millers River USGS gauge (Gauge No. 01166500).

From July 1 through November 30, the NRF is defined as the hourly sum of the discharges averaged from 1 to 12 hours previous as reported by the: Vernon Hydroelectric Project, Ashuelot River USGS gauge, and Millers River USGS gauge. Upon license issuance until 3 years thereafter, the Licensee shall operate the Turners Falls Project based on the NRF computational method from July 1 through November 30 to determine if the Turners Falls Project can be operated in this manner. If the Turners Falls Project cannot be operated in this manner, the Licensee shall consult MDFW, NMFS, and USFWS on alternative means of computing the NRF that are feasible for Turners Falls Project operation and sufficiently dampen upstream hydroelectric project flexible operations.
The Minimum Flow below Turners Falls Dam may be temporarily modified if required by equipment malfunction or operating emergencies reasonably beyond the control of the Licensee. If the Minimum Flow below Turners Falls Dam is so modified, the Licensee shall notify the Commission, MDEP, MDFW, NMFS, and USFWS as soon as possible, but no later than 10 days after such incident. The Minimum Flow below Turners Falls Dam may also be temporarily modified for short periods upon mutual agreement with the Licensee for the Northfield Mountain Pumped Storage Project (FERC No. 2485), MDEP, MDFW, NMFS and USFWS, and upon 5 days′ notice to the Commission.

7.2.1.1 Rationale

This agreed upon recommendation is a specific operational measure for the purpose of protecting Shortnose sturgeon and American shad. The purpose of these required minimum flows is to increase the amount of Shortnose sturgeon and American shad spawning habitat that is available below the project by stabilizing the operational flow regime out of the Cabot Station Powerhouse. This flow regime will dampen the rate at which flow changes below the project occur. These minimum flow provide more suitable habitat for spawning and adult American shad downstream of the project.

The minimum flow below Cabot Station directly affects the availability and suitability of habitat to support spawning and rearing of ESA listed Shortnose sturgeon. The proposed minimum flow conditions would result in considerably more habitat for Shortnose sturgeon spawning and rearing/development of Shortnose sturgeon eggs and larvae. The minimum flows also increase the amount of contiguous suitable habitat that would persist under a range of generation conditions. These agreed upon minimum flow requirements are essential to support the survival and recovery of the species in the Connecticut River, are consistent with the requirements of section 7(a)(1) and 7(a)(2) of the ESA, and address Recovery Criteria 3.1.1 and 3.1.2 in NMFS Recovery Plan for Shortnose sturgeon (NMFS 1998).

7.2.2 Cabot Station Ramping Rates (FFP agreement proposed license article A140)

The Licensee shall ramp Cabot Station from April 1 to June 30 with an up and down ramping rate of 2,300 cfs/hour[56].

The Cabot Station ramping rates may be temporarily modified if required by equipment malfunction or operating emergencies reasonably beyond the control of the Licensee. If the Cabot Station ramping rates are so modified, the Licensee shall notify the Commission, MDEP, MDFW, NMFS, and USFWS as soon as possible, but no later than 10 days after such incident. The Cabot Station ramping rate may also be temporarily modified for short periods upon mutual agreement with the Licensee for the Northfield Mountain Pumped Storage Project (FERC No. 2485), MDEP, MDFW, NMFS, and USFWS, and upon 5 days′ notice to the Commission.

7.2.2.1 Rationale

This agreed upon recommendation is a specific operational measure for the purpose of protecting ESA listed Shortnose sturgeon. The Cabot Station ramping rates above are to avoid and minimize effects of rapid changes in habitat conditions below Cabot Station on spawning adult and early life stage Shortnose sturgeon. Turning Cabot Station generating units rapidly on and off may cause spawning to cease and the Shortnose sturgeon egg and larval rearing area to become dewatered or scoured with high velocity flow; the ramping rates avoid and minimize this disruption. These minimum flow requirements are essential to support the survival and recovery of the species in the Connecticut River, are consistent with the requirements of section 7(a)(1) and 7(a)(2) of the ESA, and address Recovery Criteria 3.1.1 and 3.1.2 in NMFS Recovery Plan for Shortnose sturgeon

[56] If the NRF is greater than the sum of the hydraulic capacity of Cabot Station and Station No. 1 and the Minimum Flow below Turners Falls Dam in effect at the time, the Cabot Station up-ramping rates will not apply

7.2.3 Cabot Station Emergency Gate Use (FFP agreement proposed license article A180)

Upon license issuance, the Licensee will use the Cabot Station Emergency Gates under the following conditions: a) a Cabot load rejection that could cause overtopping of the canal, b) dam safety issues such as potential canal overtopping or partial breach, and c) to discharge up to approximately 500 cfs from April 1 to June 15 for debris management. If the Licensee desires to discharge higher flows during April 1 to June 15, the Licensee shall coordinate with NMFS to minimize potential impacts to Shortnose sturgeon in the area below Cabot Station.

7.2.3.1 Rationale

This agreed upon recommendation is a specific operational measure for the purpose of protecting ESA listed Shortnose sturgeon. This recommendation is intended to avoid and minimize the effects of the high flows through the Emergency Gates on ESA listed Shortnose sturgeon, which can disrupt spawning and result in the mortality of early life stages. Discharge of high flows through the Emergency Gates during the spring may cause spawning to cease and the Shortnose sturgeon egg and larval rearing area to become scoured with high velocity flow; the restrictions avoid and minimize this disruption. These requirements are essential to support the survival and recovery of the species in the Connecticut River, are consistent with the requirements of section 7(a)(1) and 7(a)(2) of the ESA, and address Recovery Criteria 3.1.1 and 3.1.2 in NMFS Recovery Plan for Shortnose sturgeon.

7.2.4 Project Operation, Monitoring and Reporting Plan (FFP agreement proposed license article A200)

Within 1 year of license issuance, the Licensee shall file with the Commission, for approval, a Project Operation, Monitoring and Reporting Plan describing how the Licensee will document compliance with the operating conditions. The Plan will include the following:

a. The licensee will provide a description of how the Licensee will comply with all required minimum flows, ramping rates, and flow stabilization requirements. These are collectively referred to hereinafter as the operating requirements.
b. A provision to file with the Commission, after consultation with the MDEP, MDFW, NFMS, and USFWS, a minimum flow and operation compliance report detailing implementation of the plan, including any allowable deviations that occurred during the reporting period. For the period January 1 to March 31 and July 1 to December 31, the compliance report, including any deviations, will be filed with the Commission by March 1 of the following year. For the months of April, May, and June, the monthly compliance report, including any deviations, will be filed with the Commission on June 1, July 1 and August 1, respectively. Upon license issuance until 3 years thereafter, the Licensee shall document on an hourly basis for each day any allowable deviations from the Cabot Station Ramping Rates in Section 7.2.2 (Article A140). Beginning three years after license issuance until license expiration, the Licensee shall document on an hourly basis for each day any allowable deviations from the Cabot Station Ramping Rates restrictions stated in Section 7.2.2 (FFP agreement proposed license article A140). Each day, from April 1 to November 30, the Licensee shall record any allowable deviations in a spreadsheet showing the daily deviations, the reason for the deviation, the number of hours, and scope. The Licensee shall provide the total number of deviations to the MDEP, MDFW,

NFMS, and USFWS per the reporting schedule above. Allowable deviations will be tracked as follows:

Identify Allowable Deviations

The Licensee shall record the NRF, Turners Falls Dam discharge, Station No. 1 discharge, Cabot Station discharge and total Turners Falls Project discharge (below the Cabot Station tailrace) at the top of each hour. Allowable deviations in both the Cabot Station Ramping Rate and Flow Stabilization below Cabot Station requirements will be recorded. At the top of each hour, the Licensee shall record the change in Cabot Station discharge from the previous hour to determine if any deviation has occurred from the agreed upon Cabot Station Ramping Rate. In addition, the NRF (as detailed in paragraph (b) of the "Operational Regime" section) will be compared with the recorded total Turners Falls Project discharge in a given hour to identify if a Flow Stabilization below Cabot Station deviation occurred over the past hour. Any deviation of either the Cabot Station Ramping Rate or total Turners Falls Project discharge within the hour will be counted in one-hour increments.

7.2.4.1 Rationale

This agreed upon recommendation is a specific reporting measure for the purpose of protecting a number of diadromous species under our jurisdiction. Given the amount, degree, and complexity of all the recommended flow requirements for the protection, mitigation of damages to, and enhancement of fish resources affected by the project, we deem it critical for the licensee to provide reports on its ability to meet and fulfill these various requirements. There is a benefit to ensuring that mandatory flows in the bypass reach for the purpose of fish passage, as well as providing suitable habitat for anadromous species are met. This recommendation specifically calls for bypass flow data to be provided that is strictly related to project operations within the project boundary.

7.2.5 Flow Notification Website (FFP agreement proposed license article A210)

Within 1 year of license issuance, the Licensee shall provide the following information year-round on a publicly available website:

a) On an hourly basis, the Turners Falls Impoundment water elevation, as measured at the Turners Falls Dam, the Turners Falls Dam total discharge, and the Station No. 1 discharge.
b) On an hourly basis, the anticipated Turners Falls Dam total discharge and the anticipated Station No. 1 discharge for a 12-hour window into the future. Should the Licensee deviate from passing the 12- hour previous NRF from December 1 to May 31 or the 12-hour average NRF from June 1 to November 30, it will post the revised flows (in the 12-hour look ahead window) to a website as soon as practicable after they are known.
c) Within one month prior to its annual power canal drawdown, the Licensee shall post on its website the starting and ending time/date of the drawdown, which will last at least 4 days. Throughout the duration of the canal drawdown, the NRF, as defined in Section 7.3.1 (FFP agreement proposed license article A110), will be maintained below the Turners Falls Dam.

7.2.5.1 Rationale

This agreed upon recommendation is a specific operations reporting measure for the purpose of protecting a number of diadromous species under our jurisdiction. The purpose of providing Turners Falls Dam spill and the Station No. 1 generation flow is to allow access by resource agencies to ensure that minimum flow requirements from the dam and from Station No. 1 are being provided. There is a benefit to ensuring that deviations from required flows are quickly provided to the public and to resource agencies. The costs for ensuring that flow deviations are being reported are minimal. This recommendation specifically calls for operational data to be provided that is strictly related to project operations within the project boundary. This recommendation is intended to be consistent with the State of Massachusetts 401 Water Quality Certificate conditions.

