ENVIRONMENTAL ASSESSMENT
FOR
HYDROPOWER LICENSE

Turners Falls Project

Docket No. P-2622-013

Massachusetts

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
888 First Street, NE
Washington, D.C. 20426

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ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
APE	area of potential effect
°C	degree Celsius
Certification	water quality certification
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeters
Commerce	U.S. Department of Commerce
Commission	Federal Energy Regulatory Commission
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
EA	environmental assessment
EFH	essential fish habitat
ESA	Endangered Species Act
°F	degree Fahrenheit
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
fps	feet per second
FWS	U.S. Fish and Wildlife Service
Turners Falls Project	Turners Falls Hydroelectric Project No. 2622
HPMP	Historic Properties Management Plan
IPaC	U.S. Fish and Wildlife Service Information for Planning and Consultation
Interior	U.S. Department of the Interior
kW	kilowatt
TFH	Turners Falls Hydro, LLC
mg/L	milligrams per liter
msl	mean sea level
Massachusetts DEC	Massachusetts Department of Environmental Conservation
Massachusetts DEP	Massachusetts Department of Environmental Protection
Massachusetts DFW	Massachusetts Division of Fisheries and Wildlife
Massachusetts SHPO	Massachusetts State Historic Preservation Officer
Massachusetts OCZM	Massachusetts Office of Coastal Zone Management
MW	megawatt
MWh	megawatt-hours
NMFS	National Marine Fisheries Service
National Register	National Register of Historic Places
NERC	North American Electric Reliability Corporation
NHPA	National Historic Preservation Act
NLEB	northern long-eared bat
NMFS	National Marine Fisheries Service

NPCC	Northeast Power Coordinating Council, Inc.
NRI	Nationwide Rivers Inventory
PAD	Pre-Application Document
RM	river mile
SCADA	supervisory control and data acquisition
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SHRU	Salmon Habitat Recovery Unit
USGS	U.S. Geological Survey
WUA	weighted usable area

ENVIRONMENTAL ASSESSMENT

Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Licensing
Washington, DC

TURNERS FALLS PROJECT
Docket No. 2622-013 – Massachusetts

1.0 INTRODUCTION

1.1 APPLICATION

On February 4, 2019, Turners Falls Hydro, LLC (TFH) filed an application with the Federal Energy Regulatory Commission (Commission or FERC) for a subsequent license to continue to operate and maintain the Turners Falls Project No. 2622 (Turners Falls Project, Project No. 2622, or project).[1] The 937-kilowatt (kW) project is located on the Connecticut River, within the power canal of the Turners Falls Hydroelectric Project No. 1889 (Project No. 1889),[2] in Franklin County, Massachusetts (Figure 1). Project No. 2622 does not occupy federal land.

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[1] The original license for the project was issued on February 25, 1969, for a term of 50 years, with an effective date of March 1, 1941, and an expiration date of February 28, 1991. *See Hammermill Paper Company,* 41 F.P.C. 192 (1969). The license was transferred to International Paper Company on September 29, 1989. *See Hammermill Paper Company and International Paper Company,* 48 FERC ¶ 62,242 (1989). The current license for the project was issued on June 29, 1990, for a term of 30 years, with an effective date of March 1, 1991, and an expiration date of February 28, 2021. *See International Paper Company*, 51 FERC ¶ 62,330 (1990). The current license was transferred to Turners Fall Hydro LLC on May 10, 2001. *See International Paper Company and Turners Falls Hydro LLC,* 95 FERC ¶ 62,106 (2001).

[2] The Turners Falls Project No. 1889 is licensed to FirstLight Hydro MA Hydro LLC (FirstLight). FirstLight filed an application for a new license for Project No. 1889 on April 29, 2016. In the application, FirstLight states that it will file an amended final license application after it completes the required environmental studies for Project No. 1889. FirstLight has since completed the environmental studies and anticipates filing amendments to its license application by December, 2020. *See* FirstLight, Updated Schedule for Amended License Application, Docket No. P-1889-085 (filed September 1, 2020).

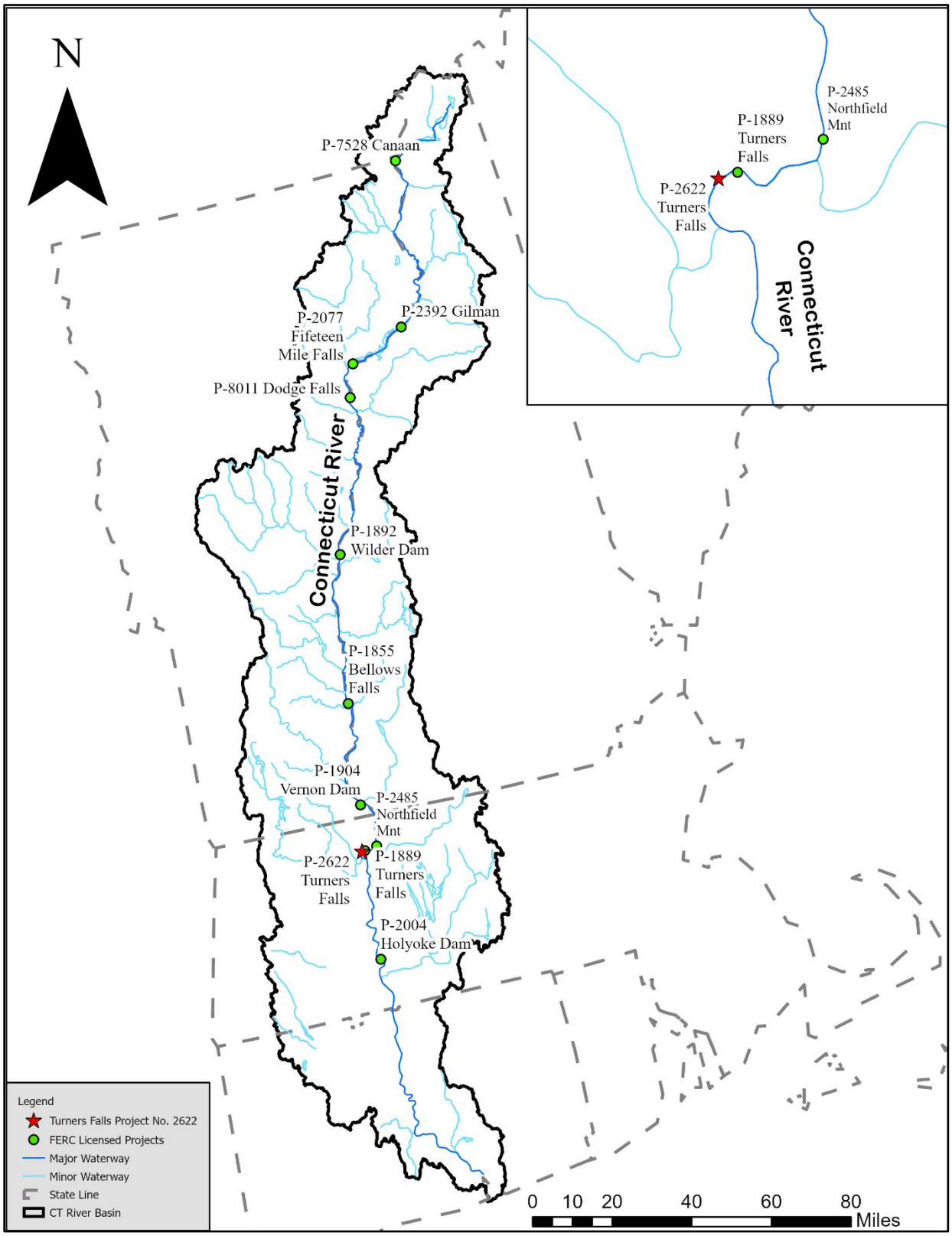

Figure 1. Location of the Turners Falls Project and other FERC-licensed hydroelectric projects on the Connecticut River, in the Connecticut River Basin. (Source: staff).

1.2 PURPOSE OF ACTION AND NEED FOR POWER

1.2.1 Purpose of Action

The purpose of the Turners Falls Project is to provide a source of hydroelectric power. Therefore, under the provisions of the Federal Power Act (FPA), the Commission must decide whether to issue a subsequent license[3] to TFH for the Turners Falls Project and what conditions should be placed on any license issued. In deciding whether to issue a license for a hydroelectric project, the Commission must determine that Project No. 2622 would be best adapted to a comprehensive plan for improving or developing the waterway. In addition to the power and developmental purposes for which licenses are issued (such as flood control, irrigation, and water supply), the Commission must give equal consideration to the purposes of: (1) energy conservation; (2) the protection of, mitigation of damage to, and enhancement of fish and wildlife resources; (3) the protection of recreational opportunities; and (4) the preservation of other aspects of environmental quality.

Issuing a subsequent license for the Turners Falls Project would allow TFH to continue to generate electricity at Project No. 2622 for the term of the subsequent license, making electric power from a renewable resource available to its customers.

This environmental assessment (EA) has been prepared in compliance with the National Environmental Policy Act of 1969 (NEPA) to assess the environmental and economic effects associated with operation of Project No. 2622 and alternatives to the proposed project. It includes recommendations to the Commission on whether to issue a license, and if so, recommends terms and conditions to become a part of any license issued.

In this EA, we assess the environmental and economic effects of continuing to operate Project No. 2622: (1) as proposed by TFH; and (2) as proposed by TFH with staff-recommended measures (staff alternative). We also consider the effects of the no-action alternative. Under the no-action alternative, Project No. 2622 would continue to operate as it does under the existing license, and no new environmental protection, mitigation, or enhancement measures would be implemented. The primary issues associated with relicensing Project No. 2622 are the effects of project operation on: (1) American eels and American shad; (2) aquatic habitat in the power canal and bypassed reach of Project No. 1889; and (3) cultural resources.

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[3] A subsequent license is a license for a water power project that is issued under Part I of the FPA after the expiration of a minor license that is not subject to sections 14 and 15 of the FPA. *See* 18 C.F.R. § 16(2)(d) (2019). A minor license is a license for a minor water power project that has a total installed generation capacity of 1.5 megawatts or less. *See* 18 C.F.R. § 4.30(b)(17) (2019).

We have not identified any substantive issues related to geology and soils, land use, recreation, aesthetic resources, or socioeconomics associated with the proposed actions; therefore, these resources are not addressed in the EA.

1.2.2 Need for Power

The Turners Falls Project has an installed capacity of 937 kW and an average annual energy production of about 1,512 megawatt-hours (MWh) from 2011 through 2015. Project No. 2622 provides power to TFH's residential and industrial customers.

To assess the need for power, we looked at the needs in the operating region in which Project No. 2622 is located. The North American Electric Reliability Corporation (NERC) annually forecasts electrical supply and demand nationally and regionally for a 10-year period. The Turners Falls Project is located within the Northeast Power Coordinating Council's New England region (NPCC-New England) of the NERC. According to NERC's 2018 Long-Term Reliability Assessment, the summer internal demand for this region is projected to decrease by 0.2 percent from 2019 to 2029. The anticipated reserve margin (*i.e.*, the primary metric used to evaluate the adequacy of projected generation resources to serve forecasted peak load) is forecasted to range from 32.24 percent in 2020 to 27.12 percent in 2029. The NPCC-New England assessment area is forecasted to meet NPCC-New England's target reserve margin of 18.5 percent in 2020, 18.0 percent in 2021, and 17.8 percent in 2022 through 2029 (NERC, 2019).

Although demand is projected to decrease somewhat in the region, Project No. 2622 currently provides power that helps to meet part of the region's power requirements and capacity needs. Project No. 2622 provides power that can displace non-renewable, fossil-fired generation and contributes to a diversified generation mix. Displacing the operation of non-renewable facilities may avoid some power plant emissions and create an environmental benefit.

1.3 STATUTORY AND REGULATORY REQUIREMENTS

A subsequent license for Project No. 2622 would be subject to numerous requirements under the FPA and other applicable statutes. The major regulatory and statutory requirements are described below.

1.3.1 Federal Power Act

1.3.1.1 Section 18 Fishway Prescriptions

Section 18 of the FPA, 16 U.S.C. § 811, states that the Commission is to require construction, operation, and maintenance by a licensee of such fishways as may be

prescribed by the Secretaries of the U.S. Department of Commerce (Commerce) or the U.S. Department of the Interior (Interior).

On November 22 and November 26, 2019, respectively, the National Marine Fisheries Service (NMFS), on behalf of Commerce, and Interior filed requests that the Commission include a reservation of authority to prescribe fishways under section 18 in any license issued for Project No. 2622.

1.3.1.2 Section 10(j) Recommendations

Under section 10(j) of the FPA, 16 U.S.C. § 803(j)(1), each hydroelectric license issued by the Commission must include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by Project No. 2622. The Commission is required to include these conditions in any subsequent license unless it determines that they are inconsistent with the purposes and requirements of the FPA or other applicable law. Before rejecting or modifying an agency recommendation, the Commission is required to attempt to resolve any such inconsistency with the agency, giving due weight to the recommendations, expertise, and statutory responsibilities of such agency.

On October 25, 2019, November 22, 2019, and November 26, 2019, respectively, the Massachusetts Division of Fisheries and Wildlife (Massachusetts DFW), NMFS, and Interior filed timely recommendations under section 10(j). These recommendations are summarized in Table 15 and discussed in section 5.3, *Fish and Wildlife Agency Recommendations*.

1.3.2 Clean Water Act

Under section 401(a)(1) of the Clean Water Act (CWA), 33 U.S.C. § 1341(a)(1), a license applicant must obtain either a water quality certification (certification) from the appropriate state pollution control agency verifying that any discharge from Project No. 2622 would comply with applicable provisions of the CWA, or a waiver of such certification. A waiver occurs if the state agency does not act on a request for certification within a reasonable period of time, not to exceed one year after receipt of such request.

On October 16, 2019, TFH applied to the Massachusetts Department of Environmental Protection (Massachusetts DEP) for section 401 certification for the Turners Falls Project. Massachusetts DEP received the request on October 17, 2019. Massachusetts DEP has not yet acted on the application. The certification is due by October 17, 2020.

1.3.3 Endangered Species Act

Section 7 of the Endangered Species Act (ESA), 16 U.S.C. § 1536, requires federal agencies to ensure that their actions are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of the critical habitat of such species. On September 1, 2020, we accessed the U.S. Fish and Wildlife Service's (FWS) Information for Planning and Consultation (IPaC) database to determine whether any federally listed species could occur in the vicinity of Project No. 2622. According to the IPaC database, the federally endangered northeastern bulrush (*Scirpus ancistrochaetus*) and threatened northern long-eared bat (*Myotis septentrionalis*) could occur in the vicinity of Project No. 2622.[4] No critical habitat has been designated for these species. In addition, the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) could occur in the vicinity of Project No. 2622. No critical habitat has been designated for the shortnose sturgeon.