7.3 Section 18 Prescription for Fishways for American shad and American eel

We hereby submit the following preliminary prescription for fishways pursuant to Section 18 of the FPA, 16 USC §811. Section 18 of the FPA states in relevant part that, "the Commission must require the construction, maintenance, and operation by a Licensee of...such fishways as may be prescribed by the Secretary of Commerce or the Secretary of the Interior." Congress provided guidance on the term "fishway" in 1992 when it stated as follows:

> "*The items which may constitute a 'fishway' under Section 18 for the safe and timely upstream and downstream passage of fish must be limited to physical structures, facilities, or devices necessary to maintain all life stages of such fish, and Project operations and measures related to such structures, facilities, or devices which are necessary to ensure the effectiveness of such structures, facilities, or devices for such fish.*" Pub.L. 102-486, Title XVII, § 1701(b), Oct. 24, 1992.

We base the following mandatory fishway prescription on the best available scientific information including the best biological and engineering information available at this time, as described in the explanatory statements that accompany each prescription. We developed the basis for this prescription over a period of several years by our biological and engineering staff, in consultation with the Licensee, the USFWS and other entities that participated both in this relicensing proceeding. We fully considered a broad array of issues in formulating the preliminary prescription for fishways. Consideration for this analysis is documented in the Administrative Record submitted to the Commission. These mandatory conditions are consistent with the agreed upon measures in the FFP agreement. Our conclusion that the prescription for fishways is justified is based on, but not limited to, the following primary points: (1) numerous long-standing resource agency management and restoration goals are achieved through fish passage, (2) a well- documented historical presence of robust diadromous fish populations within the Connecticut River watershed prior to dam construction, (3) professional experience across the region demonstrates that diadromous fish will be motivated to migrate above barriers when effective passage is provided, (4) access to the spawning, rearing and migration habitat above the Turners Falls Project is necessary for the full restoration of diadromous fish, (5) consideration of the cumulative impacts on migratory fish and their habitat resulting from a heavily dammed riverine system, and (6) state and federal comprehensive plans indicate the significant potential for diadromous fish populations in the Connecticut River watershed once fish passage and habitat restoration is accomplished. Specific citations and detailed explanations in support of these reasons are found in the text of this prescription.

We support each prescription measure with substantial evidence contained in the record of pre-filing consultation, and subsequent updates, compiled and submitted in accordance with the Commission's procedural regulations. The explanatory statements included with each prescription summarize the supporting information and analysis supporting the prescription. We include an index to the administrative record for this filing herein, and reserve the right to file updated and supplemental supporting information as needed.

7.3.1 Required Bypass Minimum Flows (FFP agreement proposed license articles A110 & A120)

The Licensee shall provide a flow in the bypass reach sufficient for safe, timely, and effective passage to the dam during the upstream American shad passage season.

Below the Turners Falls Dam

Upon license issuance, the Licensee shall discharge from the Turners Falls Dam or from the gate located on the power canal ("canal gate") just below the Turners Falls Dam the following seasonal minimum flows.

Table 8. Summary of minimum flow releases below Turners Falls Dam

Date	Flow requirement
04/01-05/30[1]	If the NRF is ≤ 6,500 cfs, the Minimum Flow below Turners Falls Dam shall be 67% of the NRF. If the NRF is > 6,500, the Minimum Flow below Turners Falls Dam shall be 4,290 cfs.
06/01-06/15,[1,2]	If the NRF is ≤ 4,500 cfs, the Minimum Flow below Turners Falls Dam shall be 67% of the NRF. If the NRF is > 4,500 cfs, the Minimum Flow below Turners Falls Dam shall be 2,990 cfs.
06/16-06/30[2]	If the NRF is ≤ 3,500 cfs, the Minimum Flow below Turners Falls Dam shall be 67% of the NRF. If the NRF is > 3,500 cfs, the Minimum Flow below Turners Falls Dam shall be 2,280 cfs.

[1] One of the upstream fish passage adaptive management measures (AMMs) described in Article A330 calls for increasing the Total Minimum Bypass Flow below Station No. 1 referred to in Section 7.3.2 (FFP agreement proposed license article A120) from June 1 to June 15 from 4,500 cfs to 6,500 cfs. If this AMM is enacted, and if the NRF is ≤ 6,500 cfs, the Minimum Flow below the Turners Falls Dam shall be 67% of the NRF, subject to the conditions in FFP agreement proposed license article A330. If this AMM is enacted, and if the NRF is > 6,500 cfs, the Minimum Flow below the Turners Falls Dam shall be 4,290 cfs, subject to the conditions in Section 7.3.6 (FFP agreement proposed license article A330).
[2]The magnitude of the Minimum Flow below Turners Falls Dam from June 1 to June 30 may be modified in the future pending fish passage effectiveness studies referenced in Section 7.3.6 (see FFP agreement proposed license article A330). If the Licensee conducts fish passage effectiveness studies, in consultation with the Massachusetts Division of Fisheries and Wildlife (MDFW), National Marine Fisheries Service (NMFS), and United States Fish and Wildlife Service (USFWS) and determines that migratory fish are not delayed by passing a greater percentage of the Total Minimum Bypass below Station No. 1 referenced in

Section 7.3.2 (see FFP agreement proposed license article A120) via Station No. 1 discharges, the Licensee may file for a license amendment to increase the Station No. 1 discharge upon written concurrence of MDFW, NMFS, and USFWS. Prior to filing for a license amendment with the Commission, the Licensee shall consult the Massachusetts Department of Environmental Protection (MDEP) and address any of its comments in the license amendment filing.

From December 1 through June 30, the NRF is defined as the hourly sum of the discharges from 12 hours previous as reported by the: Vernon Hydroelectric Project (FERC No. 1904), Ashuelot River at Hinsdale, NH gauge (USGS 01161000)[57], and Millers River at Erving, MA gauge (USGS 01166500)[58].

The Minimum Flow below Turners Falls Dam may be temporarily modified if required by equipment malfunction or operating emergencies reasonably beyond the control of the Licensee. If the Minimum Flow below Turners Falls Dam is so modified, the Licensee shall notify the Commission, MDEP, MDFW, NMFS, and USFWS as soon as possible, but no later than 10 days after such incident. The Minimum Flow below Turners Falls Dam may also be temporarily modified for short periods upon mutual agreement with the Licensee for the Northfield Mountain Pumped Storage Project (FERC No. 2485), MDEP, MDFW, NMFS and USFWS, and upon 5 days′ notice to the Commission. This flow requirement is consistent with FFP agreement proposed license article A110.

Below Station No. 1

Upon license issuance, the Licensee shall maintain the Total Minimum Bypass Flows below Station No. 1 as presented in Table 9:

Table 9. Summary of minimum flow releases below Station 1

Date	Total Minimum Bypass Flows below Station No. 1[1]
04/01-05/3[1]	If the NRF is ≤ 6,500 cfs, the Total Minimum Bypass Flow below Station No. 1 shall be the NRF. If the NRF is > 6,500 cfs, the Total Minimum Bypass Flow below Station No. 1 shall be 6,500 cfs.
06/01-06/15[1,2]	If the NRF is ≤ 4,500 cfs, the Total Minimum Bypass Flow below Station No. 1 shall be the NRF. If the NRF is > 4,500 cfs, the Total Minimum Bypass Flow below Station No. 1 shall be 4,500 cfs.
06/16-06/30[2]	If the NRF is ≤ 3,500 cfs, the Total Minimum Bypass Flow below Station No. 1 shall be the NRF. If the NRF is > 3,500 cfs, the Total Minimum Bypass Flow below Station No. 1 shall be 3,500 cfs.

[1] One of the upstream fish passage adaptive management measures (AMMs) described in Article A330 calls for increasing the Total Minimum Bypass Flow below Station No. 1 from June 1 to June 15 from 4,500 cfs to 6,500 cfs. If this AMM is enacted, and if the NRF is ≤ 6,500 cfs, the Total Minimum Bypass Flow below Station No. 1 shall be the NRF, subject to the conditions in Article A330. If this AMM is enacted, and the NRF > 6,500 cfs, the Total Minimum Bypass Flow below Station No. 1 is 6,500 cfs, subject to the conditions in Section 7.3.6 (FFP agreement proposed license article A330).

[57] https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=01161000
[58] https://waterdata.usgs.gov/nwis/inventory?agency_code=USGS&site_no=01166500

[2] The amount of flow needed from Station No. 1 from June 1 to June 30 may be modified in the future pending fish passage effectiveness studies. If the Licensee conducts fish passage effectiveness studies, in consultation with the MDFW, NMFS, and USFWS and determines that migratory fish are not delayed by passing a greater percentage of the Total Minimum Bypass Flow below Station No. 1 via Station No. 1 discharge, the Licensee may file for a license amendment to increase the magnitude of Station No. 1 discharge upon written concurrence of MDFW, NMFS, and USFWS.

The Total Minimum Bypass Flow below Station No. 1 may be temporarily modified if required by equipment malfunction or operating emergencies reasonably beyond the control of the Licensee. If the Total Minimum Bypass Flow below Station No. 1 is so modified, the Licensee shall notify the Commission, MDEP, MDFW, NMFS, and USFWS as soon as possible, but no later than 10 days after such incident. The total bypass flow below Station No. 1 may also be temporarily modified for short periods upon mutual agreement with the Licensee for the Northfield Mountain Pumped Storage Project (FERC No. 2485), MDEP, MDFW, NMFS, and USFWS, and upon 5 days′ notice to the Commission.

7.3.1.1 Rationale

Adequate flow is necessary in the bypass reach to attract American shad upstream to the spillway and deep enough to provide a zone-of-passage to the upstream fishway entrance at the dam[59]. Flow in the bypass channel is far field attraction necessary to attract fish away from Cabot Station to the proposed fishway near the Turners Falls Dam. The April and May flow requirements are designed to take advantage of the water that is typically available in the Connecticut River during the upstream migratory period. The conveyance of these flows will originate from the fishway, the spillway Bascule gates, and Station No. 1. However, Station No. 1 may only convey up to 1/3 of the minimum bypass flow to minimize any potential migratory delay in that tailrace.

The maximum hydraulic capacity of Cabot Station is 13,728 cfs. With 6,500 cfs going down the bypass channel, this flow represents a far field attraction flow that is 47%. Many fish passage guidelines documents recommend that far field attraction flow is greater than 10% the river flow (Clay 1995, NMFS 2022, USFWS 2019). The reduced minimum flows in June acknowledge that providing 6,500 cfs down the bypass is less feasible because there is typically less flow in the river, yet still exceeds far field attraction guidance.

The prescribed flows represent our preference for keeping migrating adult American shad out of the power canal and in the Connecticut River. The habitat in the power canal is not suitable for adult shad and their offspring. In addition, the power canal contains multiple withdrawals (both hydroelectric and other) that present a risk of entrainment. Finally, the power canal has multiple high velocity zones that exhaust adult shad and overwhelm juvenile life stages. Keeping adult

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[59] The zone of passage (ZOP) refers to the contiguous area of sufficient lateral, longitudinal, and vertical extent in which adequate hydraulic and environmental conditions are maintained to provide a route of passage through a stream reach influenced by a dam (or stream barrier).

shad out of the power canal reduces the likelihood of injury or mortality for any eggs or and larvae that might be entrained through either Station 1 or the Cabot Station powerhouses.

Relicensing Study 3.3.2 evaluated the upstream movement of adult American shad. After the first year this study was conducted, this report stated that when bypass flows increase fish are 1.22 times more likely to move to the spillway.[60] Relicensing Study 3.3.19 report included Appendix E – Bypass Movement Analysis. This section of the report stated that as the cumulative average flow while present increases by 1,000 cfs over the baseline, fish are nearly 7 times more likely to migrate to the spillway."[61] The agreed upon flows demonstrate the increased likelihood of fish using the spillway entrance as an effective zone of passage.

As with the minimum flow requirement from the dam, this requirement to provide minimum flows from Station No. 1 is also considered far field attraction. The additional flow provided from this powerhouse is intended to attract fish away from the Cabot Station powerhouse and guide them up the bypass reach towards the dams.

7.3.2 Fish Passage Facilities and Consultation (FFP agreement proposed license article A300)

The Licensee shall implement the following fish passage measures on the schedule specified. When due dates cited in this and other articles are in "years after license issuance," this shall mean on the appropriate date in the specified calendar year after license issuance, regardless of the quarter in which the license is issued. For example, "Year 1 after license issuance" begins on the first January 1 following license issuance.

<u>Upstream Fish Passage</u>

a) construct a Spillway Lift at the Turners Falls Dam to be operational no later than April 1 of Year 9 after license issuance.
b) rehabilitate the Gatehouse Trapping facility (sampling facility) to be operational no later than April 1 of Year 9 after license issuance.
c) retire, either by removal or retaining in place, the Cabot Ladder and the power canal portions of the Gatehouse Ladder within 2 years after the Spillway Lift becomes operational.
d) install and operate interim upstream eel passage in the vicinity of the existing Spillway Ladder within 1 year of license issuance and continue operating it until permanent upstream eel passage facilities are operational. The Licensee shall consult MDFW, NMFS, and USFWS on the location and design of the interim eelway(s).
e) conduct up to 2 years of eelway siting studies after the Spillway Lift becomes operational, using a similar methodology to relicensing Study 3.3.4 for both years. Based on the siting survey results, design, construct, operate, and maintain up to two permanent upstream eel passage facilities at the Turners Falls Project no later than 3 years after completing the final siting survey. The Licensee shall consult MDFW, NMFS, and USFWS on the location of the two permanent upstream eel passage facilities. The final eelway siting will take into account the ability to maintain the eelway(s) in light of spillage conditions at the Turners Falls Project. The Licensee will not be required to place any eelways at the foot of any active spillway structures.

[60] Accession # 20170501-5352 page 2-44
[61] Accession # 20190312-5199 page E-3

Downstream Fish Passage

a) Within 4 years of license issuance, replace the existing Cabot Station trashrack structure with a new full depth trashrack with 1-inch clear spacing. The new trashracks will have multiple openings for fish passage, including openings on the top and bottom of the water column. The Licensee will attempt to maximize the hydraulic capacity of these openings within the constraints of the conveyance mechanisms. The Licensee will base detailed design alternatives on the following conceptual design; however, the Parties will remain flexible on design alternatives as necessary to meet fish passage goals.

   The new trashrack will have multiple surface entrances including a) between Cabot Units 2 and 3; b) between Cabot Units 4 and 5; and c) at the right wall of the intake (looking downstream) at Cabot Unit 6. The openings will be 3-feet-wide by 2-feet-deep and will connect to the existing trash trough located behind the racks. Each opening at the top of the trashrack will have an approximate hydraulic capacity of 24 cfs, and the existing trash trough will convey a total hydraulic capacity of approximately 72 cfs from these openings. The new trashrack will have an additional entrance near the bottom at the left wall of the intake (looking downstream) at Unit 1. This entrance will be approximately 3-feet- wide by 3-feet-tall and will connect to a vertical pipe to safely convey fish to the existing trash trough or log sluice. This entrance will be sized to provide a velocity that attracts fish to the bypass relative to the turbine intakes (approximately 5 feet-per-second). In addition to the entrances integral to the new trashrack structure, fish will be conveyed via a new uniform acceleration weir (UAW) and log sluice. The log sluice will be resurfaced to limit turbulence and injury to migrants. A steel panel (or equivalent) will be provided below the UAW to exclude migrants from being delayed in the space below the UAW. Total flow from all downstream passage components at Cabot Station will be 5% (685 cfs) of maximum hydraulic station capacity (13,728 cfs). The conveyance at each bypass entrance will be determined during the design phase.

b) Within 4 years[62] of license issuance, construct a ¾-inch clear-spaced bar rack at the entrance to the Station No. 1 branch canal.

c) Construct a plunge pool downstream of the Turners Falls Dam Bascule Gate No. 1 as part of the construction of the Spillway Lift, to be operational no later than April 1 of Year 9 after license issuance.

Consultation

For any new fish passage facility, the Licensee shall consult and obtain approval from MDFW, NMFS, and USFWS on the facility design and on operation and maintenance procedures. The Licensee shall consult MDFW, NMFS, and USFWS at the 30%, 60%, 90% and 100% design plan milestones. The Licensee shall file the 100% design plans with the Commission, along with documentation of consultation with MDFW, NMFS, and USFWS. If any fish passage adaptive

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[62] Relative to the Cabot Intake Protection and Downstream Passage Conveyance and the Station No. 1 Bar Rack, the times cited are from license issuance based on the time needed to complete construction. The actual first year of operation of these two facilities will depend on when the Commission issues the license. If the License is issued in quarter 1
(Q1, Jan 1-Mar 31) then these two facilities will be operational no later than April 1 of Year 4 after license issuance; if it is issued in Q2 then these two facilities will be operational no later than August 1 of Year 4 after license issuance; and if it is issued after Q2 then these two facilities will be operational no later than April 1 of Year 5 after license issuance.

management measures (AMMs) are implemented as discussed in in Sections 7.3.5 and 7.3.6 (FFP agreement proposed license articles A320 and A330) and require facility design and operation and maintenance procedures, then the Licensee shall follow the same consultation process as the initial fish passage build- out.

The Licensee shall submit design plans to NMFS for review and approval during the conceptual, 30, 60 and 90 percent design stages. The Licensee shall incorporate into their schedule a minimum of 30 days of review time by NMFS for each stage. The Licensee may deviate from the design milestone schedule based on design complexity or permitting constraints; however the deviation requires approval by the resource agencies before filing extension of time requests with the Commission. The Licensee shall allow reasonable time to construct the fishway such that it is operational as prescribed. Once the fishway is constructed, final as-built drawings that accurately reflect the project as constructed shall be filed with NMFS and USFWS.

7.3.2.1 Rationale

Restoration of diadromous fish is a resource goal for the Connecticut River which is consistent with several CRASC and ASMFC plans[63]. Specifically, the CRASC shad Plan has a goal of establishing a minimum of 397,000 adult American shad to exit the Turners Falls project. The requirement for safe, timely and effective fish passage facilities in this licensing proceeding is necessary to support our broader restoration goals for the watershed.

Restoration of anadromous fish is a long-standing resource goal for the Connecticut River watershed. The requirement for dedicated fish passage facilities issued during this licensing proceeding, as well as other hydropower dams throughout the watershed, is necessary to mitigate project related impacts and support our broader restoration goal for the watershed. Upstream fish passage at the Turners Falls Project, and enhanced protection measures at the Northfield Mountain Project, will improve passage conditions within the mainstem river for the benefit of migratory, spawning and rearing habitat for diadromous fish. Further, improvements to upstream fish passage facilities will support the management goals within the identified comprehensive plans for the Connecticut River watershed and the broader species populations.

We further support this position on the factual background herein and the following facts:

a. American shad historical habitat has been identified in the Connecticut River watershed (CRASC 2020)
b. American shad currently have access to the Project area.
c. Dams such as the Turners Falls Dam are an impediment to upstream migration of anadromous fish (74 FR 29300, June 19, 2009; 74 FR 29344, June 19, 2009; 78 FR 48944, August 12, 2013)
d. Properly designed and located fishways, with suitable near-field and far-field attraction are capable of passing each of the target species upstream of dams (Bunt et al. 2012, Larinier 2002, Larinier and Marmulla 2004, USFWS 2019).

[63] See list of Resource Management Plans in Section 10.

The existing fishways at Cabot Station and the spillway are inadequate to mitigate project related impacts or to support management goals. Relicensing study 3.3.2 found that overall shad passage through the power canal was 21.4%. Based on this finding, we are prioritizing the project's bypass reach, or, the Connecticut River itself, as the preferred route of passage for our American shad, Sea Lamprey and American eel[64]. The lift is intended to reduce delay and increase the overall passage efficiency. The gatehouse ladder has a high degree of effectiveness that will allow for management goals to be obtained. The multiple entrances and rack in front of the Cabot Station powerhouse are intended to minimize delay and provide downstream passage that will meet the CRASC shad management plan performance standard.

Dedicated upstream eel passage is necessary to provide migration to rearing habitat upstream of the Project throughout the migratory season. We base this position on the factual background herein and the following:

a. Upstream migrating juvenile eel were observed at the Turners Falls Project.
b. Dams similar to the Turners Falls Dam inhibit the passage of American eel juveniles, including elver and yellow eel (Shepard 2015).
c. Upstream migrating juvenile eels can be effectively passed at hydroelectric projects (Solomon and Beach 2004).
d. These required fishways can function to support passage and prevent injury and mortality of adult eel (Solomon and Beach 2004).