Our analysis of project impacts on the shortnose sturgeon, northeastern bulrush, and northern long-eared bat is presented in section 3.3.3.2, *Threatened and Endangered Species – Environmental Effects*. Based on available information, we conclude that licensing Project No. 2622, as proposed with the staff-recommended measures, would have no effect on northeastern bulrush or northern long-eared bat. Project No. 2622 may affect, but is not likely to adversely affect, shortnose sturgeon.

1.3.4 Coastal Zone Management Act

Under section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA), 16 U.S.C. §1456(c)(3)(A), the Commission cannot issue a license for a project within or affecting a state's coastal zone unless the state's CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA Program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of its receipt of the applicant's certification.

Project No. 2622 is not located within the state-designated Coastal Management Zone,[5] and Project No. 2622 would not affect Massachusetts's coastal resources.

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[4] *See* Interior's official list of threatened and endangered species, accessed by staff using the IPaC database (https://ecos.fws.gov/ipac/) on March 6, 2020, and placed into the record for Docket No. P-2622-013 on March 6, 2020.

[5] The state-designated Coastal Management Zone extends from the lands and waters within the seaward limit of the state's territorial sea to generally 100 feet beyond (landward of) the first major land transportation route encountered (a road, highway, rail line, *etc.*) (Massachusetts Office of Coastal Zone Management, 2011).

Therefore, Project No. 2622 is not subject to Massachusetts coastal zone program review and no consistency certification is needed for the action. By letter dated January 11, 2019, the Massachusetts Office of Coastal Zone Management (Massachusetts OCZM) concurred.

1.3.5 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA), 54 U.S.C. § 306108, requires that a federal agency "take into account" how its undertakings could affect historic properties. Historic properties are districts, sites, buildings, structures, traditional cultural properties, and objects significant in American History, architecture, engineering, and culture that are eligible for inclusion in the National Register of Historic Places (National Register).

Commission staff invited consultation with the Mashpee Wampanoag Tribe, Wampanoag Tribe of Gay Head (Aquinnah), and Narragansett Indian tribe (tribes) on March 31, 2016, and with the Massachusetts State Historic Preservation Officer (Massachusetts SHPO) on April 22, 2016, to identify historic properties, determine the eligibility of cultural resources for listing on the National Register, and assess potential adverse effects on historic properties within Project No. 2622's area of potential effects (APE). Contributing resources of the Turners Falls Historic District, a listed property on the National Register, are located within Project No. 2622's APE.

No tribes responded to the initial consultation letter or filed any comments on the record of the proceeding. In a letter filed on June 24, 2019, the Massachusetts SHPO stated that the proposed project would have no adverse effects on historic properties. Our analysis of project effects on cultural resources is presented in section 3.3.4.2, *Cultural Resources, Environmental Effects*. We conclude that relicensing Project No. 2622 would not affect any historic properties, and a programmatic agreement is not needed to protect historic properties.

1.4 PUBLIC REVIEW AND COMMENT

The Commission's regulations (18 CFR § 16.8) require applicants to consult with appropriate resource agencies, tribes, and other entities before filing an application for a license. This consultation is the first step in complying with the Fish and Wildlife Coordination Act (16 U.S.C. § 661 *et seq*.), ESA, NHPA, and other federal statutes. Pre-filing consultation must be completed and documented according to the Commission's regulations.

1.4.1 Scoping

Before preparing this EA, staff conducted scoping to determine what issues and alternatives should be addressed. A scoping document was distributed to interested

agencies and others on July 25, 2019. It was noticed in the *Federal Register* on July 31, 2019. No written comments were provided pertaining to the scoping document.

1.4.2 Interventions

On July 16, 2019, the Commission issued a notice accepting the application to relicense Project No. 2622, and setting September 14, 2019, as the deadline for filing motions to intervene and protests. The notice was published in the *Federal Register* on July 22, 2019. The following entities filed motions/notices of intervention (none opposed issuance of a license):

Intervenor	Date Filed
Massachusetts DFW	July 18, 2019
NMFS	July 22, 2019
FirstLight	September 12, 2019
Northfield Mountain LLC (Northfield)	September 12, 2019

1.4.3 Comments on the Application

On September 30, 2019, the Commission issued a notice setting November 29, 2019, as the deadline for filing comments, recommendations, terms and conditions, and prescriptions. The notice also established a deadline of January 13, 2020 for filing reply comments. The following entities responded:

Commenting Entity	Date Filed
Massachusetts DFW	October 25, 2019
NMFS	November 22, 2019
Interior	November 26, 2019
FirstLight and Northfield	November 26, 2019

TFH filed reply comments on January 13, 2020.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 NO ACTION ALTERNATIVE

Under the no-action alternative, Project No. 2622 would continue to operate under the terms and conditions of the current license, and no new environmental protection, mitigation, or enhancement measures would be implemented. We use this alternative to establish baseline environmental conditions for comparison with other alternatives, and to

judge the benefit and costs of any measures that might be required under a subsequent license.

2.1.1 Existing Project Facilities

The Turners Falls Project No. 2622 is located on the Connecticut River, in the power canal of the Turners Falls Hydroelectric Project No. 1889, in Franklin County, Massachusetts. The Turners Falls Project No. 2622 facilities are shown in Figure 2. Figure 3 shows additional facilities that are part of Project No. 1889 and that are in close proximity to Project No. 2622.

The existing Turners Falls Project includes: (1) an existing 10-foot-long, 20-foot-wide, 12- to 22-foot-high intake structure with a 20-foot-wide, 22-foot-high trashrack with 1.5-inch clear-bar spacing and two 9.75-foot-wide, 10.3-foot-high headgates; (2) an 8.5-foot-diameter, 50-foot-long steel penstock; (3) a 77-foot-long, 42-foot-wide powerhouse containing one 937-kilowatt vertical Francis-type turbine-generator unit; (4) a 50-foot-long, 10-foot diameter draft tube; (5) an 80-foot-long, 10-foot-wide tailrace; (6) a 110-foot-long, 2.3-kilovolt generator lead line that connects the generator to a step-up transformer; and (7) appurtenant facilities.

Project No. 2622 has no dam or impoundment.

2.1.2 Current Project Boundary

The current project boundary for the Turners Falls Project as established in the Commission's June 29, 1990 license order, and amended on April 12, 2002, encompasses approximately 0.2 acre and includes all lands that are needed for project purposes, including lands associated with the intake, powerhouse, tailrace, and appurtenant facilities.

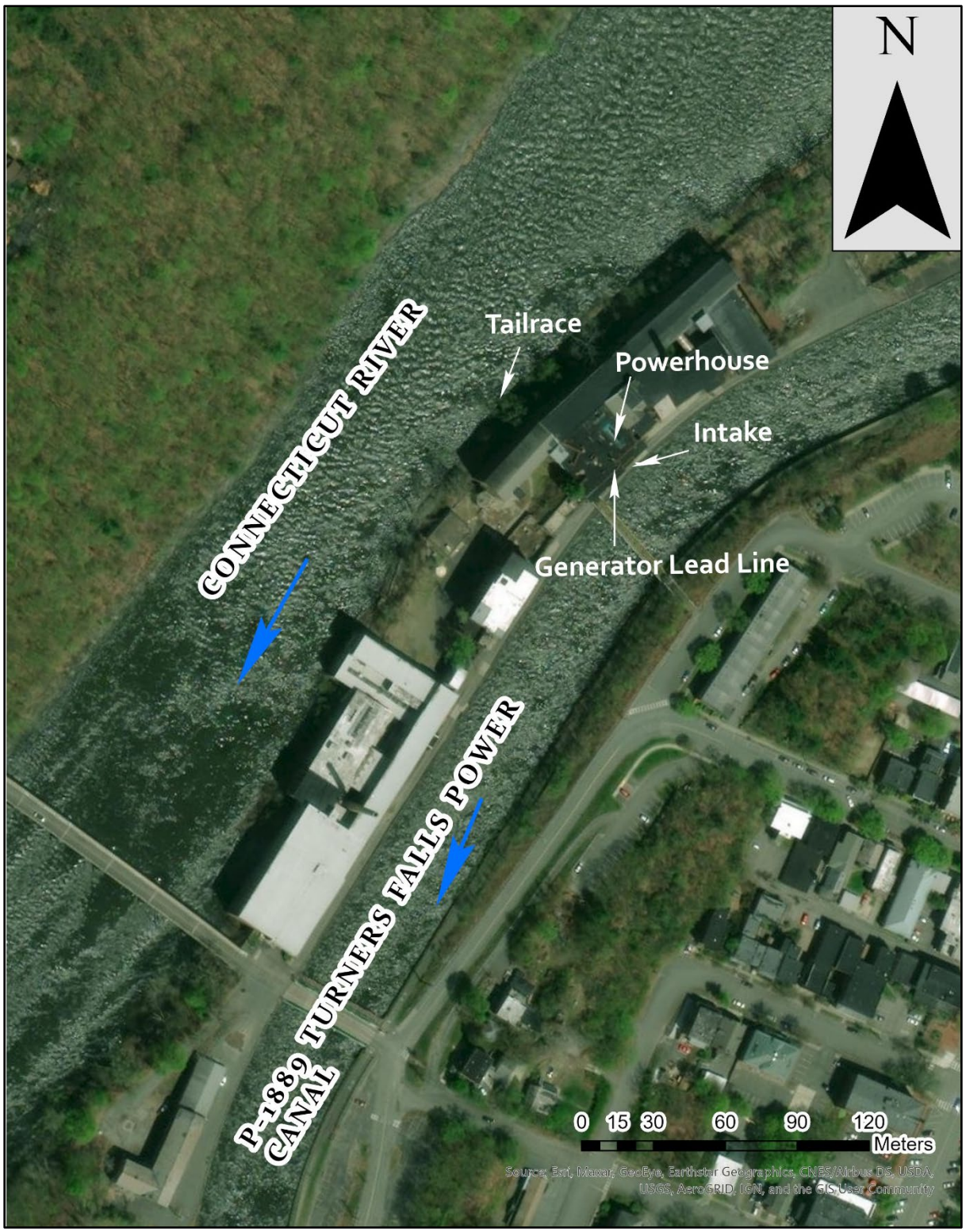

Figure 2. Turners Falls Project facilities (Source: staff).

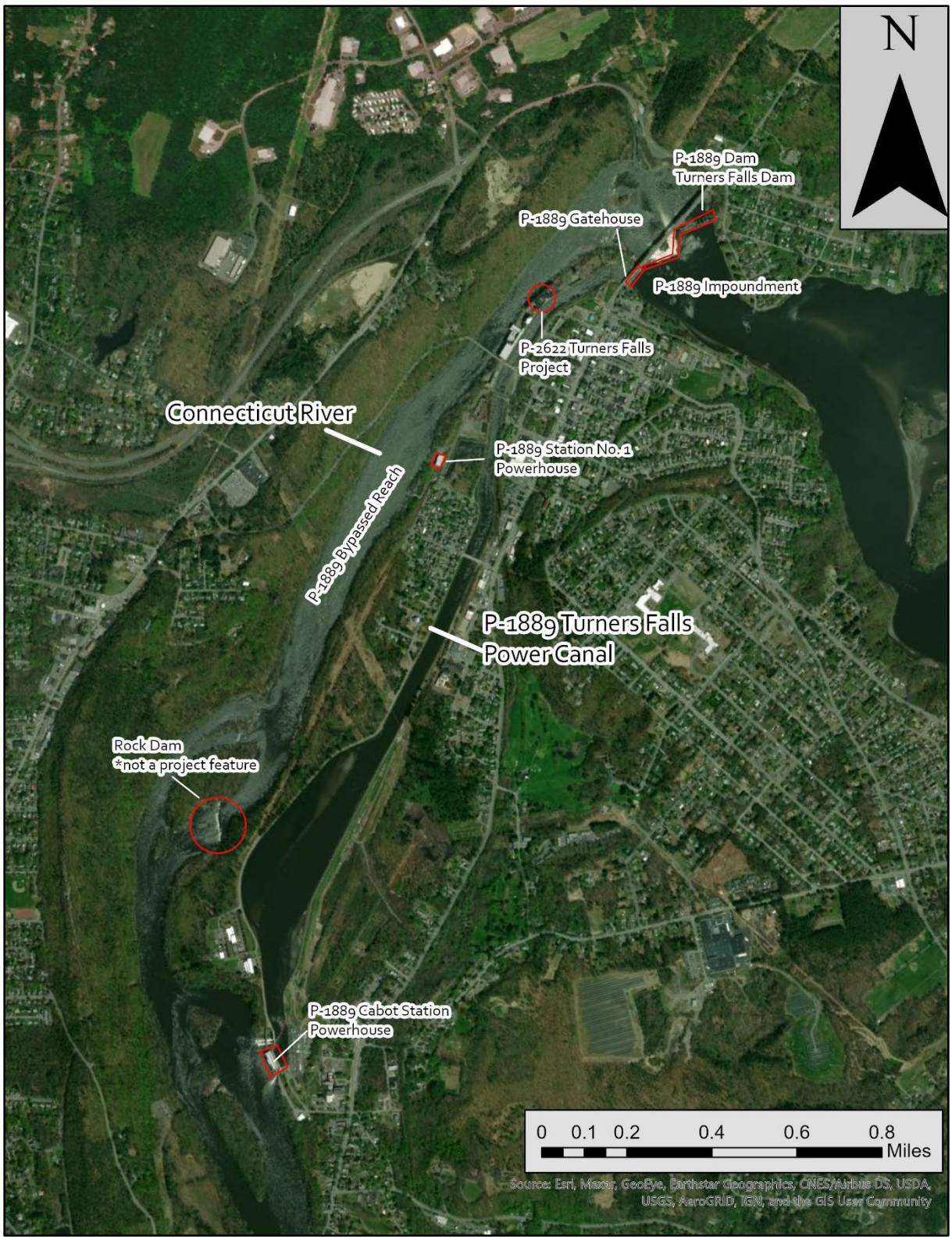

Figure 3. Turners Falls Project and Project No. 1889 Facilities (Source: staff).

2.1.3 Project Safety

The Turners Falls Project has been operating for more than 30 years under the existing license. During this time, Commission staff has conducted operational inspections focusing on the continued safety of the structures, identification of unauthorized modifications, efficiency and safety of operations, compliance with the terms of the license, and proper maintenance.

As part of the licensing process, Commission staff will evaluate the continued adequacy of Project No. 2622's facilities under a subsequent license. Special articles will be included in any license issued, as appropriate. Commission staff would continue to inspect Project No. 2622 during the term of any subsequent license to assure continued adherence to Commission-approved plans and specifications, special license articles relating to construction (if any), operation and maintenance, and accepted engineering practices and procedures.