7.3.3 Schedule of Initial Effectiveness Testing, Consultation Process on Effectiveness Testing Study Plans, and Fish Passage Performance Goals (FFP agreement proposed license article A310)

Schedule of Initial Effectiveness Testing

The Licensee shall complete construction of each fish passage facility, operate the fish passage facility for one season (shakedown year), and then conduct representative and quantitative fish passage effectiveness testing per the schedule below (Table 9).

Table 10. Summary of protective measures and the schedule for which each measure should be operational and tested.

Facility	Operational/Shakedown Date	Initial Effectiveness Study Years and Locations to be Tested
Cabot Rack and Downstream Conveyance	Year 4 after license issuance[65]	Years 6-7, the Cabot Downstream Fish Passage Structure and Station No. 1 Rack will be tested.
Station No. 1 Bar Rack	Year 4 after license issuance[1]	

[64] Accession # 20170501-5352 Relicensing Study 3.3.2

[65] Relative to the Cabot Intake Protection and Downstream Passage Conveyance and the Station No. 1 Bar Rack, the times cited are from license issuance based on the time needed to complete construction. The actual first year of operation of these two facilities will depend on when the license is issued. If the license is issued in quarter 1 (Q1, Jan 1-Mar 31) then these two facilities will be operational no later than April 1 of Year 4 after license issuance; if it is issued in Q2 then these two facilities will be operational no later than August 1 of Year 4 after license issuance; and if it is issued after Q2 then these two facilities will be operational no later than April 1 of Year 5 after license issuance.

Facility	Operational/Shakedown Date	Initial Effectiveness Study Years and Locations to be Tested
Turners Falls Dam Plunge Pool	Year 9 (by April 1st) after license issuance	Years 10-11, the Turners Falls Plunge Pool and Spillway Lift will be tested.
Spillway Lift	Year 9 (by April 1st) after license issuance	
Rehabilitate Gatehouse Trapping Facility (Sampling Facility)	Year 9 (by April 1st) after license issuance	Not Applicable
Retire Cabot Ladder and Portions of Gatehouse Ladder	No later than Year 11 after license issuance (tied to within 2 years after the Spillway Lift becomes operational).	Not Applicable
Permanent Eel Passage Structure(s)	Year 13 after license issuance	Year 14, the internal efficiency of the permanent eel passage structure(s) will be tested.

Consultation Process on Effectiveness Study Plans

For any initial fish passage effectiveness studies and any subsequent fish passage effectiveness studies required after implementing any AMMs described in Article A320 and A330, the Licensee shall provide the effectiveness study plans to MDFW, NMFS, and USFWS and request comments on the study plans within 30 days. The Licensee shall consult MDFW, NMFS, and USFWS and obtain their approval on the study plans before conducting the effectiveness studies. The Licensee shall file the effectiveness study plans with the Commission, along with any consultation records.

Fish Passage Performance Goals

The Licensee shall compare the effectiveness study results to the following fish passage performance goals:

Downstream Passage

- 95% of juvenile American shad arriving 500 meters upstream of the Turners Falls Dam survive migration past the Turners Falls Project within 24 hours.
- 95% of adult American shad arriving 1 kilometer upstream of the Turners Falls Dam survive migration past the Turners Falls Project within 24 hours.
- 95% of American eel arriving 1 kilometer upstream of the Turners Falls Dam survive migration past the Turners Falls Project within 48 hours of a flow event. The definition of what constitutes a flow event shall be determined by the Licensee in consultation with MDFW, NMFS and USFWS during effectiveness study plan development.

The downstream passage at the Turners Falls Project is project wide and will include all routes of passage (e.g., spill, fish bypass, and turbine passage).

Upstream Passage

- 75% of adult American shad arriving 500 meters below Cabot Station successfully pass into the Turners Falls Impoundment within 48 hours. The 75% passage efficiency for American shad will be based on the first 90% of the American shad run. The effectiveness testing will be conducted over the entire adult American shad run, but the 75% passage efficiency goal will be based on the first 90% of the run as determined by the Licensee as *a posteriori* analysis of run counts. The Licensee will determine where and how run counts will occur in consultation with MDFW, NMFS and USFWS during effectiveness study plan development. The Licensee, MDFW, NMFS and USFWS will revisit whether the 75% passage efficiency goal is achievable or should be reduced, and whether the 48-hour time-to-pass goal is achievable or should be increased, after implementing the first (Tier 1) and second (Tier 2) round of AMMs as described in Section 7.3.6 (FFP agreement proposed license article A330).
- An internal passage efficiency of 95% within the permanent passage structure(s) for American eel. The 95% internal efficiency assumes it is possible for the Licensee to successfully tag up-migrating eels. The Licensee shall consult MDFW, NMFS, and USFWS on the appropriate size American eel, based on available technology, to test the internal efficiency.

7.3.3.1 Rationale

CRASC (2020) states that state and federal management agencies are committed to restoring American shad in the Connecticut River basin[66]. These performance standards ensure that safe, timely and effective passage are achieved. CRASC developed and adopted the fish passage performance standards for the purpose of achieving management goals for American shad.

7.3.4 Downstream Fish Passage – Initial Effectiveness Studies, Adaptive Management Measures and Subsequent Effectiveness Studies (FFP agreement proposed license article A320)

<u>Initial Effectiveness Studies- Years 6 and 7</u>

The Licensee shall conduct initial effectiveness testing in Years 6 and 7 (see FFP agreement proposed license article 310) to evaluate the fish passage survival and time-to-pass of the newly constructed Station No. 1 bar rack and Cabot Rack and Conveyance Structure and compare the findings at individual components (e.g., Cabot Station and Station No. 1) to the performance goals in Article 310. The Licensee shall develop reports by February 1 of Years 7 and 8 for adult American shad and by April 1 of Years 7 and 8 for juvenile American shad and adult American eel summarizing the survival study findings and provide it to MDFW, NMFS, and USFWS. The Licensee shall consult MDFW, NMFS, and USFWS on the effectiveness study results and determine what, if any, adaptive management measures (AMMs) may be implemented from the table below. The Licensee will target any AMMs to those locations where fish passage performance goals are not achieved. The Licensee shall file a report with the Commission to include the effectiveness testing report and documentation of any AMMs agreed to by the Licensee, MDFW, NMFS, and USFWS, along with any consultation records. If warranted, the Licensee shall consult MDFW, NMFS, and USFWS on when to implement the Round 1 AMMs at Station No. 1 and/or Cabot Station.

[66] Accession # 20200302-5300

Effectiveness Testing of Round 1 AMMs at Station No. 1 and/or Cabot Station and Initial Effectiveness Testing at Turners Falls Dam Plunge Pool- Years 10 and 11

The Licensee shall conduct Round 1 AMM effectiveness testing at Station No. 1 and/or Cabot Station and initial effectiveness testing of the Turners Falls Dam plunge pool in Years 10 and 11. The Licensee shall:

- Compare the effectiveness study results to the performance goals in Section 7.3.4 (FFP agreement proposed license article 310).
- Provide the effectiveness study report to MDFW, NMFS, and USFWS by February 1 of Years 11 and 12 for adult American shad and by April 1 of Years 11 and 12 for juvenile American shad and adult American eel summarizing the survival study findings.
- Consult MDFW, NMFS, and USFWS to determine what, if any AMMs may be implemented from the table below and target AMMs to those locations where passage performance goals are not achieved.
- File the effectiveness study report and documentation of any AMMs with the Commission.

If a second round of adaptive management measures are warranted, the Licensee shall consult MDFW, NMFS and USFWS on when to implement any Round 2 AMMs at Station No. 1 and/or Cabot Station and Round 1 AMMs at the Turners Falls Dam plunge pool.

Effectiveness Testing of Round 2 AMMs at Station No. 1 and/or Cabot Station and Round 1 AMMs at Turners Falls Dam Plunge Pool- Years 14 and 15

The Licensee shall conduct Round 2 AMM effectiveness testing at Station No. 1 and/or Cabot Station and Round 1 AMMs at the Turners Falls Dam plunge pool in Years 14 and 15. The Licensee shall follow the same consultations steps bulleted above; however, the Licensee shall provide the effectiveness study report to MDFW, NMFS, and USFWS by February 1 of Years 15 and 16 for adult American shad and by April 1 of Years 15 and 16 for juvenile American shad and adult American eel.

If a third round of adaptive management measures are warranted, the Licensee shall consult MDFW, NMFS and USFWS on when to implement any Round 3 AMMs at Station No. 1 and/or Cabot Station and Round 2 AMMs at the Turners Falls Dam plunge pool.

Effectiveness Testing of Round 3 AMMs at Station No. 1 and/or Cabot Station and Round 2 AMMs at Turners Falls Dam Plunge Pool- Years 18 and 19

The Licensee shall conduct Round 3 AMM effectiveness testing at Station No. 1 and/or Cabot Station and Round 2 AMMs at the Turners Falls Dam plunge pool in Years 18 and 19. The Licensee shall follow the same consultations steps bulleted above however, the Licensee shall provide the effectiveness study report to MDFW, NMFS, and USFWS by February 1 of Years 19 and 20 for adult American shad and by April 1 of Years 19 and 20 for juvenile American shad and adult American eel.

Table 11. Downstream Adaptive Management Measures

Adaptive Management Measure (if needed)	Timing
<u>Turners Falls Dam</u> • Modify the bascule gate setting(s) and resultant spill (rate, location). <u>Station No. 1</u> • Install a behavioral barrier. <u>Cabot Station</u> • Modify the downstream passage conveyance design to reduce impact velocities and shear stresses (e.g., pump-back system; gradient reduction; piping, lining);	Initial Effectiveness Testing at Cabot Station and Station No. 1: **Years 6-7**. Initial Effectiveness Testing at Turners Falls Dam Plunge Pool and Round 1 Effectiveness Testing for any AMMs implemented at Cabot Station and/or Station No. 1 (if needed): **Years 10-11**. Round 2 AMM Effectiveness Testing at Cabot Station and/or Station No. 1 (if needed) and Round 1 Effectiveness
Adaptive Management Measure (if needed)	**Timing**
• Modify the downstream passage conveyance design to increase water depth; • Modify the area of flow convergences of the trash trough, Uniform Acceleration Weir, eel pipe, and sluiceway; • Modify the area of flow convergence of the sluiceway and the receiving waters in the Connecticut River (e.g., adjustable lip, velocity control, and plunge pool depth)	Testing at Turners Falls Dam Plunge Pool (if needed): **Years 14-15** Round 3 AMM Effectiveness Testing at Cabot Station and/or Station No. 1 (if needed) and Round 2 Effectiveness Testing at Turners Falls Dam Plunge Pool (if needed): **Years 18-19**

7.3.4.1 Rationale

The purpose of these measures is to ensure that the project is providing high downstream survival for species under our jurisdiction. Research has found that high downstream survival is critical to restoring depressed populations of shad (CRASC 2020, Stich et al. 2018). Adaptive management measures will be based on effectiveness testing study results. The results from the effectiveness testing will be used to identify areas within the project where delay is occurring, such as excessive milling behavior, or where fish are not effectively finding fishway entrances. We will use the results of the effectiveness testing as a diagnostic tool that identifies unforeseen issues with the prescribed fish passage measures allowing the Licensee, the Commission, and the resources agencies flexibility to address these challenges. Throughout the course of a 50-year license, there may be situations that require adaptive management including, but not limited to, the status of diadromous species, operational demands of the Project, and changes to environmental conditions as a result of changes in climate. The adaptive management plan we have prescribed allows the Licensee to plan for potential mitigating actions while facilitating our dynamic management of the fisheries resource. In other words, the effectiveness testing data will drive where adaptive management measures need to occur.

7.3.5 Upstream Fish Passage Initial Effectiveness Studies, Adaptive Management Measures, and Subsequent Effectiveness Testing (FFP agreement proposed license article A330)

<u>Initial Effectiveness Testing of Adult American shad- Years 10 and 11</u>

The Licensee shall conduct initial effectiveness testing in Years 10 and 11 (see Article 310) to evaluate upstream fish passage efficiency and time-to-pass at the Cabot Station tailrace, Rawson Island, Station No. 1 tailrace, and at the Spillway Lift through the Gatehouse Ladder exit and compare the findings to the performance goals in Article 310. The Licensee shall develop a report by February 1 of Years 11 and 12 for adult American shad summarizing the effectiveness study findings and provide it to MDFW, NMFS, and USFWS. The Licensee shall consult MDFW, NMFS, and USFWS on the effectiveness study results and determine what, if any, Tier 1 adaptive management measures (AMMs) from the table below may be implemented.

The Licensee′s implementation of Tier 1 AMMs, if warranted, will be informed by the initial effectiveness testing results. While the overall passage efficiency goal is 75% in 48 hours, there are four locations (or nodes) of interest, where the Licensee can provide enhancements as part of the AMMs for upstream passage efficiency including at Cabot Station, Rawson Island, Station No. 1 and the Spillway Lift. If the individual passage efficiency at all four locations is 90% or higher, or if the overall passage efficiency goals are met, no Tier 1 AMMs will be implemented. If the individual passage efficiency at any of the four locations is less than 90%, the Licensee shall target Tier 1 enhancements to achieve an individual location passage efficiency of 90% or higher. However, if the Licensee, MDFW, NFMS, and USFWS agree that improvements can be made at other nodes that would improve the overall passage efficiency a comparable amount as an enhancement to achieve an individual location/node to at least 90%, then that enhancement can be implemented.

If adaptive management measures are warranted, the Licensee shall consult MDFW, NMFS and USFWS on when to implement the Tier 1 AMMs.

<u>Tier 1 Adaptive Management Measures Effectiveness Testing of Adult American shad- Years 13 and 14</u>

The Licensee shall conduct Tier 1 AMM effectiveness testing in Years 13 and 14 in accordance with the following:

- The Licensee shall compare the effectiveness study results to the performance goals in Section 7.3.4 (FFP agreement proposed license article A 310).
- The Licensee shall provide the effectiveness study report to MDFW, NMFS and USFWS by February 1 of Years 14 and 15.
- At the election of the Licensee, the Licensee may provide the effectiveness study report to an Independent Peer Review Panel (IPRP) of experts to evaluate the study results. The IPRP will consist of one member selected by the Licensee, one member selected collectively by MDFW, NMFS, and USFWS, and one member selected jointly by the Licensee, MDFW, NMFS, and USFWS. After the IPRP's review of the effectiveness study findings, the IPRP will evaluate the ability to achieve the upstream fish passage performance goals in Article 310 and provide a summary report of its findings to the Licensee, MDFW, NMFS, and USFWS within 3 months of receiving the effectiveness study report.
- If the 75% passage efficiency within a48-hour time frame-to-pass performance goal is not met, the Licensee shall consult MDFW, NMFS, and USFWS to determine whether the 75% passage efficiency goal is achievable or should be reduced, and/or the 48-hour time-to-pass goal is achievable or should be increased.

Any modifications to the 75% passage efficiency/48-hour time-to-pass must be agreed to by the Licensee, MDFW, NMFS, and USFWS.

- The Licensee shall consult MDFW, NMFS, and USFWS to determine what, if any, AMMs will be implemented.
- The Licensee shall file the effectiveness study report and documentation of any AMMs with the Commission.

If adaptive management measures are warranted, the Licensee shall consult MDFW, NMFS and USFWS on when to implement either the remaining Tier 1 AMMs and/or Tier 2 AMMs.

<u>Tier 1 and/or Tier 2 Adaptive Management Measures Effectiveness Testing of Adult American shad- Years 18 and 19</u>

The Licensee shall conduct any Tier 1 and/or Tier 2 AMM effectiveness testing in Years 18 and 19 and conduct the following:

- The Licensee shall compare the effectiveness study results to the performance goals in Section 7.3.4 (FFP agreement proposed license article 310).
- The Licensee shall provide the effectiveness study report to MDFW, NMFS and USFWS by February 1 of Years 19 and 20.
- The Licensee shall file the effectiveness study report and documentation of any AMMs with the Commission.

<u>Effectiveness Testing of Juvenile American eel- Year 14</u>

The Licensee shall conduct effectiveness testing in Year 14 to evaluate the internal efficiency of the permanent eelway structure(s) and compare the findings to the performance goals in Section 7.3.4 (FFP agreement proposed license article A310).

7.3.5.1 Rationale

The purpose of effectiveness testing is to understand the degree to which upstream passage performance measures are being met. These results from these studies will be used to determine whether or not any adaptive management measures need to be taken in order to ensure that sufficient numbers of adult upstream migrating eel are exiting into the Turners Falls headpond.

Adaptive management measures will be based on effectiveness testing study results. The results from the effectiveness testing will be used to identify areas within the project where delay is occurring or where fish are not effectively finding fishway entrances. We will use the results of the effectiveness testing as a diagnostic tool that identifies unforeseen issues with the prescribed fish passage measures allowing the Licensee, the Commission, and the resources agencies flexibility to address these challenges. Throughout the course of a 50-year license, there may be situations that require adaptive management including, but not limited to, the status of diadromous species, operational demands of the Project, and changes to environmental conditions as a result of climate change. The adaptive management plan we have prescribed allows the Licensee to plan for potential mitigating actions while facilitating our dynamic management of the fisheries resource. In other words, the effectiveness testing data will drive where adaptive management measures need to occur.

7.3.6 Fishway Operating Periods (FFP agreement proposed license article A340)

The license shall operate the fishways during the periods stated in Table 12.

Table 12. Fish passage operational dates for fishways in the Connecticut River watershed

Fishway	Required operational period
Upstream eel passage	May 1 to November 15
Upstream anadromous	April 4 to July 15
Downstream anadromous	April 4 to November 15

Future refinement of the timing on an annual or permanent basis may be made by the MDFW, NMFS, and USFWS based on new information and after consultation with the Licensee.

7.3.6.1 Rationale

The agreed upon operating period is designed to protect our Trust species during their migration season. These dates are consistent with the Schedule of Operations requirements that the USFWS Connecticut River Coordinator has sent to federally licensed fishway operators on the Connecticut River for several years. Dalton et al. (2022) recommended the need for adaptive management strategies due to climate change and that these strategies are updated as new information becomes available.

7.3.7 Fish Passage Facilities Operations and Maintenance Plan (FFP agreement proposed license article A350)

The Licensee shall develop and implement a Fish Passage Facilities Operations and Maintenance Plan (FOMP). The FOMP shall detail how and when the fishways will be operated and describe routine maintenance activities that will occur both during and outside of the fish passage season. The FOMP will include a provision to provide annual fishway Operation and Maintenance (O&M) reports that summarize the status of the fish passage facilities, identify needed repairs or equipment replacement, etc. The O&M report shall be submitted to the MDFW. NMFS, and USFWS by January 31 annually. The FOMP shall be developed in consultation with and require approval by the MDFW, NMFS, and USFWS prior to submitting the final FOMP to the FERC for approval.

The FOMP shall be completed no later than 6 months after license issuance for the interim upstream American eel passage that will be placed into service within 1 year of license issuance per Article A300, and for existing fish passage facilities (i.e., Cabot downstream fish bypass; Cabot Ladder; Spillway Ladder; and Gatehouse Ladder). Thereafter, the same FOMP shall be amended by the Licensee within 6 months prior to the following:

- Any fish passage structures are placed into service, as outlined in the schedule in Section 7.3.3 (FFP agreement proposed license article A300);
- Any AMMs are placed into service, as outlined in the schedule in Sections 7.3.5 and 7.3.6 (FFP agreement proposed license articles A320 & A330) and,
- Any operational or facilities modifications resulting from new information obtained from operation of the fish passage facilities pursuant to the annual O&M reports.

FOMP provisions dealing with facilities that are decommissioned over the term of the license may be dropped from revisions of the FOMP after decommissioning.

7.3.7.1 Rationale

Operation and maintenance plans are a standard license article, and are necessary in order to ensure that the fishways are being operated and maintained in a manner that protects species under our jurisdiction. The FOMP is an important component in ensuring that all fish passage license article requirements as well as fish passage guidelines are indeed being met. This plan will develop institutional knowledge for resource agencies, facilitates adaptive management and will memorialize a consensus understanding of fish passage effectiveness at the Project.