2.1.4 Current Project Operation

The Turners Falls Project uses water from the power canal of Project No. 1889. When generating, water flows from the power canal, through the headgates and penstock, to the powerhouse. From the powerhouse, water flows through the draft tube and tailrace to the Connecticut River approximately 0.30 mile downstream of the dam for Project No. 1889. The average annual energy production for Project No. 2622 from 2011 through 2015 was approximately 1,512 megawatt-hours.

The current license does not include any requirements that limit when Project No. 2622 can utilize flows from the power canal for hydropower generation. However, TFH coordinates the operation of the Turners Falls Project with the licensee of Project No. 1889 (FirstLight), pursuant to an off-license "Water Use Agreement" that was executed by the companies on January 1, 1998 and amended on May 14, 2003. The Water Use Agreement dictates that TFH will only produce hydropower with the Turners Falls Project when flows in the power canal are greater than 15,000 cubic feet per second (cfs) and water supply is sufficient for Project No. 1889's Station No. 1 and Cabot Station Developments to produce hydropower. The Turners Falls Project does not control flow or storage within the power canal of Project No. 1889.

TFH manually operates Project No. 2622 after being notified by FirstLight that water is available from the power canal for hydropower generation. Although the Project No. 2622 generating unit has an operating range of approximately 60 cfs to 289 cfs, when generating, TFH only operates at the 289-cfs maximum hydraulic capacity and does not fluctuate its water use from 289 cfs.

2.1.5 Current Environmental Measures

To protect resident and anadromous fish species from injury and mortality associated with turbine entrainment, Article 401 of the current license required the licensee to install a trashrack with clear bar spacing that does not exceed 1 inch and an intake velocity that does not exceed an average of 0.68 foot per second (fps), as estimated within 3 inches of the face of the trashrack. However, as described in section 2.1.1, the existing trashrack at Project No. 2622 has a clear bar spacing of 1.5 inches, not 1 inch. In the Joint Agency Meeting presentation, filed on March 2, 2017, TFH states that a trashrack with 1-inch clear bar spacing was initially installed, and the trashrack was replaced in 2007. The license application states that the current trashrack has a clear bar spacing at 1.5 inches.

To minimize delays to upstream migrating anadromous fish at the Turners Falls Project, Article 402 of the current license required the licensee to develop a plan for a tailrace screen or other structure, upon notification by Massachusetts DFW, the U.S. Fish and Wildlife Service (FWS), and the Connecticut River Atlantic Salmon Commission. No tailrace screen or other structure has been installed at Project No. 2622 since the issuance of the license in 1990.

There are no project recreation facilities.

2.2 APPLICANT'S PROPOSAL

2.2.1 Proposed Project Facilities

TFH does not propose to add any new project facilities or revise the Project No. 2622 boundary.

2.2.2 Proposed Operation and Environmental Measures

TFH proposes to:

- Operate Project No. 2622 "continuously" (*i.e.*, operate Project No. 2622 any time flow to the project intake is greater than or equal to the 60-cfs minimum hydraulic capacity of the project), instead of limiting project operation to when flow in the power canal is greater than 15,000 cfs, as stipulated in the off-

license Water Use Agreement that is currently in place between TFH and FirstLight;[6] and

- Develop a trashrack replacement plan that includes replacing the existing trashrack with a trashrack that has 0.75-inch clear bar spacing to protect fish from turbine entrainment and mortality.[7]

2.3 STAFF ALTERNATIVE

Under the staff alternative, Project No. 2622 would be operated as proposed by TFH, with the following modifications and additional staff-recommended measures:

- Replace the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing to reduce fish injury and mortality associated with turbine entrainment, instead of developing a trashrack replacement plan as proposed by TFH;

- Provide operational data, including records of project generation and flow releases, to resource agencies upon written request from the agencies.

- Consult with the Massachusetts SHPO to establish protocols to be implemented prior to conducting maintenance activities in the vicinity of Project No. 2622 that could affect cultural resources; and

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[6] In section 1.3 of Exhibit A of the February 6, 2019 license application, TFH states that it "proposes to continue operating the Project as currently licensed during the next license term, with the flexibility to operate up to continuously or to operate under the current or a modified Water Use Agreement between [TFH] and FirstLight." In its July 3, 2019 response to Commission staff's request for additional information, TFH explains that it is "considering operating the Project as currently licensed (*i.e.*, continuously), or under the existing off-license Water Use Agreement, or a modified off-license Water Use Agreement between TFH and FirstLight."

[7] In Exhibit E of its February 4, 2019 license application, TFH proposes to develop the trashrack replacement plan only if the new license for Project No. 1889 does not require the installation of a fish screen near the power canal entrance, upstream of the intake for the Turners Falls Project. However, TFH includes the cost of trashrack installation, operation, and maintenance in the average annual cost of power for the proposed project in Exhibit H of the license application. Therefore, for purposes of our analyses herein, we assume that TFH is proposing to develop a trashrack replacement plan to install a new trashrack with 0.75-inch clear bar spacing at the project.

- If previously unidentified cultural resources are encountered during the course of constructing, maintaining, or developing project facilities, consult with the Massachusetts SHPO to ensure the proper treatment of these resources and discontinue all exploratory or construction-related activities until the proper treatment of the resources is established.

Section 10(j) Measures Not Recommended[8]

The staff alternative does not include the following section 10(j) recommendations, because pursuant to sections 4(e) and 10(a) of the FPA, the benefits do not justify the costs, or the recommendations are for actions that do not serve a project-related purpose or provide a project-related benefit:

- Develop a plan to minimize delays for upstream migrating anadromous fish when notified by Interior, Massachusetts DFW, or NMFS.

- Develop an Operation Compliance Monitoring Plan for maintaining and monitoring flow releases, including procedures for recording and reporting data to FERC and resource agencies.

2.4 ALTERNATIVE CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

Project decommissioning was considered as an alternative to Project No. 2622, but has been eliminated from further analysis because it is not reasonable in the circumstances of this case.

As the Commission has previously held, decommissioning is not a reasonable alternative to relicensing a project in most cases, when appropriate protection, mitigation, and enhancement measures are available.[9] The Commission does not speculate about possible decommissioning measures at the time of relicensing, but rather waits until an applicant actually proposes to decommission a project, or there are serious resource concerns that cannot be addressed with appropriate license measures, making

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[8] See section 5.3, *Fish and Wildlife Agency Recommendations*, for additional details on the recommendations. As discussed in section 5.3, some of the measures listed below are outside of the scope of section 10(j). Here, we account for all measures that were characterized as section 10(j) recommendations by the resource agencies, but are not being adopted by Commission staff.

[9] *See*, *e.g.*, *Eagle Crest Energy Co.*, 153 FERC ¶ 61,058, at P 67 (2015); *Pub. Util. Dist. No. 1 of Pend Oreille Cty.*, 112 FERC ¶ 61,055, at P 82 (2005); *Midwest Hydro, Inc.*, 111 FERC ¶ 61,327, at PP 35-38 (2005).

decommissioning a reasonable alternative to relicensing.[10] This is consistent with NEPA and the Commission's obligation under section 10(a) of the FPA to issue licenses that balance developmental and environmental interests.[11]

TFH does not propose decommissioning, nor does the record to date demonstrate there are serious resource concerns that cannot be mitigated if Project No. 2622 is relicensed; as such, there is no reason, at this time, to include decommissioning as a reasonable alternative to be evaluated and studied as part of staff's NEPA analysis.

3.0 ENVIRONMENTAL ANALYSIS

This section includes: (1) a general description of the project vicinity, (2) an explanation of the scope of our cumulative effects analysis, and (3) our analysis of the proposed action and other recommended environmental measures. Sections are organized by resource area (aquatics, terrestrial, *etc.*). Historic and current conditions are described under each resource area. Current conditions are the baseline against which the environmental effects of the proposed action and alternatives are compared, including an assessment of the effects of proposed protection, mitigation, and enhancement measures, and any cumulative effects of the proposed action and alternatives. Staff conclusions and recommended measures are discussed in section 5.1, *Comprehensive Development and Recommended Alternative*.[12]

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[10] *See generally Project Decommissioning at Relicensing; Policy Statement*, FERC Stats. & Regs., Regulations Preambles (1991-1996), ¶ 31,011 (1994); *see also City of Tacoma, Washington*, 110 FERC ¶ 61,140 (2005) (finding that unless and until the Commission has a specific decommissioning proposal, any further environmental analysis of the effects of project decommissioning would be both premature and speculative).

[11] In the unlikely event that the Commission denies relicensing of a project or a licensee decides to surrender an existing project, the Commission must approve a surrender "upon such conditions with respect to the disposition of such works as may be determined by the Commission." 18 C.F.R. § 6.2 (2019). This can include simply shutting down the power operations, removing all or parts of the project, or restoring the site to its pre-project condition.

[12] Unless otherwise indicated, our information is taken from the application for license filed by TFH on February 4, 2019, and TFH's license amendments filed on July 3, 2019, and August 13, 2019.

3.1 GENERAL DESCRIPTION OF THE RIVER BASIN

The Turners Falls Project is located in the town of Montague, Franklin County, Massachusetts, on an island that is situated between the Project No. 1889 power canal and the reach of the Connecticut River that is bypassed by Project No. 1889 (*i.e.*, "bypassed reach"; Figure 3). The Connecticut River is the largest river in New England and generally flows north to south, starting from the Connecticut Lakes region near the U.S.-Canada border and flowing approximately 410 miles south to Long Island Sound. The watershed of the Connecticut River is approximately 11,250 square miles, and the watershed area upstream of the Project No. 1889 dam is approximately 7,160 square miles. There are 11 dams on the mainstem Connecticut River used for hydropower generation (Table 1).

Table 1. Hydropower projects on the Connecticut River.

Project	FERC No.	River Mile	Generation Capacity (MW)	Dam Height (feet)	Impoundment Volume (acre-feet)
Holyoke	2004	87	43.84	30	26,000
Turners Falls	1889	122	67.71	55	20,300
Turners Falls	2622	122	0.94	NA	NA
Northfield Mountain Pumped Storage[13]	2485	127	1,167	140	17,050
Vernon	1904	142	32.40	58	54,000
Bellows Falls	1855	174	40.80	48	30,000
Wilder	1892	217	35.60	59	55,000
Dodge Falls	8011	270	5.00	18	4,940
Fifteen Mile Falls (McIndoes, Comerford, and Moore dams)	2077	274 281 288	319.96	25 170 149	4,800 32,270 223,722
Gilman	2392	302	48.50	38	705
Canaan	7528	373	11.00	19	120

(Source: staff).

The power canal for Project No. 1889 is approximately 2.1 miles long and ranges in width from approximately 170 feet at the upstream end to a maximum of approximately 783 feet near the downstream end. The hydraulic capacity of the power canal is approximately 18,000 cfs. Flow into the power canal is controlled at a gatehouse adjacent to the Project No. 1889 dam (Figure 3). FirstLight owns and operates the

gatehouse and the dam. The Turners Falls Project is located approximately 0.22 mile downstream of the gatehouse. The power canal terminates at Project No. 1889's 62.017-MW Cabot Station powerhouse. Project No. 1889's Station No. 1 Development (5.693 MW), is approximately 0.35 mile downstream of the Turners Falls Project. The maximum hydraulic capacities of Cabot Station and Station No. 1 are 13,728 cfs and 2,210 cfs, respectively (FirstLight, 2016a). In addition to these facilities, the Southworth Company and the U.S. Geological Survey's (USGS) Conte Anadromous Laboratory (Conte Lab) also withdraw water from the power canal. The hydraulic capacity of the Southworth Company is approximately 113 cfs, and the withdrawal rate for the Conte Lab ranges from 2 cfs to 200 cfs depending on the month (FirstLight, 2016a).

The Turners Falls Project lies within the New England Upland section of the New England physiographic province of Massachusetts. The Connecticut River Valley (Valley) is a dominant feature within this section. The Valley is generally narrow in the vicinity of Project No. 2622, with some areas of the floodplain characterized by river and stream terrace silt, sand, and gravel. The Valley topography is mostly level to rolling, with some higher hills. Project No. 2622 is located within the Connecticut River Valley ecoregion, which is mostly urban, but also has croplands, pasture, and oak-hickory and maple-beech-birch forest in higher elevations (Mass Audubon, 2018). Land use in the Connecticut River Basin is approximately 77 percent forested, 9 percent agricultural, 7 percent wetlands, and 7 percent developed (FirstLight, 2016a). However, the area within the project boundary and the immediate vicinity of Project No. 2622 is entirely urban with limited vegetative cover near the tailrace and along the shoreline of the Turners Falls Project No. 1889's bypassed reach.

Based on climatological data from 2000 to 2019 collected approximately 3.3. miles southwest of Project No. 2622 in Greenfield, Massachusetts, the annual average air temperature is 48 °F, with July being the warmest month and January being the coldest month (NOAA Online Weather Data, 2020). The average annual rainfall is 49.4 inches, and average annual snowfall is 47.0 inches. June is the wettest month and January is the driest month in terms of rainfall, and February is the snowiest month.

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[13] The upper reservoir of the Northfield Mountain Pumped Storage Project is located on Northfield Mountain and the project uses the Turners Falls Project No. 1889 impoundment as its lower reservoir. The upper reservoir has multiple dams and dikes, and the heights shown represent the range of heights over the underlying material. (Source: FirstLight (2016a) and USACE (2018)).

3.2 SCOPE OF CUMULATIVE EFFECTS ANALYSIS

According to the Council on Environmental Quality's regulations that implement NEPA (40 C.F.R. § 1508.7), a cumulative effect is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

Based on our review of the license application, as well as agency and public comments, we have identified resident fish species and migratory fish species (*i.e.*, alewife, American eel, American shad, blueback herring, sea lamprey, and shortnose sturgeon) as having the potential to be cumulatively affected by the continued operation and maintenance of the Turners Falls Project, in combination with other past, present, and foreseeable activities, such as the operation of hydroelectric projects in the Connecticut River Basin.

3.2.1 Geographic Scope

The geographic scope of the cumulative effects analysis defines the physical limits or boundaries of the proposed action's effects on the resource and contributing effects from other hydropower activities within the Connecticut River Basin. We have identified the geographic scope for our cumulative effects analysis for resident fish species to include the power canal and bypassed reach of Project No. 1889.

We have identified the Connecticut River Basin as our geographic scope of analysis for migratory fish species. We chose this geographic scope because the operation and maintenance of the Turners Falls Project, in combination with other dams and hydroelectric projects along the Connecticut River, may affect the movements of migratory fish within the Connecticut River Basin.

3.2.2 Temporal Scope

The temporal scope of our cumulative effects analysis includes a discussion of past, present, and reasonably foreseeable future actions and their effects on each resource that could be cumulatively affected. Based on the potential term of a subsequent license, the temporal scope looks 30 to 50 years into the future, concentrating on the effects on the resources from reasonably foreseeable future actions. The historical discussion is limited, by necessity, to the amount of available information. We identified the present resource conditions based on the license application, agency comments, and comprehensive plans.

3.3 PROPOSED ACTION AND ACTION ALTERNATIVES

In this section, we discuss the project-specific effects of Project No. 2622 alternatives on environmental resources. For each resource, we first describe the affected environment, which is the existing condition and baseline against which we measure project effects. We then discuss and analyze the site-specific environmental issues.

Only the resources that would be affected, or about which comments have been received, are addressed in detail in this EA. Based on this, we have determined that aquatic resources, terrestrial resources, threatened and endangered species, and cultural resources may be affected by the proposed action and alternatives. We have not identified any substantive issues related to geology and soils, land use, recreation, aesthetic resources, or socioeconomics associated with the proposed action; therefore, these resources are not addressed in the EA. We present our recommendations in section 5.1, *Comprehensive Development and Recommended Alternative*.

3.3.1 Aquatic Resources

3.3.1.1 Affected Environment

Water Quantity

Flows at Turners Falls Project No. 1889's Dam

Project No. 2622 receives water from the Connecticut River, which has a drainage area of approximately 11,250 square miles. The drainage area upstream of Project No. 1889's Dam is approximately 7,160 square miles. FirstLight (2012a) provided flow duration curves for the Connecticut River at Project No. 1889's dam. Based on the annual flow duration curve for 1941 to 2010 at the dam (Figure 4), Connecticut River flow exceeds Project No. 1889's capacity (*i.e.*, 15,938 cfs) approximately 29 percent of the time. Exceedance of 15,938 cfs ranges from 0 percent of the time in September to 93 percent of the time in April.

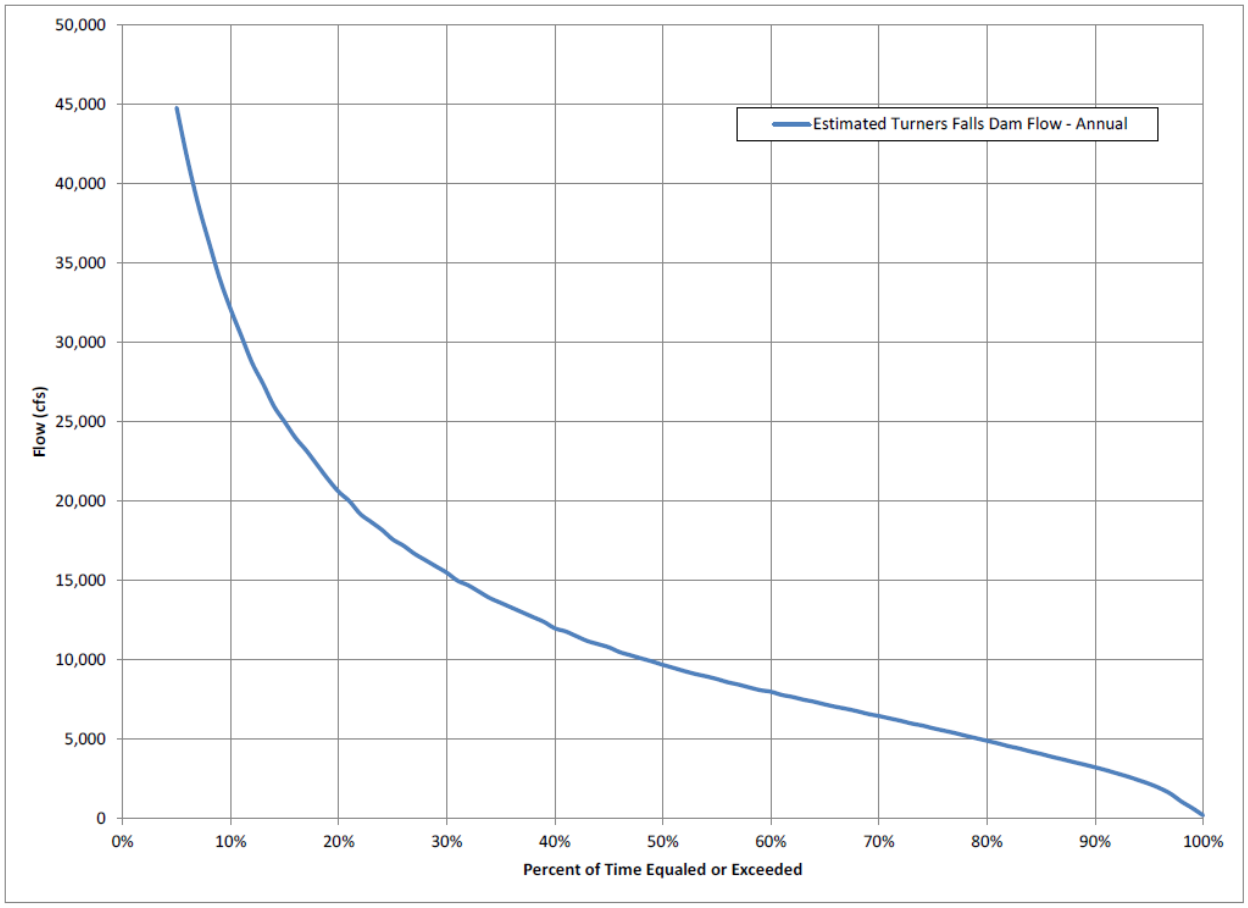


Figure 4. Annual flow duration curve for the Connecticut River at Project No. 1889's dam from January 1941 to September 2010. (Source: FirstLight, 2012a).

Project No. 1889's Power Canal Flows

The current license does not include any requirements that limit when Project No. 2622 can utilize flows from the power canal for hydropower generation. However, TFH coordinates the operation of the Turners Falls Project with the licensee of Project No. 1889 (FirstLight), pursuant to an off-license Water Use Agreement. The Water Use Agreement dictates that TFH can generate only when flows within the power canal are greater than 15,000 cfs, and water supply is sufficient for Project No. 1889's Station No. 1 and Cabot Station Developments to produce hydropower. TFH manually operates Project No. 2622 upon notice from FirstLight that water is available from the power canal for hydropower generation.

Based on the power canal flow duration curves provided by FirstLight (2012a) for 2000 to 2009, flow in the power canal exceeds 15,000 cfs, and the Turners Falls Project could operate, based on the Water Use Agreement, approximately 23 percent of the time on an annual basis (Figure 5). Exceedance of 15,000 cfs ranges from approximately 2 percent of the time in September to 75 percent of the time in April.

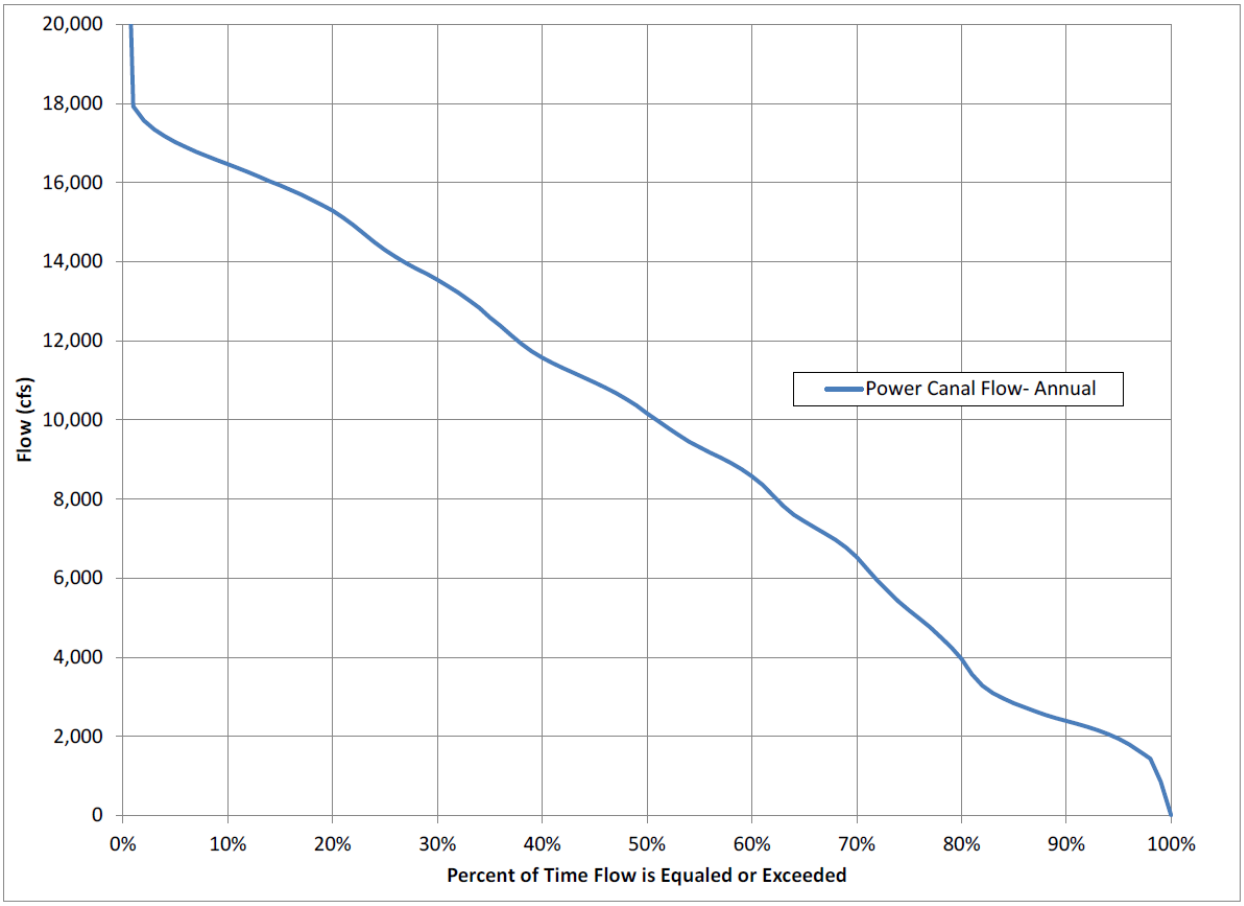


Figure 5. Annual flow duration curve for the Project No. 1889 power canal from 2000 to 2009. (Source: FirstLight, 2012a).

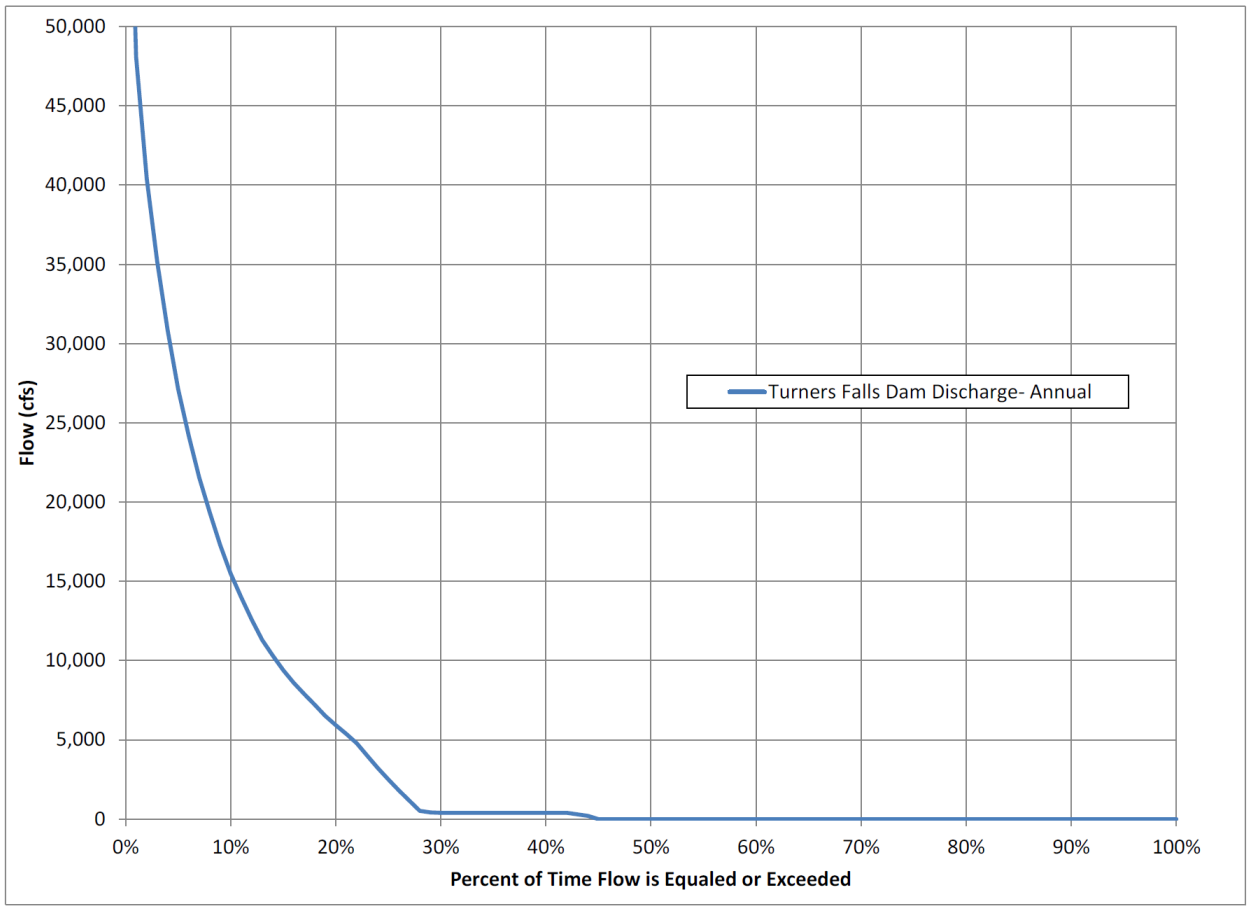
Project No. 1889's Bypassed Reach Flows

Project No. 1889 bypasses approximately 2.5 miles of the Connecticut River (Figure 3). The current license for Project No. 1889 requires a continuous minimum flow of 200 cfs in the Connecticut River bypassed reach starting on May 1 of each year. The current license also requires FirstLight to release 400 cfs into the bypassed reach at the beginning of the upstream fish passage season[14] through July 15, unless the upstream fish passage season ends prior to July 15. At the end of the upstream fish passage season, the

[14] The beginning and end of the upstream fish passage season is determined by the Connecticut River Atlantic Salmon Commission (CRASC), which consists of representatives from FWS, NMFS, Connecticut Department of Energy and Environmental Protection, Massachusetts DFW, New Hampshire FGD, and Vermont FWD. The upstream fish passage season typically begins in early April (FirstLight, 2016a).

minimum flow in the bypassed reach is reduced to 120 cfs.[15] FirstLight maintains a 120-cfs continuous minimum flow from the date the fishways are closed (or by July 16) until the river temperature drops below 44.6 °F, which typically occurs around November 15. After the river temperature drops below 44.6 °F each year, there is no required minimum flow for the bypassed reach until the earlier of the upstream fish passage season or May 1, as described above (FirstLight, 2013).