7.3.8 Reservation of Authority

This prescription for fishways was developed in response to the proposals being considered by the Commission in this proceeding, our current policies and mandates, and our understanding of current environmental conditions at the Project, and the Settlement Agreement (FFP) filed by NMFS and the licensee on March 31, 2023[67]. We have agreed not to exercise any reserved authority regarding passage for upstream or downstream passage for 25 years. If any of these factors change over the term of the license, then we may need to alter or add to the measures prescribed in this licensing process. Therefore, we hereby reserve authority under Section 18 of the FPA to prescribe such additional or modified fishways at those locations and at such times as we may subsequently determine are necessary to provide for effective upstream and downstream passage of diadromous fish through the Project facilities. This reservation of authority includes, without limitation, our authority to amend this fishway prescription upon approval by us of such plans, designs, and completion schedules pertaining to fishway construction, operation, maintenance, and monitoring as may be submitted by the Licensee in accordance with the terms of the license articles containing such fishway prescriptions. We propose to reserve authority by requesting that the Commission include the following condition in any license it may issue for the Project:

> *Pursuant to Section 18 of the Federal Power Act, the licensee shall build the fishways described in the Department of Commerce's Prescription for Fishways at the Turners Falls Hydroelectric Project (FERC No.1889) and the Northfield Mountain Pumped Storage Project (P-2485). The Secretary of Commerce reserves her authority to prescribe additional or amended fishways as she may decide are required in the future.*

8 MANDATORY TERMS AND CONDITIONS FOR THE NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT (P-2485)

8.1 <u>Section 18 Prescription for Fishways for American shad and American eel</u>

We hereby submit the following preliminary prescription for fishways pursuant to Section 18 of the FPA, 16 USC §811. Section 18 of the FPA states in relevant part that, "the Commission must require the construction, maintenance, and operation by a Licensee of...such fishways as may be

[67] Accession # 20230331-5600

prescribed by the Secretary of Commerce or the Secretary of the Interior." Congress provided guidance on the term "fishway" in 1992 when it stated as follows:

> "*The items which may constitute a 'fishway' under Section 18 for the safe and timely upstream and downstream passage of fish must be limited to physical structures, facilities, or devices necessary to maintain all life stages of such fish, and Project operations and measures related to such structures, facilities, or devices which are necessary to ensure the effectiveness of such structures, facilities, or devices for such fish.*" Pub.L. 102-486, Title XVII, § 1701(b), Oct. 24, 1992.

We base the following mandatory fishway prescription on the best biological and engineering information available at this time, as described in the explanatory statements that accompany each prescription. We developed the basis for this prescription over a period of several years by our biological and engineering staff, in consultation with the Licensee, the USFWS and other entities that participated both in this relicensing proceeding. We fully considered a broad array of issues in formulating the preliminary prescription for fishways including the terms of our offer of settlement submitted to the Commission pursuant to 18 CFR 385.602 . Consideration for this analysis is documented in the Administrative Record as submitted with the Commission. Our conclusion that the prescription for fishways is justified is based on, but not limited to, the following primary points: (1) numerous long-standing resource agency management and restoration goals are achieved through fish passage, (2) a well- documented historical presence of robust diadromous fish populations within the Connecticut River watershed prior to dam construction, (3) professional experience across the region demonstrates that diadromous fish will be motivated to migrate above barriers when effective passage is provided, (4) access to the spawning, rearing and migration habitat above the Northfield Mountain Pumped Storage Project is necessary for the full restoration of diadromous fish, (5) consideration of the cumulative impacts on migratory fish and their habitat resulting from a heavily dammed riverine system, and (6) state and federal comprehensive plans indicate the significant potential for diadromous fish populations in the Connecticut River watershed once fish passage and habitat restoration is accomplished. Specific citations and detailed explanations in support of these reasons are found in the text of this prescription.

We support each prescription measure with substantial evidence contained in the record of pre-filing consultation, and subsequent updates, compiled and submitted in accordance with the Commission's procedural regulations. The explanatory statements included with each prescription summarize the supporting information and analysis supporting the prescription. We include an index to the administrative record for this filing herein, and reserve the right to file updated and supplemental supporting information as needed.

8.1.1 Fish Intake Protection and Consultation (FFP agreement proposed license article B200)

Intake Protection

The Licensee shall install a barrier net in front of the Northfield Mountain tailrace/intake, having 3/8-inch mesh on the top and ¾-inch mesh on the bottom. The barrier net design shall be based on the conceptual design in the Amended FLA filed with the Commission in December 2020, as modified through consultation with MDFW, NMFS, and USFWS, from June 1 to November 15 to protect out- migrating American shad and adult American eel, to be operational no later than June 1 of Year 7 after license issuance.

Consultation

The Licensee shall consult and obtain approval from MDFW, NMFS, and USFWS on the barrier net design and on operation and maintenance procedures. The Licensee shall consult MDFW, NMFS, and USFWS at the 30%, 60%, 90% and 100% design plan milestones. The Licensee shall file the 100% design plans with the Commission, along with documentation of consultation with MDFW, NMFS, and USFWS.

8.1.1.1 Rationale

The barrier net is intended to minimize juvenile and adult American shad and adult American eel from being entrained into the upper reservoir that, in turn, will reduce mortality to these life stages. During the design review process, steps will be taken to ensure that juvenile impingement is minimized to the maximum extent possible.[68] The operational period of June 1 to November 15 is based on data indicating when these species are migrating. The upper 3/8 inch mesh is intended to minimize juvenile shad and river herring from entrainment into the Upper Reservoir. The ¾ inch mesh is intended to provide behavioral deterrence that in turn will minimize entrainment for migratory species that in the vicinity of the intake structure.

In 2019, FERC issued a new license for the Ludington Pumped Storage Hydroelectric Project (P-2680). License article 402 required the installation of a fish barrier net and License article 403 required exclusion effectiveness monitoring[69]. The licensee filed its monitoring report at the end of 2020 stating that the 3-year rolling average for excluding fish over 5-inches in length was 91%. Small alewife (from 4 to 5 inches) effectiveness had an average of 86% and large alewife (greater than 5 inches) had an average effectiveness of 92%.[70] These data indicate that barrier nets can prevent juvenile shad from being entrained and lost to the population.

8.1.2 Initial Intake Protection Effectiveness Testing and Fish Passage Performance Goals (FFP agreement proposed license article B210)

Initial Effectiveness Testing

The Licensee shall complete construction of the Northfield Mountain barrier net, operate the barrier net for one season (shakedown year), and conduct representative and quantitative effectiveness testing in Years 10 and 11 to evaluate the downstream fish passage survival and time-to-pass compared to the performance goals below.

Consultation Process on Effectiveness Study Plans

For any initial fish passage effectiveness studies and any subsequent fish passage effectiveness studies required after implementing any AMMs described in Article B220, the Licensee shall provide the effectiveness study plans to MDFW, NMFS, and USFWS and request comments on the study plans within 30 days. The Licensee shall consult MDFW, NMFS, and USFWS and

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[68] We note that this net will not prevent entrainment of ichthyoplankton American shad. The agreed upon Ichthyoplankton Mitigation Fund in the Settlement Agreement is designed to mitigate this documented impact.
[69] Accession # 20190606-3058
[70] Accession # 20201218-5047 (pages 26-28)

obtain their approval on the study plans before conducting the effectiveness study. The Licensee shall file the effectiveness study plans with the Commission, along with any consultation records.

Fish Passage Performance Goals

The Licensee shall compare the effectiveness study results to the following fish passage performance goals:

- 95% of juvenile American shad arriving 500 meters upstream of the Northfield Mountain Pumped Storage Project tailrace survive migration past the Northfield Mountain Pumped Storage Project tailrace within 24 hours.
- 95% of adult American shad arriving 1 kilometer upstream of the Northfield Mountain Pumped Storage Project tailrace survive migration past the Northfield Mountain Pumped Storage Project tailrace within 24 hours.
- 95% of American eel arriving 1 kilometer upstream of the Northfield Mountain Pumped Storage Project tailrace survive migration past the Northfield Mountain Pumped Storage Project tailrace within 48 hours of a flow event. The definition of what constitutes a flow event shall be determined by the Licensee in consultation with MDFW, NMFS, and USFWS during effectiveness study plan development.

8.1.2.1 Rationale

These standards are derived from the stated objectives in the CRASC American shad Management Plan.

On June 29, 2018, FERC wrote in its Environmental Assessment for the American Tissue Project, in Maine the following[71]:

> *Commerce and Interior have not included any specific performance standards that would be used to test the effectiveness of the fish passage facilities… Without specific performance standards to analyze, there is no basis for assessing the benefits of effectiveness testing for fish passage and determining whether effectiveness testing would or would not provide benefits to alosines"*

The purpose of this effectiveness testing is to determine whether the net does or does not meet the performance standards necessary to achieve CRASC stated goals for the American shad population[72].

8.1.3 Downstream Fish Passage- Initial Effectiveness Studies, Adaptive Management Measures and Subsequent Effectiveness Studies (FFP agreement proposed license article B220)

Initial Effectiveness Studies- Years 10 and 11

The Licensee shall conduct initial effectiveness testing in Years 10 and 11 (Article B210) to evaluate the fish passage survival and time-to-pass of the newly constructed barrier net and compare the findings to the performance goals in Article B210. The Licensee shall develop a report by February 1 of Years 11 and 12 for adult American shad and by April 1 of Years 11 and 12 for juvenile American shad and adult American eel summarizing the survival study findings and provide it to MDFW, NMFS, and USFWS. The Licensee shall consult MDFW, NMFS, and

[71] Accession # 20180629-3008
[72] Accession # 20200302-5300

USFWS on the effectiveness study results and determine what, if any, adaptive managements measures (AMMs) may be implemented from the table below. The Licensee shall file a report with the Commission to include the effectiveness testing report and documentation of any AMMs agreed to by the Licensee, MDFW, NMFS, and USFWS, along with any consultation records. If implementation of an adaptive management measure may be warranted, the Licensee shall consult MDFW, NMFS and USFWS on when to implement any Round 1 AMMs.

Effectiveness Testing of Round 1 AMMs - Years 14 and 15

The Licensee shall conduct Round 1 AMM effectiveness testing in Years 14 and 15. The Licensee shall:

- Compare the effectiveness study results to the performance goals in Article B210.
- Provide the effectiveness study report to MDFW, NMFS, and USFWS by February 1 of Years 15 and 16 for adult American shad and by April 1 of Years 15 and 16 for juvenile American shad and adult American eel.
- Consult MDFW, NMFS, and USFWS to determine what, if any AMMs may be implemented from the table below.
- File the effectiveness study report and documentation of any AMMs with the Commission.

If a second round of adaptive management may be warranted, the Licensee shall consult MDFW, NMFS and USFWS on when to implement any Round 2 AMMs.

Effectiveness Testing of Round 2 AMMs - Years 17 and 18

The Licensee shall conduct Round 2 AMM effectiveness testing in Years 17 and 18. The Licensee shall follow the same consultations steps bulleted above; however; the Licensee shall provide the effectiveness study report to MDFW, NMFS, and USFWS by February 1 of Years 18 and 19 for adult American shad and by April 1 of Years 18 and 19 for juvenile American shad and adult American eel (Table 12).

Table 13. Downstream Adaptive Management Measures

Adaptive Management Measure (if needed)	Timing
Northfield Mountain Intake/Tailrace Alter the arrangement and size of the net panels (e.g. extend depth of the smaller panels). Improve maintenance measures for the net.	Initial Effectiveness Testing of Barrier Net: Years 10-11. Round 1 AMM Effectiveness Testing (if needed): Years 14-15 Round 2 AMM Effectiveness Testing (if needed): Years 17-18

8.1.3.1 Rationale

The purpose of effectiveness testing is to understand how well the intake protection is working. These results from these studies will be used to determine any adaptive management measures that may need to be taken in order to ensure that migrating American shad and American eel are not being entrained to the Upper Reservoir, and to ensure high escapement rates.

8.1.4 Fishway Operating Periods (FFP agreement proposed license article B230)

The Licensee shall operate the barrier net for downstream passage from June 1 to November 15.[73]

8.1.4.1 Rationale

The agreed upon operating period is designed to protect species under our jurisdiction during their migration season.

8.1.5 Fish Passage Facility Operation and Maintenance Plan for Barrier Net (FFP agreement proposed license article B240)

The Licensee shall develop and implement a Fish Passage Facilities Operations and Maintenance Plan (FOMP) for the barrier net. The FOMP shall detail how and when the barrier net will be operated and describe routine maintenance activities that will occur both during and outside of the downstream fish passage season. The FOMP will include a provision to provide annual fishway Operation and Maintenance (O&M) reports that summarize the status of the barrier net, identify needed repairs or equipment replacement, etc. The O&M report shall be submitted to the MDFW, NMFS, and USFWS by January 31 annually. The FOMP shall be developed in consultation with and require approval by the MDFW, NMFS, and USFWS prior to submitting the final FOMP to the FERC for approval.

The FOMP shall be completed no later than 6 months prior to the barrier net being placed into service, as outlined in the schedule in Article B200. Thereafter, the same FOMP shall be amended by the Licensee within 6 months prior to the following:

- Any AMMs are placed into service, as outlined in Articles B220; and,
- Any operational or facility modifications resulting from new information obtained from operation of the barrier net pursuant to the annual O&M reports.

8.1.5.1 Rationale

Operation and maintenance plans are a standard license article. In addition, such a plan is necessary for our agency to reference in order to ensure that the intake protection is being operated and maintained in a manner that protects migratory species that encounter this project. This plan will be referenced when inspections occur. Should biofouling occur or any damage to the intake occur, this plan will ensure that such matters are addressed in a timely manner.

8.1.6 Reservation of Authority

This prescription for fishways was developed in response to the proposals being considered by the Commission in this proceeding, our current policies and mandates, our understanding of current environmental conditions at the Project, and the Settlement Agreement (FFP) filed by NMFS and the licensee on March 31, 2023[74]. If any of these factors change over the term of the license, then we may need to alter or add to the measures prescribed in this licensing process. Therefore, we hereby reserve authority under Section 18 of the FPA to prescribe such additional or modified fishways at those locations and at such times as we may subsequently determine are

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[73] Future refinement of the timing may be made by the MDFW, NMFS, and USFWS based on new information and after consultation with the Licensee

[74] Accession # 20230331-5600

necessary to provide for effective upstream and downstream passage of diadromous fish through the Project facilities. This reservation of authority includes, without limitation, our authority to amend this fishway prescription upon approval by us of such plans, designs, and completion schedules pertaining to fishway construction, operation, maintenance, and monitoring as may be submitted by the Licensee in accordance with the terms of the license articles containing such fishway prescriptions. We propose to reserve authority by requesting that the Commission include the following condition in any license it may issue for the Project:

> *Pursuant to Section 18 of the Federal Power Act, the licensee shall build the fishways described in the Department of Commerce's Prescription for Fishways at the Turners Falls Hydroelectric Project (FERC No.1889) and the Northfield Mountain Pumped Storage Project (P-2485). The Secretary of Commerce reserves his authority to prescribe additional or amended fishways as he may decide are required in the future.*

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Attachment B:
Species Life History Summaries

American shad

The American shad is the largest member of the herring family, averaging between 17 and 24 inches in length and between 3 and 6 pounds in weight at sexual maturity (Merrimack River Technical Committee (MRTC 1997). The American shad's range extends along the East Coast from the Bay of Fundy, Canada to Florida (Stier and Crance 1985). American shad is considered in the marine environment to be pelagic and highly migratory, moving between summer feeding areas and overwintering areas (ASMFC 2009). The species exhibits strong homing to its natal river and this has led to the development of discrete spawning stocks (Hasselman et al. 2013). Mature adults home back to natal rivers to spawn in freshwater habitat typically as males at age-4 and age-5 and as females at age-4 and age-5 for first time spawners.[75]. A latitudinal variation in the ability to spawn more than once (iteroparity) occurs from Cape Hatteras, North Carolina and northward, with rates in repeat spawner proportions generally increasing in that direction(Limburg et al. 2003). The spawning run typically lasts 2 to 3 months, with the Connecticut River stock entering the river between late March and early April, depending on the environmental conditions.[76]. River entry is often associated with river temperatures reaching approximately 10°C (Leggett 1976). American shad is a broadcast spawner and eggs are initially semi-buoyant, becoming demersal and gradually sinking to the substrate. Connecticut River female fecundity has been determined to average 303,000 eggs with a standard deviation of 75,000 (McBride et al. 2016). Shad are batch spawners, with Connecticut River females averaging 6.7 batches and 45,950 eggs per batch (McBride et al. 2016). Spawning activity is primarily nocturnal and has been noted as occurring among habitat types (ASMFC 2009). American shad spawn repeatedly, typically in water temperatures ranging from 15 to 23°C, with eggs developing over time in relation to water temperature (ASMFC 2009). Marcy (1976) found that eggs developing in water temperatures from 14° to 20°C hatched in approximately 3 days. Yolk sac larvae transition to first feeding larvae after a period of 4 to 7 days (water temperature dependent) at a size of 0.4 to 0.5 inches (ASMFC 2009).

Juvenile shad may use a variety of habitats as they grow and feed on zooplankton and are also opportunistic users of other prey items (ASMFC 2009). The growth rate of juvenile shad has been shown to be consistently faster in upstream areas compared with downstream areas in the Connecticut River main stem and in comparison to the Farmington River. Juvenile outmigration has been reported to occur after a period of 80 days, which corresponded to a length of approximately 3 inches (O'Donnell and Letcher 2008). Decreasing water temperature has also been correlated with the peak juvenile outmigration; on the Connecticut River (Marcy 1976). O'Leary and Kynard (1986) first sampled juvenile migrants at the Holyoke Dam when water temperature was 19°C, with the number of juveniles sampled peaking at temperatures between 14 and 9°C, and migration ending as water temperatures fell to between 10 and 8°C. While information on American shad in the marine environment is more limited, three main offshore overwintering areas have been identified: 1) off the Scotian Shelf/Bay of Fundy; 2) Middle Atlantic Bight; and 3) off the Florida Coast (Dadswell et al. 1987). Summer feeding areas contain mixed stocks that aggregate in the upper Bay of Fundy and Gulf of Maine, the St. Lawrence estuary, and off Newfoundland and Labrador (Dadswell et al. 1987). American shad size, schooling behavior, and timing of migration (up- and downstream) are key factors in

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designing, locating, and timing the operation of any fishway for the species and have been taken into account in preparing the (Amended) Prescription for Fishways.

Blueback herring

The Blueback herring is an anadromous fish distributed along the Atlantic coast from Nova Scotia to Florida (McBride et al. 2010). Adults grow to between 10 and 11 inches long, on average. The onset of spawning is related to temperature, and thus, varies with latitude (MRTC 1997). In the southern part of their range, adults were collected as early as January and as late as April during the spawning runs of 2002 through 2005 (McBride et al. 2010), whereas Blueback herring in Long Island Sound typically begin their upstream spawning migration when water temperature exceeds 14°C (Loesch and Lund 1977), which typically occurs in May on the lower Connecticut River. Their spawning migrations typically peak in mid-June, 3 to 4 weeks after the peak of the alewife spawning runs (Mullen et al. 1986). Adults prefer to spawn in swift flowing sections of freshwater tributaries, channel sections of fresh and brackish tidal rivers, and coastal ponds, over gravel and clean sand substrates, especially in northeastern rivers where alewife and Blueback herring coexist (MRTC 1997). Blueback herring are iteroparous, meaning they do not die after spawning and will return (assuming they survive another year at sea) to spawn again. Spawning consists of males and females broadcasting their gametes simultaneously into the water column and over the substrate (MRTC 1997). Post-spawn adults migrate rapidly downstream after spawning, usually leaving the spawning area within 5 days (Mullen et al. 1986). Larvae begin to feed externally 3 to 5 days after hatching, and transform gradually into the juvenile stage (MRTC 1997). Juveniles remain in freshwater nursery areas feeding mainly on zooplankton (MRTC 1997), growing to a length of 3 to 4 inches before moving downstream to more saline waters and eventually to the sea. In the Gulf of Maine, juvenile Blueback herring migrate to the ocean from August through November (Saunders et al. 2006). Blueback herring mature in 3 to 5 years, whereupon they return to their natal streams to spawn (Mullen et al. 1986). Adult Blueback herring are strong swimmers, with abilities comparable to alewives adjusted for body size (Castro-Santos 2005). Generally, Blueback herring do not leap or jump over obstacles; they use streaming flow to pass impediments. Blueback herring size, schooling behavior, and timing of migration (up- and downstream) are key factors in designing, locating, and timing the operation of any fishway for this species and have been taken into account in preparing this Preliminary Prescription for Fishways.

Sea lamprey

The Sea lamprey (Petromyzon marinus) is a primitive non-bony fish species with a long eel-like body (Applegate 1950, Beamish 1980). It is the largest of the 41 lamprey species worldwide. Sea lampreys lack scales, bones, jaws, ribs, shoulder and pelvic girdles and paired fins, unlike the more common and diverse group of bony fishes such as Atlantic Salmon (*Salmo salar*) and American shad (*Alosa sapidissima*). They also lack paired nostrils and vertical gills, instead having a single nostril in front of and between the eyes and seven pairs of gill openings resembling small portholes.