Figure 6 shows the annual duration curve for discharge from the Project No. 1889 dam into the bypassed reach. Overall, discharge is greater than or equal to 400 cfs approximately 42 percent of the time and exceeds 120 cfs approximately 44 percent of the time. The exceedance rate of 400 cfs declines from approximately 81 percent in April to approximately 17 percent in July (Table 2). For 120 cfs, the exceedance rate declines from 45 percent in July to 9 percent in September and then increases to 41 percent by November (Table 2).



[15] The 120-cfs flow release was determined in 1993 in consultation with Massachusetts DFW, NMFS, and the FWS to ensure that an adequate zone of passage exists in the reach during the months when sturgeon may be present.

Figure 6. Annual flow duration curve for the Project No. 1889's Turners Falls Dam discharge into the bypassed reach from 2000 to 2009. (Source: FirstLight, 2012a).

Table 2. Approximate exceedance of current minimum flow requirements by month in the reach of the Connecticut River that is bypassed by Project No. 1889.

Month	Current Required Minimum Flow	Percent Exceedance
April	400	81
May	400	37
June	400	19
July*	400 120	17 45
August	120	11
September	120	9
October	120	23
November	120	41

(Source: FirstLight, 2012a)
*The current license requires FirstLight to provide 400 cfs to the bypassed reach until the end of the upstream fish passage season or July 15, when the required minimum flow is 120 cfs.

Water Quality

State Water Quality Classifications

Massachusetts' water quality laws (314 CMR 4.00) establish the state's classification system for surface waters. The state of Massachusetts classifies the Connecticut River from Turners Falls Dam to the dam of the Holyoke Hydroelectric Project No. 2004 (Holyoke Project) as Class B, warm water. Massachusetts Department of Environmental Conservation's criteria for these waters include, but are not limited to:

(1) dissolved oxygen (DO) concentrations not less than 5 milligrams per liter (mg/L) unless natural background conditions are lower, whereupon DO shall not be less than natural background conditions; and

(2) water temperature not to exceed 83 °F in warm water fisheries, and the rise in temperature due to a discharge shall not exceed 5 °F in rivers and streams designated as warm water fisheries.

Water Quality Monitoring

While TFH did not conduct any water quality monitoring in the project area, FirstLight conducted a water quality monitoring study in 2015 as part of the relicensing of Project No. 1889, including monitoring locations in the Project No. 1889 impoundment, bypassed reach, power canal, and downstream of the Cabot Station powerhouse (sites 7 through 11, Figure 7).[16] FirstLight installed a continuous temperature and DO data logger 2 to 12 feet below the surface at each monitoring site and collected data every 15 minutes. Data collection began and ended on different dates for these monitoring sites, but FirstLight collected temperature and DO data at all five stations from May 14 through September 30 (FirstLight, 2016b).

[16] Site 7 is located in Project 1889's impoundment, approximately 0.5 mile upstream of the Turners Falls Project. Site 8 is located in Project 1889's bypassed reach of the Connecticut River, approximately 0.4 mile downstream from the Turners Falls Project tailrace. Site 9 is located in Project 1889's bypassed reach of the Connecticut River, approximately 1.3 miles downstream from the Turners Falls Project tailrace. Site 10 is located in Project 1889's power canal, approximately 0.4 mile downstream from the Turners Falls Project intake. Site 11 is located in the Connecticut River, approximately 0.5 mile downstream of the Project No. 1889 Cabot Station Development's tailrace.

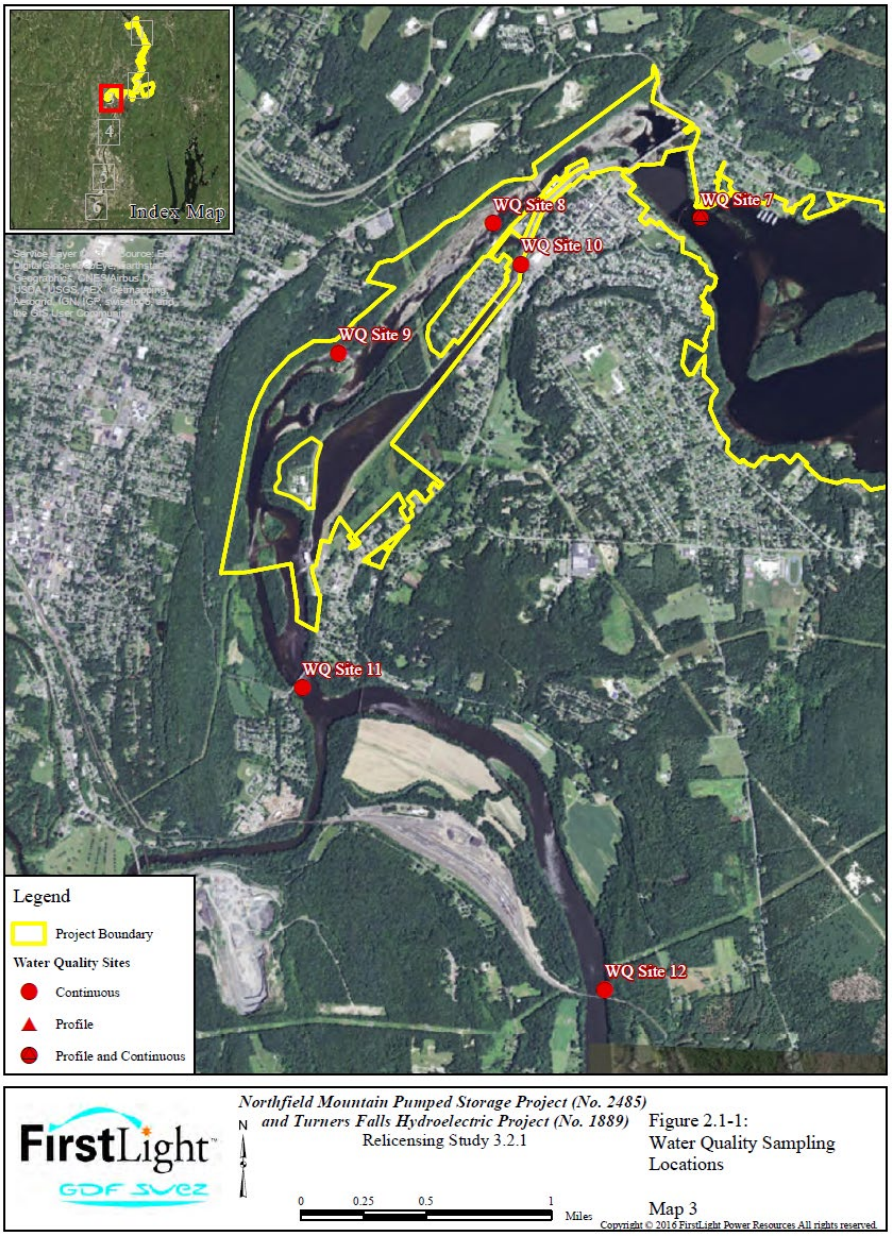


Figure 7. Water quality monitoring locations near the Turners Falls Project No. 2622 from FirstLight's 2015 water quality monitoring study for Project No. 1889. (Source: FirstLight (2016b)).

During the study, the monthly average DO concentrations ranged from 6.1 to 16.1 mg/L across the five monitoring locations. The lowest DO concentrations generally occurred in August and the highest concentrations occurred in June. The monthly mean DO concentration generally varied by less than 1 mg/L across the monitoring sites (Table 3). While DO concentrations at the impoundment site (site 7) and the power canal (site 10) were very similar, DO concentrations in the bypassed reach sites (sites 8 and 9), were consistently higher than the other sites. The higher DO concentrations observed in the bypassed reach were likely a combination of the installation depth of the data loggers

(*i.e.*, 2 to 3 feet in the bypassed reach versus 5 to 12 feet at the other sites) as well as the aerating effect of spill over the dam and the riffles present in the bypassed reach. DO concentrations were consistent with the Massachusetts Class B DO criteria of at least 5.0 mg/L at all five sites during the duration of the study (FirstLight, 2016b).

Table 3. DO concentrations (mg/L) at five water quality monitoring sites near the Turners Falls Project No. 2622.

Month	Statistic	Site 7 Project 1889 Impoundment	Site 8 Project 1889 Bypassed Reach	Site 9 Project 1889 Bypassed Reach	Site 10 Project 1889 Power Canal	Site 11 Downstream of Project 1889's Cabot Station Tailrace
May	Mean	9.8	10.5	10.2	9.9	9.9
	Min.	8.9	9.0	8.9	9.1	8.9
	Max.	10.5	11.8	11.6	10.4	11.2
June	Mean	9.6	10.4	9.6	9.5	9.9
	Min.	8.7	6.5	8.2	8.7	8.9
	Max.	10.8	16.1	11.4	10.9	11.2
July	Mean	8.7	9.4	8.4	8.7	8.8
	Min.	7.2	7.8	6.9	7.8	5.8
	Max.	10.1	15.3	11.4	9.6	10.5
August	Mean	7.8	8.5	8.3	7.9	7.9
	Min.	6.8	6.1	7.5	6.4	6.0
	Max.	8.7	9.6	9.5	8.6	8.6
September	Mean	7.9	8.8	8.4	7.8	8.0
	Min.	6.4	7.5	7.4	6.8	7.2
	Max.	9.3	10.4	10.5	8.8	9.5

(Source: FirstLight, 2016b).

During the study, the monthly mean water temperature ranged from 46.6 to 81.4 °F across the five monitoring locations. Water temperature increased from May through August and decreased slightly in September (Table 4). Except for May and September, the difference in average water temperature among the five sites was generally less than 0.9 °F. In May and September, the monthly mean water temperature in the impoundment

was approximately 2.9 and 1.4 °F warmer, respectively, than in the bypassed reach. In the power canal, the mean monthly water temperature was less than 0.2 °F warmer than in the impoundment, except for May when the power canal water temperature was 3.1 °F cooler. The difference in monthly mean water temperature between the power canal and the Connecticut River downstream of the Cabot Station tailrace was generally less than 0.3 °F. Therefore, the water in the project area appears consistent with Massachusetts Class B water temperature criteria.

Table 4. Water temperature (°F) at five water quality monitoring sites near the Turners Falls Project No. 2622.

Month	Statistic	Site 7 Project 1889 Impoundment	Site 8 Project 1889 Bypassed Reach	Site 9 Project 1889 Bypassed Reach	Site 10 Project 1889 Power Canal	Site 11 Downstream of Project 1889's Cabot Station Tailrace
May	Mean	63.3	60.3	60.3	60.2	60.3
	Min.	59.6	46.9	46.9	46.6	46.9
	Max.	70.2	71.6	71.0	70.2	70.8
June	Mean	65.9	66.0	66.0	66.0	66.1
	Min.	59.3	59.9	60.2	59.5	60.2
	Max.	70.0	70.2	70.7	70.1	70.3
July	Mean	73.0	72.8	72.8	73.0	73.1
	Min.	63.7	64.0	63.9	63.8	64.0
	Max.	78.3	80.1	79.9	77.9	78.2
August	Mean	77.6	76.7	77.1	77.7	77.6
	Min.	75.8	70.1	70.8	76.0	75.0
	Max.	79.9	81.3	81.4	80.1	80.3
September	Mean	73.9	72.5	73.6	74.1	73.8
	Min.	67.2	64.8	65.6	67.5	67.4
	Max.	78.6	80.2	79.6	79.1	80.0

(Source: FirstLight, 2016b).

Aquatic Habitat

Project No. 1889 Power Canal

The power canal is approximately 2.1 miles long, from the Project No. 1889 gatehouse to the Project 1889's Cabot Station Development (Figure 3). The original upstream portion of the canal was constructed around 1866, and the canal was subsequently widened, extended, and heightened around 1915 (FirstLight, 2015). The first 3,900-foot (ft) reach of the canal downstream of the gatehouse, in which the Turners Falls Project is located, is rectangular, with canal walls varying from masonry to concrete to cut-rock faces. The bottom width of the canal in this portion of the reach ranges from 170 ft at the gatehouse to 123 ft at the end of this 3,900-ft reach. The power canal in the vicinity of Project No. 2622's intake is approximately 17 feet deep, has mostly scoured bedrock ledge with some boulder and larger cobble-sized substrate. The next 3,300-ft reach has been excavated to a trapezoidal shape with 1.5H:1V slopes on both sides, and the canal walls are generally similar to the preceding segment.

The next 4,300-ft reach of the canal is essentially a pond covering about 50 acres. The surface width of the pond is approximately 783 ft at its widest point. The average depth of the pond was about 14 ft when the canal level was raised in 1915 (FirstLight, 2015).

The last 600 ft of the canal, extending from the "pond" to the Cabot Station Development, was excavated from rock and has earth and concrete walls. It is generally trapezoidal in shape, and riprap was added to the earth portions of the channel slopes for slope protection. The topography of the lower portion of the canal ranges from large areas of silt deposits, exposed bedrock, and coarse and fine grain sediments (FirstLight, 2015).

Bypassed Reach

The 2.5-mile long Connecticut River bypassed reach of Project 1889 runs from the base of Turners Falls Dam to the tailrace of Cabot Station (Figure 3). The tailrace of Project No. 2622 discharges to the bypassed reach about 0.4 mile downstream of Turners Falls Dam. In 2014 and 2015, FirstLight mapped aquatic habitat in the bypassed reach (FirstLight, 2016a). The bypassed reach has a low gradient (approximately 0.3%) and contains mostly bedrock, boulder, cobble, and gravel substrates. Pools are the dominant mesohabitat type, followed by riffles and backwater areas. In the immediate vicinity of the Turners Falls Project, the bypassed reach is pool habitat with cobble substrate.

Fishery Resources

The Connecticut River historically supported runs of migratory fish, including alewife, American eel, American shad, Atlantic salmon, Atlantic sturgeon, blueback

herring, shortnose sturgeon, and striped bass. However, access to the Connecticut River watershed for migratory fish species has been restricted since the first dam on the mainstem river was constructed in 1800 at the former naturally-occurring falls, at present-day Turners Falls, Massachusetts (Gephard and McMenemy, 2004). Construction of the dam extirpated Atlantic salmon shortly thereafter (Atkins, 1874 and CRASC, 1998 *in* Gephard and McMenemy, 2004). However, different Atlantic salmon restoration programs existed for varying lengths of time between 1867 to 2012 when FWS announced it was discontinuing Atlantic salmon restoration in the Connecticut River due to low salmon returns, other emerging restoration priorities, and the cost to repair the White River National Fish Hatchery.[17] Other migratory fish species (*e.g.*, American eel, American shad, sea lamprey) persisted in reduced numbers despite the construction of dams downstream in Holyoke (river mile 87) and Enfield, Massachusetts (river mile 64), because some spawning habitat remained accessible downstream of these dams (Gephard and McMenemy, 2004).[18] Management and restoration efforts continue for American eel, alosines, and sea lamprey.[19]

The Connecticut River watershed also contains a variety of resident coldwater and warmwater fish species that offer sport fishing opportunities. These gamefish include native species, such as brook trout, pumpkinseed sunfish, and yellow perch, as well as non-native species, such as brown trout, smallmouth bass, and walleye.