Sea lampreys are unique because they have a third pineal eye, located on the top of their head, which functions to regulate circadian rhythms. Adults have a circular sucking mouth, which surrounds a funnel-like oral disk lined with concentric rows of horny teeth that is enclosed by an oral hood. This arrangement, along with a protractible toothed tongue, allows adults to drill a small hole in the side of a host fish and feed upon their body fluids. Sea lampreys cling to their hosts by suction, scrape a hole in the skin with their rasping tongue, and suck their blood, body fluids, and flesh assisted by the secretion of lamphedrin to prevent blood clotting and begin digesting muscle tissue before ingestion; (Beamish 1980). Although host fish often die, some survive, albeit scarred from the experience (Beamish and Potter 1975). The parasitic feeding on prey fish begins only after juveniles migrate from freshwater and enter saltwater (S. McCormick, USGS personal communication). Timing for cessation of feeding and reduction of digestive organs and expansion of gonads to occupy the entire body cavity is not precisely known, but observations by Applegate (1950) suggest it likely begins before or about the time adults enter fresh water.

Sea lampreys spawn in the spring. Spawning adults construct a nest that consists of a shallow depression created by removing gravel and cobble in or at the head of rocky riffle habitat and piling them just downstream of the nest depression. Eggs are fertilized in the bottom of the depression and drift into the rocks piled at the downstream end of the nest. After 4 to 5 days the eggs hatch and the eyeless larvae drift downstream, living a benthic life buried in the soft stream bottom. Larvae feed on microorganisms and particulate organic material for 4 years prior to metamorphosing into juveniles and migrating to the sea. Present data on migration timing of non-parasitic juveniles (known also as transformers or macrophthalmia) in freshwater are in line with Applegate's (1950) data, which found migration peaks in fall, winter, and spring (Kynard unpublished data).

Parasitic juveniles and later adults remain at sea for one or more years before being attracted to enter freshwater in response to pheromones from larvae rearing in the watershed. There is no homing to natal rivers by Sea lampreys.

American eel

The American eel is a facultative catadromous species, meaning that American eels spawn in the ocean and grow to maturity in either marine or freshwater habitats, or some combination thereof (Shepard 2015). American eels are panmictic, meaning that there is a single spawning site with no mating restrictions, neither genetic nor behavioral, upon the population, and that therefore random recombination occurs with each new generation of American eel. Thus, there are no unique adaptations to specific regions within the range of American eel from Canada to the Caribbean (Shepard 2015). The spawning location is located east of the Bahamas and south of Bermuda in the center of the gyre known as the Sargasso Sea. After spawning, American eel eggs hatch into "leptocephali," a small transparent, larval stage that is passively transported in ocean currents for about 1 year. Leptocephali eventually metamorphose into "glass eels" that leave ocean currents and swim to coastal waters anywhere from the Caribbean to eastern Canada. Within days of reaching coastal waters, glass eels transform into small, fully developed, pigmented eels. They are often called elvers at this stage, an imprecise term that is generally applied to small eels in freshwater that may be of many sizes and ages. Juvenile eels are usually referred to as yellow eels. Small yellow eels are sexually indeterminate and cannot be differentiated histologically until reaching a length of about 8 inches.

Sexual maturation and silvering begins at ages from 3 years to more than 30 years. Females mature at later ages than males and eels mature at later age in fresh water, as compared to marine and estuarine waters where growth is more rapid. Age at maturation also increases with latitude—for example, silvering in fresh waters of the Chesapeake Bay region occurs at ages from 6 to 16 years (Helfman et al. 1987). Depending on latitude, silver eel migration from the rivers occurs in large part in late summer in the north and late winter in the south. For example, silver eels migrate from the St. Lawrence River in large part from August to November, from Connecticut rivers in September through October, and from Georgia rivers from October through March (ASMFC 2012).

Downstream migration has been commonly perceived as occurring primarily at night. Overall, 81.2 percent of the 293 eel passage events (including yellow eels) at dams on the Shenandoah River occurred during turbine shutdown periods between 1800 and 0600 hours (Eyler et al. 2016). The other 18.8 percent passed during the day or were not detected. Downstream movement from fresh water is accelerated by heavy rains and rises in stream flow; two thirds of the 293 eel passage events at dams on the Shenandoah River coincided with high-discharge events (Eyler et al. 2016). Eyler's study was initially designed to record eel movement events between September 15 and December 15. That period was expanded to include all months of the year over more than 1 year. Downstream movement of eels was detected during each month of the year except July, and during day and night. Downstream migrants use tidal transport and travel near the surface, but also make vertical movements, especially when encountering dams (ASMFC 2012, Brown et al. 2009).

Shortnose sturgeon

Shortnose sturgeon are fish that occur in rivers and estuaries along the East Coast of the U.S. and Canada (SSSRT 2010). They have a head covered in bony plates, as well as protective armor called scutes extending from the base of the skull to the caudal peduncle. Other distinctive features include a subterminal, protractile tube-like mouth, and chemosensory barbels for benthic foraging (SSSRT 2010). Sturgeon have been present in North America since the Upper Cretaceous period, more than 66 million years ago. The information below is a summary of available information on the species. More thorough discussions can be found in the cited references as well as the SSSRT's Biological Assessment (2010). Detailed information on the populations that occur in the project area is provided in section 6.4.4 while details on activities that impact individual Shortnose sturgeon in the project area can be found in section 6.5.5.

There are differences in life history, behavior, and habitat use across the range of the species. Current research indicates that these differences are adaptations to unique features of the rivers where these populations occur. For example, there are differences in larval dispersal patterns in the Connecticut River (MA) and Savannah River (GA) (Parker 2007). There are also morphological and behavioral differences. Growth and maturation occurs more quickly in southern rivers but fish in northern rivers grow larger and live longer.

General life history for the species throughout its range is summarized in the table below:

Stage	Typical Size (mm)	General Duration	Behaviors/Habitat Used
Egg	3-4	13 days post spawn	stationary on bottom; Cobble and rock, fresh, fast flowing water
Yolk Sac Larvae	7-15	8-12 days post hatch	Photonegative; swim up and drift behavior; form aggregations with other

Stage	Typical Size (mm)	General Duration	Behaviors/Habitat Used
			YSL; Cobble and rock, stay at bottom near spawning site
Post Yolk Sac Larvae	15 - 57	12-40 days post hatch	Free swimming; feeding; Silt bottom, deep channel; fresh water
Young of Year	57 – 140 (north); 57-300 (south)	From 40 days post-hatch to one year	Deep, muddy areas upstream of the saltwedge
Juvenile	140 to 450-550 (north); 300 to 450-550 (south)	1 year to maturation	Increasing salinity tolerance with age; same habitat patterns as adults
Adult	450-1100 average; (max recorded1400)	Post-maturation	Freshwater to estuary with some individuals making nearshore coastal migrations

Shortnose sturgeon live on average for 30-40 years (Dadswell *et al.* 1984). Males mature at approximately 5-10 years and females mature between age 7 and 13, with later maturation occurring in more northern populations (Dadswell et al. 1984). Females typically spawn for the first time 5 years post-maturation (age 12-18; (Dadswell 1979, Dadswell et al. 1984) and then spawn every 3-5 years (Dadswell 1979, Dadswell et al. 1984). Males spawn for the first time approximately 1-2 years after maturity with spawning typically occurring every 1-2 years (Dadswell et al. 1984, Kieffer and Kynard 1996, NMFS 1998). Shortnose sturgeon are iteroparous (spawning more than once during their life) and females release eggs in multiple "batches" during a 24 to 36-hour period (total of 30,000-200,000 eggs). Multiple males are likely to fertilize the eggs of a single female.

Cues for spawning are thought to include water temperature, day length and river flow (Kynard et al. 2012). Shortnose sturgeon spawn in freshwater reaches of their natal rivers when water temperatures reach 9–15°C in the spring (Dadswell 1979, Kynard 1997, Taubert 1980). Spawning occurs over gravel, rubble, and/or cobble substrate (Buckley and Kynard 1985a, Dadswell 1979, Kynard 1997, Taubert 1980) in areas with average bottom velocities between 0.4 and 0.8 m/s. Depths at spawning sites are variable, ranging from 1.2 - 27 m (multiple references in SSSRT 2010). Eggs are small and demersal and stick to the rocky substrate where spawning occurs.

Shortnose sturgeon occur in waters between 0 – 34°C (Dadswell et al. 1984, Heidt and Gilbert 1979); with temperatures above 28°C considered to be stressful. Depths used are highly variable, ranging from shallow mudflats while foraging to deep channels up to 30 m (Dadswell 1979, Dadswell et al. 1984). Salinity tolerance increases with age; while young of the year must remain in freshwater, adults have been documented in the ocean with salinities of up 30 parts-per-thousand (Holland and Yelverston 1973, Squiers et al. 1979). Dissolved oxygen affects distribution, with preference for DO levels at or above 5mg/l and adverse effects anticipated for prolonged exposure to DO less than 3.2mg/L.

Shortnose sturgeon feed on benthic insects, crustaceans, mollusks, and polychaetes (Dadswell et al. 1984). Both juvenile and adult Shortnose sturgeon primarily forage over sandy-mud bottoms, which support benthic invertebrates (Carlson and Simpson 1987, Kynard 1997). Shortnose sturgeon have also been observed feeding off plant surfaces (Dadswell et al. 1984).

Following spawning, adult Shortnose sturgeon disperse quickly down river to summer foraging grounds areas and remain in areas downstream of their spawning grounds throughout the remainder of the year (Buckley and Kynard 1985a, Buckley and Kynard 1985b, Dadswell et al. 1984, O'Herron et al. 1993).

In northern rivers, shortnose aggregate during the winter months in discrete, deep (3-10m) freshwater areas with minimal movement and foraging (Bain et al. 1998a, Bain et al. 1998b, Buckley and Kynard 1985b, Dadswell 1979, Dovel et al. 1992, Li et al. 2007). In the winter, adults in southern rivers spend much of their time in the slower moving waters downstream near the salt-wedge and forage widely throughout the estuary (Collins and Smith 1993, Weber et al. 1998). Pre-spawning sturgeon in some northern and southern systems migrate into an area in the upper tidal portion of the river in the fall and complete their migration in the spring (Rogers and Weber 1995). Older juveniles typically occur in the same overwintering areas as adults while young of the year remain in freshwater (Jarvis 2001, Jenkins et al. 1993).

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