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[17] The White River National Fish Hatchery reared adult Atlantic salmon to produce smolts used for the restoration effort. The hatchery was severely damaged by Tropical Storm Irene in August 28, 2011, and 25 percent of the salmon brood stock was killed.

[18] The dam at Enfield, Massachusetts, was constructed in 1880. The dam was washed out by high flows in 1978.

[19] Alewife, American shad, and blueback belong to the genus *Alosa* and are collectively referred to as "alosines."

Anadromous Fish[20]

American Shad

American shad migrate into the lower Connecticut River during late March or April, reaching the Cabot Station Development of Project No. 1889 between late April and mid-May as they move upstream to spawn. Shad spawning typically occurs from April through June. American shad tend to spawn in areas dominated by runs and glides, 3 to 18 feet deep, and have been observed to spawn over a variety of substrates, but prefer sand and gravel (Stier and Crance, 1985). This type of habitat most closely corresponds to the runs and glides occurring downstream of Cabot Station, but is very limited in the bypassed reach. Female shad broadcast their eggs, about 290,000 per individual, in open water. Shad are batch spawners (McBride *et al*., 2016), which means that females can spawn multiple times during a spawning season and produce an average of 6.7 batches during the spawning season. Spawning activity primarily occurs after sunset before midnight but can also occur during daylight hours on overcast days. In northern latitudes such as the New England region, shad often survive spawning, unlike in southern regions (south of Cape Hatteras) where most fish die after spawning (Leggett and Carscadden, 1978). The proportion of repeat spawners in the Connecticut River has ranged from 53 percent in 1966 to 2 percent in 2015 (CRASC, 2017).[21] In recent years, the percentage of repeat spawners in the Connecticut River has been persistently low. The percentage of repeat spawners since 2010 has been 10 percent or less (CRASC, 2017). In contrast, Grote *et al*. (2014) found that 75 to 95 percent of American shad in the Penobscot River, in Maine, were repeat spawners.

FirstLight (2016c) conducted shad spawning surveys in May through June 2015 in the Project No. 1889's impoundment, power canal, and bypassed reach, and downstream of the Cabot Station Development. Regarding spawning activity near the Turners Falls Project, FirstLight documented shad spawning in the bypassed reach in a 2.7-acre area downstream of Rock Dam[22] and in a 0.9-acre area in the power canal downstream of the Turners Falls Project, where the canal begins to widen (Figure 3).

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[20] An anadromous fish, born in fresh water, spends most of its life in the sea and returns to fresh water to spawn. Additional information on the federally endangered shortnose sturgeon (*Acipenser brevirostrum*) can be found in section 3.3.4, *Threatened and Endangered Species*.

[21] The term "repeat spawners" refers to adult shad that survive spawning and return to the river in subsequent years to spawn.

[22] Rock Dam is natural bedrock ledge located approximately 1.5 miles downstream from the Turners Falls Project tailrace.

Young shad generally remain in river habitats for a few months before out-migrating to the sea as juveniles during late summer and early fall. Peak out-migration occurs when water temperatures begin to steadily fall below 66-69 ºF (O'Leary and Kynard, 1986). Although the timing of out-migration in a given river system can vary from year to year depending on environmental conditions (O'Leary and Kynard, 1986; Limburg *et al*., 2003), out-migration of juveniles in the project area occurs from summer through late fall with peaks in mid-August, late September, and early November (FirstLight, 2016d). Most daily movement occurs in evening hours until about 2300 hours, but movement can occur around-the-clock (Hartel *et al.*, 2002; FirstLight, 2016d). Collette and Klein-MacPhee (2002) reported that male shad mature after three to five years at sea, while females mature in four to six years. Upon maturing, shad return to their natal (birth) rivers to spawn.

River Herring

Alewives and blueback herring spend most of their lives at sea but return to their natal rivers along the eastern seaboard of North America to reproduce (Greene *et al*., 2009). Spawning runs of alewife occur earlier (March through May in the Connecticut River) than those of blueback herring and American shad (April through June) (Loesch, 1987; Saunders *et al*., 2006). In the Connecticut River, alewife use the lower portion of the river, but rarely pass above the dam of the Holyoke Project. Thus, blueback herring is the primary river herring found in the project area (Hartel *et al.*, 2002).

However, blueback herring in the Connecticut River and coast-wide experienced a decline in the mid-1990s. While hundreds of thousands of blueback herring passed upstream of the Holyoke Project in the 1980s, since 2010, only between 39 and 5,052 have passed the Holyoke Project (in 2012 and 2019, respectively) (FWS, 2020). Few blueback herring have been recorded in the project area since the late 1990s (FirstLight, 2016a). Causes for the decline were thought to be similar to those listed for American shad with offshore bycatch and predation by striped bass most likely accounting for the decline in the Connecticut River.

Adult blueback herring enter the mouth of the Connecticut River at about the same time as American shad. Blueback herring broadcast spawn on hard substrate in swift-flowing tributaries to the Connecticut River. Presumably, some spawning also occurs in the mainstem Connecticut River, where swift-flowing habitats with hard substrate are available (Hartel *et al.*, 2002). Females may produce 122,000 to 261,000 eggs, with larger fish generally producing more eggs than smaller fish. Eggs are initially associated with the bottom but become planktonic. Pardue (1983) reports that larvae in Chesapeake Bay remain near or slightly downstream of presumed spawning areas, and in Nova Scotia are associated with relatively shallow (*i.e.*, less than 6.6 feet), sandy, warm areas in and near areas of observed spawning.

Blueback herring in other river basins have been reported to spawn in both swift-flowing, deeper stretches and in slower-flowing tributaries and flooded low-lying areas adjacent to the stream where substrates may vary from coarse to fine materials (Pardue, 1983). Active spawning may occur over a wide range of water velocities. FirstLight (2012a) identified that the uppermost segments of the reach downstream of Cabot Station consist of riffle habitat with swift-flowing conditions, but swift-flowing runs are well distributed throughout the 30-mile reach downstream of Cabot Station tailrace, along with portions of the bypassed reach below Turners Falls Dam. Most of the runs featuring the hard substrates (*e.g*., cobble and/or gravel) can be found in the first 14 miles of river downstream of the Cabot Station tailrace. Fines such as sand dominate the substrates in the remaining downstream reaches.

Juveniles remain in the river, feeding on zooplankton, until the fall of the year then emigrate to the sea (Collette and Klein-MacPhee, 2002). These characteristics of their development parallel those of American shad and the young of the two species are difficult to distinguish. Juvenile blueback herring begin their seaward migration slightly earlier and at higher water temperatures (peaking at 57 to 59 °F) than American shad. Adult blueback herring spend three to six years at sea before returning to spawn in their natal streams. The average length of adults is less than 300 mm (Hartel *et al.*, 2002).

Sea Lamprey

Adult sea lamprey are parasitic fish that feed on other fish species using their sucking disc, rasping teeth, and tongue to attach to and penetrate the tissues of prey fish. The sucking disc is also used during spawning to construct 1 to 3-foot diameter nests in the substrate. Similar to other anadromous species, sea lamprey do not feed during their upstream spawning migration and thus are not parasitic while in the river (Hartel et al., 2002).

Historically, sea lamprey spawned and reared throughout a large portion of the Connecticut River Watershed and migrated as far upstream as the Bellows Falls Project and potentially farther (Scarola, 1973). In the Connecticut River, sea lamprey can use upstream fish passage facilities and have been found as far upstream as the White River (approximately 94 miles upstream of Project No. 1889's Dam) during a 2015 tracking study (FirstLight, 2016e). Sea lamprey spawn during the spring in shallow areas of moderate current with gravel, and rubble substrate.

Pre-spawning adults create a depression in the substrate by carrying larger rocks out of the nest area and by sweeping smaller particles out using rapid body movements. The female then deposits eggs, which are then fertilized by the male, and continues moving rocks and gravel as necessary until all her eggs have been released. Spawning in one nest, or redd, may continue from 16 hours to 3.5 days. During the spawning run, adults undergo considerable physiological change and deterioration and die after spawning.

After hatching, the larvae remain in the substrate for several days before emerging and drifting downstream. The larvae settle in depositional areas with soft substrate and transform into ammocoetes. Ammocetes burrow into soft sediments and emerge from the sediment surface to filter feed. This stage lasts up to seven years until the ammocoetes transform into the parasitic adult phase and migrate to sea. Downstream migration occurs in primarily in the spring, but also during the fall.

During late spring and early summer of 2015, FirstLight assessed lamprey spawning activity and habitat within the Turners Falls Project area utilizing radio telemetry techniques and visual surveys of identified redds. FirstLight found sea lamprey redds upstream and downstream of the Turners Falls Project, with the closest spawning area consisting of two redds in the Fall River just upstream of its confluence with the bypassed reach (FirstLight, 2016e), which is approximately 0.4 mile upstream of Project No. 2622's tailrace. In addition, FirstLight frequently observes sea lamprey ammocetes in the lower reach of the power canal during annual canal maintenance drawdowns.

Catadromous Fish

American eel is the only catadromous fish species that occurs at Project No. 2622.[23] The American eel spends most of its life in fresh or brackish water before migrating to the Sargasso Sea in the middle of the North Atlantic to spawn. It occurs throughout warm and cold waters of the Atlantic Ocean and Atlantic coastal drainages in North America (Boschung and Mayden, 2004). Within its range, it is most abundant throughout the Atlantic coastal states (ASMFC, 2000).

Spawning likely occurs from February through April in the Sargasso Sea, although the act of spawning has never been observed (Boschung and Mayden, 2004). Fertilized eggs and larvae, known as the planktonic phase, drift with the Gulf Stream currents along the east coast of the United States (Jenkins and Burkhead, 1993). Following this phase, the planktonic leptocephali, ribbon-like eel larvae, metamorphose (or transform) into what is termed a "glass" eel as it approaches coastal waters. Glass eels are completely transparent and make their way into brackish waters using flood tides. Once skin pigments develop in glass eels, they are considered "elvers."[24]

As eels mature, elvers become juvenile, or "yellow" eels. The majority of eels collected in freshwater rivers are typically yellow eels, which is considered the primary

[23] A catadromous fish spends most of its life in freshwater and migrates to saltwater to spawn.

[24] Elvers often serve as important forage fish for striped bass and other large piscivores.

growth phase of its life cycle (Ross *et al*., 2001). Yellow eels are typically sedentary during the day, often burying in mud or silt, and becoming active at night to feed (Jenkins and Burkhead, 1993). They associate with pools or backwater habitats, and often have relatively small home ranges (Gunning and Shoop, 1962). The juvenile stage can last from five to 40 years before finally maturing into silver eels and out-migrating in the fall and mid-winter months to spawning grounds (*i.e.*, Sargasso Sea) (Boschung and Mayden, 2004).[25] Adult eels are presumed to die after spawning (Boschung and Mayden, 2004; Jenkins and Burkhead, 1993).

In New England, adult eel out-migration typically occurs from mid-August through mid-November (Haro *et al*., 2003). Adult eels often move downstream in intermittent pulses, with a large number of eels moving downstream during short periods of activity (1 to 3 days), followed by longer periods of time (7 to 20 days) with relatively little downstream eel movement (EPRI, 2001). Peak downstream movements often occur at night, during periods of increasing river flow (Richkus and Whalen, 1999). Other environmental cues such as local rain events and moon phase may also encourage downstream movements of out-migrating eels (EPRI, 2001; Haro *et al*., 2003).

The historical upstream limit of eels in the Connecticut River was the Connecticut Lakes. Currently, American eel abundance declines rapidly upstream of the Project No. 1889. However, Great River Hydro, LLC has documented yellow eels using the upstream fish passage at the Vernon (FERC No. 1904), Bellows Falls (FERC No. 1855), and Wilder (FERC No. 1892) Projects (Great River Hydro, 2017) that occur upstream of Project No. 1889. In addition, Great River Hydro collected a single silver eel downstream of the Vernon Project and another silver eel in the impoundment of the Wilder Project (Great River Hydro, 2017).

To collect more precise data about when adult eels move downstream in the project area, FirstLight installed a dual-frequency identification sonar (DIDSON) in the power canal, approximately 0.2 mile downstream from the Turners Falls Project intake, from August 1 through November 15 in 2015 and 2016 (FirstLight, 2017a).[26] FirstLight detected 70 eels total during the two years. The highest eel counts occurred in August

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[25] Juvenile eels that reside in estuaries reach maturity and migrate earlier than juveniles found in freshwaters. These eels can reach full maturity without migrating to freshwater (Shepard, 2015).

[26] The DIDSON is an imaging sonar that records videos of fish moving through the sonar beam. The video recorded by the DIDSON supports confident visual identification of eels moving through the sonar beam because of their distinct shape and swimming motion.

2015 and in mid-October 2016. However, a lower, secondary peak occurred in mid-October, 2015 and in early September 2016.

Resident Fish

The Connecticut River in the vicinity of the Turners Falls Project, including the Project No. 1889's bypassed reach and power canal, supports a variety of warm water resident fish. Dominant family groups include sunfish and black bass, perch, suckers, and minnows. Common sunfish and black bass species in the project area include warmwater gamefish such as largemouth and smallmouth bass, crappie, bluegill, and pumpkinseed sunfish. Among the minnow species reported in the Connecticut River are the spottail shiner, fallfish, and common shiner. Yellow perch and walleye are two common perch species found in the area.

Freshwater Mussels

In 2011, FirstLight conducted a freshwater mussel survey in a 3.5-mile reach from the Project No. 1889 dam to the confluence of the Connecticut River and the Deerfield River (2.7 of the 3.5 miles of the survey area is in the bypassed reach), and a survey in the power canal (2.1 miles) (FirstLight, 2012b). The objective of the survey was to assess the distribution, abundance, and habitat of freshwater mussels. FirstLight surveyed the bypassed reach during low flow conditions in August and surveyed the power canal during a canal drawdown in September. FirstLight documented five freshwater mussel species, including the eastern elliptio, alewife floater, eastern lampmussel, eastern floater, and triangle floater. Mussels were found in a wide range of water depths, flow conditions, and substrate conditions. Eastern elliptio occupied in nearly all the sites sampled in the power canal and bypassed reach and was 100 to 1,000 times more abundant than the other species. In the power canal, FirstLight found 16 alewife floaters and 2 eastern floaters. In the bypassed reach, FirstLight found 1 triangle floater, 10 alewife floaters, and 2 eastern lampmussels.

3.3.1.2 Environmental Effects

Water Quality

TFH proposes to operate Project No. 2622 "continuously" (*i.e.*, operate Project No. 2622 any time flow to the project intake is greater than or equal to the 60-cfs minimum hydraulic capacity of the project), instead of limiting project operation to when flow in the power canal is greater than 15,000 cfs, as stipulated in the off-license Water

Use Agreement that is currently in place between TFH and FirstLight.[27] No entity provided comments regarding the effects of Project No. 2622 on water quality.

Our Analysis

Given that the Turners Falls Project only transfers water from the Project No. 1889 power canal to the bypassed reach and does not store any water for project purposes, the Turners Falls Project does not significantly affect water temperature or dissolved oxygen concentrations in the power canal or bypassed reach.

Water Quantity and Aquatic Habitat[28]

TFH proposes to operate Project No. 2622 "continuously" (*i.e.*, operate Project No. 2622 anytime flow to the project intake is greater than or equal to the 60-cfs minimum hydraulic capacity of the project), instead of limiting project operation to when flow in the power canal is greater than 15,000 cfs, as stipulated in the off-license Water Use Agreement that is currently in place between TFH and FirstLight.[29] No entity

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[27] In section 1.3 of Exhibit A of the February 6, 2019 license application, TFH states that it "proposes to continue operating the Project as currently licensed during the next license term, with the flexibility to operate up to continuously or to operate under the current or a modified Water Use Agreement between [TFH] and FirstLight." In its July 3, 2019 response to Commission staff's request for additional information, TFH explains that it is "considering operating the Project as currently licensed (*i.e.*, continuously), or under the existing off-license Water Use Agreement, or a modified off-license Water Use Agreement between TFH and FirstLight."

[28] Potential environmental effects of the project on shortnose sturgeon are discussed in section 3.3.3, *Threatened and Endangered Species.*

[29] In section 1.3 of Exhibit A of the February 6, 2019 license application, TFH states that it "proposes to continue operating the Project as currently licensed during the next license term, with the flexibility to operate up to continuously or to operate under the current or a modified Water Use Agreement between [TFH] and FirstLight." In its July 3, 2019 response to Commission staff's request for additional information, TFH explains that it is "considering operating the Project as currently licensed (*i.e.*, continuously), or under the existing off-license Water Use Agreement, or a modified off-license Water Use Agreement between TFH and FirstLight."

provided comments regarding the effects of Project No. 2622 on water quantity and aquatic habitat.[30]

Our Analysis

During operation, the Turners Falls Project transfers 289 cfs from the power canal of Project No. 1889 to the bypassed reach of Project No. 1889 (Figure 3), which could affect the aquatic habitat in both reaches. TFH did not collect any aquatic habitat data from the power canal or bypassed reach. Therefore, staff analyzed the power canal flow duration curves from 2000 to 2009 provided by FirstLight (2012a) and the results of an instream flow study that FirstLight (2016f) conducted in the bypassed reach.

Power Canal

In 2014, FirstLight conducted a power canal drawdown to examine the power canal structure (FirstLight, 2015). During the drawdown, FirstLight recorded the presence of resident and migratory fish species, as well as freshwater mussels, in the lower reach of the power canal. Among the resident species found in the power canal were smallmouth and largemouth bass, bluegill and pumpkinseed sunfish, golden and spottail shiners, walleye, and yellow perch. The migratory fish species included American eel, American shad, and sea lamprey ammocetes. In addition, FirstLight (2016c) observed American shad spawning in the power canal approximately 1.4 miles downstream from intake of the Turners Falls Project. Because the Turners Falls Project transfers 289 cfs from the power canal to the bypassed reach, project operation may affect the spawning and foraging habitat used by resident and migratory species in the power canal.

TFH currently operates Project No. 2622 in accordance with the Water Use Agreement described above. Under this operating scenario, the Turners Falls Project transfers approximately 1.6 to 1.9 percent of the flow from the power canal to the

[30] In its November 26, 2019 comments, FirstLight speculates that any new license for Project No. 1889 will require "substantially more flow to be spilled at Turners Falls Dam." FirstLight recommends that staff evaluate the aquatic habitat effects of increasing the minimum flow released from the Turners Falls Dam to the bypassed reach. However, a new license has not been issued for Project No. 1889 and any new minimum flow release requirements for Project No. 1889 would not be considered a project effect for the Turners Falls Project. Further, the Turners Falls Project is unlikely to affect aquatic habitat in the bypassed reach upstream of the project tailrace. Therefore, staff's analysis does not assess the effects of increasing minimum flow releases from Turners Falls Dam to the bypassed reach.

bypassed reach when producing hydropower.[31] As described in section 3.3.1.1, *Aquatic Resources, Affected Environment, Water Quantity*, the Turners Falls Project could operate 23 percent of the time on an annual basis under the terms of the Water Use Agreement (*i.e.*, based on how often flows exceed 15,000 cfs). On a monthly basis, Project No. 2622 could have operated from a minimum of 2 percent of the time in September to a maximum of 75 percent of the time in April, under the terms of the Water Use Agreement. Given that the Turners Falls Project removes less than 2 percent of the flow in the power canal when operating under the current Water Use Agreement, the effect of project operation on aquatic habitat in the power canal is likely minimal, especially compared to the monthly variability shown by the power canal flow duration curves.[32] Any effects are likely limited to near the shoreline of the pond-like reach of the power canal, which lies approximately 1 mile downstream of the Turners Falls Project. This area has an extensive, shallow mudflat along the northwest shore, and a minimal amount of foraging, spawning, and nursery habitat used by minnows, sunfish, and bass may be exposed by the operation of the Turners Falls Project. Under these conditions, any effects on fish foraging, spawning, nursery, mussel, and sea lamprey ammocete habitats would likely be minor and less than the effects of the seasonal variability in flow or the effects of the operation of the Project No. 1889 Cabot Station and Station No. 1 powerhouses, especially given the intermittent operation of the Turners Falls Project. Because the area where FirstLight (2016c) observed shad spawning was in deeper water, the intermittent transfer of 289 cfs from the power canal to the bypassed reach is unlikely to affect shad spawning.

Under TFH's proposal to operate Project No. 2622 "continuously," without the limitations that are currently implemented under the off-license Water Use Agreement, the project's effect on aquatic habitat in the power canal would vary by month and the amount of flow in the power canal. Assuming Project No. 2622 operates at its maximum hydraulic capacity of 289 cfs, the Turners Falls Project would generally transfer 10 percent or less of the water in the power canal to the bypassed reach (Table 5). Under these conditions, Project No. 2622's effects would likely be relatively minor and similar to the effects described above under the existing project operation that is subject to the off-license Water Use Agreement. However, under low flow conditions (i.e., 90 percent exceedance) in July, August, and September, the Turners Falls Project would transfer nearly 20 percent of the water in the power canal to the bypassed reach. As mentioned earlier, the lower, pond-like part of the power canal would likely be the area most

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[31] Pursuant to the Water Use Agreement, the Turners Falls Project currently only operates when flow in the power canal exceeds 15,000 cfs, and the maximum hydraulic capacity of the power canal is approximately 18,000 cfs. Consequently, 289 cfs is 1.6 percent of 18,000 cfs and 1.9 percent of 15,000 cfs.

[32] *See* pages 18 to 22 of Exhibit E of the final license application.

affected due to the presence of the wide, shallow area along the northwest side of the power canal. Further reducing the amount of the water in the power canal during low-flow conditions could potentially force any fish living in the power canal into a smaller amount of wetted habitat in the deeper areas of the power canal. Few, if any species, would be spawning during this time of the year, but foraging and nursery habitat would be reduced. In addition, operating Project No. 2622 during low flow conditions from July through September could potentially strand non-motile organisms, such as sea lamprey ammocetes and freshwater mussels, low numbers of which were found in this area during the 2014 power canal drawdown study (FirstLight, 2015). While these conditions only occurred 10 percent of the time overall during these months from 2000 to 2009, the duration of these effects in a given month would depend upon the duration of the low flow period and the length of time Project No. 2622 would generate during a particular low-flow period.

Table 5. Monthly 90, 50, and 10 percent power canal exceedance flows from 2000 to 2009, and the percentage of flow removed from the power canal and discharged into the bypassed by the Turners Falls Project.

Month	90 Percent Exceedance		50 Percent Exceedance		10 Percent Exceedance	
	Canal Flow (cfs)	Percent Withdrawn by TFH[a]	Canal Flow (cfs)	Percent Withdrawn by TFH	Canal Flow (cfs)	Percent Withdrawn by TFH
January	3,500	8.3	10,000	2.9	15,800	1.8
February	2,900	10.0	8,400	3.4	14,500	2.0
March	5,000	5.8	12,400	2.3	17,000	1.7
April	12,500	2.3	16,000	1.8	17,300	1.7
May	7,200	4.0	14,700	2.0	17,300	1.7
June	2,600	11.1	10,300	2.8	16,200	1.8
July	1,500	19.3	6,200	4.7	15,400	1.9
August	1,800	16.1	5,200	5.6	14,200	2.0
September	1,600	18.1	3,000	9.6	10,500	2.8
October	2,200	13.1	7,900	3.7	14,100	2.0
November	3,000	9.6	11,300	2.6	16,100	1.8
December	4,500	6.4	11,400	2.5	16,200	1.8
Annual	2,400	12.0	10,000	2.9	16,500	1.8

[a] Staff calculated the percentage of water withdrawn from the power canal by the Turners Falls Project by dividing Project No. 2622's maximum hydraulic capacity (*i.e.*, 289 cfs) by the canal flow.
Source: (FirstLight, 2012a and staff).

Bypassed Reach

During 2014 and 2015, FirstLight conducted an instream flow study in the bypassed reach to assess the potential effects of discharges from Project No. 1889's dam, Station No. 1 Development, and Cabot Station Development on wetted area and aquatic habitat suitability in the Connecticut River downstream of the dam (FirstLight, 2016f; Figure 3). To evaluate the effects of different flow levels on aquatic organisms in the bypassed reach, FirstLight conducted a literature review to define habitat suitability criteria for multiple life stages of American shad, shortnose sturgeon, white sucker, fallfish, longnose dace, tessellated darter, and benthic macroinvertebrates. Because some fish species did not have existing habitat suitability criteria, FirstLight defined suitability criteria for habitat use "guilds."[33] The guilds FirstLight defined were based on depth and water velocity and included shallow-slow, shallow-fast, deep-slow, and deep-fast guilds (Table 6).

Table 6. Species found in the project area included in the instream flow study habitat guilds.

Guild	Species	
Deep-slow	white perch	yellow perch
	bluegill	carp
Deep-fast	carp	
Shallow-fast	mottled and slimy sculpins	slimy sculpin
Shallow-slow	banded killifish	chain pickerel
	largemouth bass	smallmouth bass
	redbreast sunfish	black crappie
	bluegill	pumpkinseed sunfish

[33] Guilds are groups of species that occupy similar habitat.

	carp	three-spine stickleback

(Source: FirstLight, 2014, as modified by staff).

As part of the study, FirstLight collected depth, velocity, and substrate data from two transects (transects 10 and 11) located approximately 0.4 mile downstream from the Turners Falls Project tailrace and approximately 300 feet upstream from the tailrace of the Station No. 1 Development (Figure 8). FirstLight collected stream bed and water surface elevation data at three test calibration flows, 200, 700, and 4,000 cfs. FirstLight collected velocity data at 200 and 700 cfs and substrate data at 200 cfs. FirstLight then used these data in a one-dimensional physical habitat simulation system model (PHABSIM) to evaluate how habitat suitability for the included species and life stages changed at different flow levels. Because the operation of Station No. 1 caused a backwatering effect at the two transects, FirstLight analyzed the conditions when Station No. 1 was shut down (low backwater conditions) and when it was operating (high backwater conditions). Downstream of these transects, habitat availability in the bypassed reach is also affected by Station No. 1 operation, Cabot Station operation, and Deerfield River flow (FirstLight, 2016f; Figure 3)

Figure 8. Transect locations for FirstLight's instream flow study in the bypassed reach. Transect 10 and 11 are shown as T10 and T11. (Source: FirstLight, 2016f).

Using PHABSIM, FirstLight (2016) calculated the weighted usable area (WUA) of habitat at the two transects for the species and life stages of interest at 18 different flows for low and high backwater conditions (Appendix A, Tables A1 and A2).[34] To assess the effects of the Turners Falls Project on habitat suitability in the bypassed reach, staff analyzed the percent change in WUA in 200 to 250-cfs increments from 120 to 2,000 cfs to approximate how much the percentage of maximum WUA available would change from an additional 289 cfs (the maximum hydraulic capacity of the Turners Falls Project) discharged into the bypassed reach when the Turners Falls Project is operating.

Low Backwater Conditions

During low backwater conditions, the maximum WUA for the species and life stages of interest in the area represented by transects 10 and 11 ranges from 0.0 acres to 31.2 acres (Table 7). The flow at which maximum WUA occurs ranges from 150 to 7,500 cfs, depending on the life stage and the species/guild. The amount of WUA at transects 10 and 11 increases with flow from 120 cfs to 2000 cfs for all life stages of American shad, shortnose sturgeon spawning and eggs/larvae, all life stages of fallfish, all stages of longnose dace, walleye spawning/incubation and adults, tessellated darter, macroinvertebrates, and the deep-fast guild. The WUA increases, then decreases at flows at or approaching 2,000 cfs for white sucker fry and juveniles/adults, walleye fry, the shallow-slow guild, shallow-fast guild, and the deep-slow guild. For fallfish spawning/incubation, fallfish fry, and walleye juveniles, the maximum WUA occurs at or under 200 cfs. There is no available habitat at these transects for white sucker spawning/incubation or walleye fry.

The largest change in WUA generally occurs at the lower end of the flow range when the 289-cfs discharge from the Turners Falls Project represents a larger proportion of flow at the two transects. The largest change in WUA occurred in the interval between 120 cfs and 400 cfs for 13 species/life stages (Table 7). Overall, the additional 289-cfs flow discharged from the Turners Falls Project appears to increase the amount of habitat for most species and life stages at transects 10 and 11 for bypassed reach flows between 120 and 2,000 cfs during low backwater conditions. However, because of the intermittent operation of the Turners Falls Project under the current Water Use Agreement (*i.e.*, where operation is limited to approximately 23 percent of the year, as discussed in section 3.3.1.1), any benefit of the additional 289 cfs in the bypassed reach would be temporary. In contrast, continuous operation of the Turners Falls Project, as proposed by TFH, would allow the additional habitat provided by the 289-cfs discharge to remain more consistently wetted.

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[34] FirstLight calculated WUA at 120, 150, 200, 250, 400, 500, 600, 700, 800, 1,000, 1,200, 1,400, 1,600, 1,800, 2,000, 3,000, 4,000, and 5,000 cfs.

While the addition of the 289-cfs discharge from the Turners Falls Project generally increases habitat availability, that habitat becomes unavailable when Project No. 2622 ceases generation, which would be less common under TFH's proposal to operate the project on a continuous basis. There is potential for spawning to be disrupted and for some species and life stages to be stranded in shallow areas when Project No. 2622 ceases generation. The potential for stranding depends upon the habitat preferences of the species and life stages and the shape of the streambed downstream of Project No. 2622. Species and life stages preferring shallow areas near the stream margin would be more likely to be stranded when generation ceases. In addition, life stages with no or poor swimming ability, such as eggs and larvae, would be more likely to be stranded because they would not be able to retreat to deeper water fast enough. Further, the habitat for spawning/incubation and larval stages of several species had the greatest increase in habitat availability at flows less than 700 cfs (Table 7), which suggest that shallow habitat becomes available with additional flow at bypassed reach flow levels under 700 cfs. Staff cannot thoroughly evaluate stranding potential because FirstLight (2016f) did not provide streambed profiles for transects 10 and 11. However, stranding potential is likely highest at low flows when discharge from the Turners Falls Project represents a large percentage of total bypassed reach flow and more habitat becomes available for species and life stages that use shallow areas. While stranding potential may be highest at lower flows, there are no reports in the record of fish stranding between the Turners Falls Project and the Station No. 1 Development.

Table 7. Minimum, median, and maximum percent change in weighted usable area (WUA) for flows between 120 and 2,000 cfs at transects 10 and 11 during low backwater conditions.

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	Minimum Percent WUA Change	Median Percent WUA Change	Maximum Percent WUA Change	Change in Flow (cfs) for Largest Positive or Negative Percent Change
American Shad	Spawning/ Incubation	May-June	7,500	20.0	4.0%	5.3%	9.4%	120 to 400
American Shad	Juvenile	June-Oct	2,000	14.2	2.3%	7.7%	14.8%	120 to 400
American Shad	Adult	May-June	7,500	14.4	3.7%	4.0%	8.0%	120 to 400
Shortnose Sturgeon	Spawning/ Incubation	April-May	6,000	20.1	2.5%	7.5%	14.2%	120 to 400
Shortnose Sturgeon	Egg-Larvae	May	3,000	31.2	2.7%	6.8%	16.4%	1000 to 1200
Shortnose Sturgeon	Fry	May	700	1.4	-2.5%	1.8%	32.6%	120 to 400
Fallfish	Spawning/ Incubation	May-June	120	0.1	-41.5%	-19.5%	0.0%	120 to 400
Fallfish	Fry	May-June	200	0.7	-28.9%	-9.5%	0.9%	500 to 700
Fallfish	Juvenile	Year Round	2,000	5.4	0.3%	4.1%	19.2%	150 to 400
Fallfish	Adult	Year Round	2,000	10.1	-4.4%	5.6%	14.8%	1,200 to 1,400
Longnose Dace	Juvenile	Year Round	2,000	4.5	-12.2%	11.5%	31.0%	120 to 400
Longnose Dace	Adult	Year Round	2,000	10.6	-3.1%	13.2%	20.3%	1,200 to 1,400

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	Minimum Percent WUA Change	Median Percent WUA Change	Maximum Percent WUA Change	Change in Flow (cfs) for Largest Positive or Negative Percent Change
White Sucker	Spawning/ Incubation	April-May	NA	0.0	0.0%	0.0%	0.0%	NA
White Sucker	Fry	May-June	1,200	14.7	-24.4%	0.7%	22.8%	1,800 to 2,000
White Sucker	Adult/Juvenile	Year Round	1,600	4.7	-29.2%	-12.2%	26.9%	120 to 400
Walleye	Spawning/ Incubation	April-May	3,000	3.5	0.1%	9.0%	12.7%	120 to 400
Walleye	Fry	April-May	NA	0.0	0.0%	0.0%	0.0%	NA
Walleye	Juvenile	Year Round	150	0.0	-42.9%	-14.2%	5.7%	250 to 500
Walleye	Adult	Year Round	3,000	0.1	-5.7%	4.1%	10.6%	400 to 600
Tessellated Darter	Adult/Juvenile	Year Round	2,000	3.9	-13.8%	12.0%	24.3%	120 to 400
Sea Lamprey	Spawning/ Incubation	May-June	2,000	2.2	0.4%	4.7%	41.8%	120 to 400
Macro-invertebrates	Larvae	Year Round	4,000	22.1	2.0%	8.9%	12.6%	1,800 to 2,000
Habitat Guild	Shallow-Slow	Year Round	1,200	18.1	-11.4%	10.0%	36.0%	120 to 400
Habitat Guild	Shallow-Fast	Year Round	1,800	12.8	-8.6%	6.8%	31.2%	1,000 to 1,200
Habitat Guild	Deep-Slow	Year Round	1,400	8.9	-36.4%	-11.9%	24.1%	250 to 500

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	Minimum Percent WUA Change	Median Percent WUA Change	Maximum Percent WUA Change	Change in Flow (cfs) for Largest Positive or Negative Percent Change
Habitat Guild	Deep-Fast	Year Round	3,000	2.9	-11.7%	4.4%	46.1%	120 to 400

(Source: FirstLight, 2016f, as modified by staff).

High Backwater Conditions

During high backwater conditions, the maximum WUA increased modestly for 16 species and declined for 10 species (Table 8). Similar to the low backwater conditions, there is no habitat for walleye fry and fallfish spawning and incubation. For the remaining species/life stages, maximum WUA ranged from 0.6 to 31.2 acres. In addition, the flow at maximum WUA ranged from 120 to 7,500 cfs. The flow at maximum WUA remained unchanged compared to low backwater conditions for 14 species/life stages and decreased for 10 species/life stages.

There are five general patterns for how WUA changes with increasing flow from 120 to 2,000 cfs: (1) increase throughout, (2) decrease throughout, (3) increase then decrease near 2,000 cfs, (4) increases at low and high flows with decreases at intermediate flows, and (5) variable throughout. The WUA increased throughout the flow range for American shad adults and spawning and incubation, fallfish juveniles, macroinvertebrates, the deep-fast guild, and spawning and incubation for sea lamprey and shortnose sturgeon. The WUA decreased throughout the flow range for walleye juveniles and adults and fallfish and white sucker fry. The WUA for longnose dace juveniles and walleye spawning and incubation followed the third pattern. The WUA for American shad juveniles, fallfish adults, and shortnose sturgeon fry increased from 120 to 250 cfs, then decreased at 400 cfs before increasing again at higher flows. The change in WUA with increasing flow was variable for the deep-slow guild, shallow-fast guild, and tessellated darter and white sucker adults and juveniles.

Similar to the low backwater conditions described above, the largest change in WUA generally occurs at the lower end of the flow range when the 289-cfs discharge from the Turners Falls Project represents a larger proportion of flow at the two transects. The largest change in WUA occurred in the interval between 120 cfs and 400 cfs for nine species/life stages (Table 8). In contrast to the low backwater conditions, the largest change in WUA for the eight other species/life stages occurred between 1,000 cfs and 1,200 cfs (Table 8). Overall, the effect on WUA during high backwater conditions was more variable than during low backwater conditions, but the additional 289-cfs flow discharged from the Turners Falls Project appears to increase the amount of available habitat for many of the species/life stages at transects 10 and 11 for most bypassed reach flows between 120 and 2,000 cfs. As described during low backwater conditions, the benefit of any additional habitat provided by the Turners Falls Project discharge would be more persistent under continuous operation than under the current Water Use Agreement. Similarly, the potential for stranding and disruption of spawning activity would be as described above for low backwater conditions.

Table 8. Minimum, median, and maximum percent change in weighted usable area (WUA) for flows between 120 and 2,000 cfs at transects 10 and 11 during high backwater conditions.

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	Minimum Percent WUA Change	Median Percent WUA Change	Maximum Percent WUA Change	Change in Flow (cfs) for Largest Positive or Negative Percent Change
American Shad	Spawning/ Incubation	May-June	7,500	20.6	2.9	4.7	9.6	120 to 400
American Shad	Juvenile	June-Oct	2,000	15.3	-3.3	5.2	9.8	1,000 to 1,200
American Shad	Adult	May-June	7,500	16.0	1.9	3.0	6.0	120 to 400
Shortnose Sturgeon	Spawning/ Incubation	April-May	6,000	20.5	1.5	8.5	22.6	120 to 400
Shortnose Sturgeon	Egg-Larvae	May	3,000	31.2	-10.6	4.4	11.0	1,000 to 1,200
Shortnose Sturgeon	Fry	May	500	1.5	-3.5	0.0	54.8	120 to 400
Fallfish	Spawning/ Incubation	May-June	NA	0.0	0.0	0.0	0.0	NA
Fallfish	Fry	May-June	150	0.6	-24.6	-11.7	-3.1	600 to 800
Fallfish	Juvenile	Year Round	1,800	6.0	-2.7	3.3	15.5	120 to 400
Fallfish	Adult	Year Round	2,000	12.6	-8.6	4.8	10.6	1,000 to 1,200
Longnose Dace	Juvenile	Year Round	1,800	3.6	-5.1	6.5	20.0	1,000 to 1,200
Longnose Dace	Adult	Year Round	2,000	9.5	-1.3	6.0	19.9	1,000 to 1,200

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	Minimum Percent WUA Change	Median Percent WUA Change	Maximum Percent WUA Change	Change in Flow (cfs) for Largest Positive or Negative Percent Change
White Sucker	Spawning/ Incubation	April-May	NA	0.0	0.0	0.0	0.0	NA
White Sucker	Fry	May-June	120	23.0	-16.4	-12.9	3.3	250 to 500
White Sucker	Adult/Juvenile	Year Round	250	8.3	-28.9	-4.7	18.1	250 to 500
Walleye	Spawning/ Incubation	April-May	3,000	3.2	-1.6	4.9	9.8	800 to 1,000
Walleye	Fry	April-May	NA	0.0	0.0	0.0	0.0	NA
Walleye	Juvenile	Year Round	120	0.0	-73.5	-5.8	0.5	120 to 400
Walleye	Adult	Year Round	120	0.8	-80.6	-0.1	0.7	120 to 400
Tessellated Darter	Adult/Juvenile	Year Round	1,800	3.1	-4.5	5.8	20.8	1,000 to 1,200
Sea Lamprey	Spawning/ Incubation	May-June	2,000	2.2	-0.2	5.9	38.7	120 to 400
Macro-invertebrates	Larvae	Year Round	4,000	21.1	3.5	7.3	11.9	1,800 to 2,000
Habitat Guild	Shallow-Slow	Year Round	700	18.8	-12.2	0.4	3.0	1,000 to 1,200
Habitat Guild	Shallow-Fast	Year Round	1,600	12.3	-18.6	1.3	20.2	1,000 to 1,200
Habitat Guild	Deep-Slow	Year Round	500	14.1	-34.4	2.8	8.0	500 to 700

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	Minimum Percent WUA Change	Median Percent WUA Change	Maximum Percent WUA Change	Change in Flow (cfs) for Largest Positive or Negative Percent Change
Habitat Guild	Deep-Fast	Year Round	3,000	2.9	-1.2	13.7	35.4	120 to 400

(Source: FirstLight, 2016f as modified by staff).

Upstream Migration Delay

TFH proposes to operate Project No. 2622 "continuously" (*i.e.*, operate Project No. 2622 anytime flow to the project intake is greater than or equal to the 60-cfs minimum hydraulic capacity of the project), instead of limiting project operation to when flow in the power canal is greater than 15,000 cfs, as stipulated in the off-license Water Use Agreement that is currently in place between TFH and FirstLight.[35]

Interior, NMFS, and Massachusetts DFW recommend under section 10(j) that TFH develop a plan that includes measures for minimizing delays to upstream migrating anadromous fish at Project No. 2622, when notified by the agencies that such measures are needed. The agencies recommend that the plan be developed in consultation with the agencies and be approved by the agencies. The agencies also recommend that the plan be filed for Commission approval within six months of agency notification. The agencies recommend that the licensee implement the plan within two years of any Commission order approving the plan.

TFH states that it would be prepared to implement a plan to minimize delays if notified of such delays by the agencies during a new license term.[36]

Our Analysis

The Turners Falls Project tailrace is located in the Project No. 1889 bypassed reach, upstream of the Cabot Station Development, Cabot Station Fishway, and Station No. 1 Development (Figure 3). There are no upstream fish passage facilities at the Turners Falls Project. Project No. 1889 provides upstream fish passage at the Cabot Station Development, which is located 2.2 miles downstream of the Turners Falls Project tailrace. Project No. 1889 also provides upstream fish passage at the Spillway fishway that is located at the Project No. 1889 dam, which is 0.4 mile upstream of the Turners Falls Project. Historically, the majority of American shad, the most common anadromous species in the project area, have migrated upstream using the Cabot Station

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[35] In section 1.3 of Exhibit A of the February 6, 2019 license application, TFH states that it "proposes to continue operating the Project as currently licensed during the next license term, with the flexibility to operate up to continuously or to operate under the current or a modified Water Use Agreement between [TFH] and FirstLight." In its July 3, 2019 response to Commission staff's request for additional information, TFH explains that it is "considering operating the Project as currently licensed (*i.e.*, continuously), or under the existing off-license Water Use Agreement, or a modified off-license Water Use Agreement between TFH and FirstLight."

[36] *See* TFH's letter filed January 13, 2020.

fishway (Table 9; FirstLight 2019). However, a higher proportion of shad used the Spillway fishway during 2015, 2016, and 2018, when FirstLight increased flows in the bypassed reach. Given the location of the Turners Falls Project in the Project No. 1889 bypassed reach, fish that migrate past the discharges of the Cabot Station and Station No. 1 Developments, and past the Cabot Station Fishway, could be attracted to discharge from the Turners Falls Project.

Table 9. The number of American shad using the Project No. 1889 Cabot Station Development fishway and the Spillway fishway from 2008 to 2018.

Year	Cabot Station Development Fishway	Spillway Fishway	Percentage of Shad Using the Spillway Ladder
2008	15,809	627	3.8
2009	13,360	928	6.5
2010	30,232	2,735	8.3
2011	27,077	1,966	6.8
2012	51,901	10,608	17.0
2013	46,886	10,571	18.4
2014	40,666	24,262	37.4
2015[a]	47,588	41,836	46.8
2016[b]	34,709	19,337	35.8
2017	43,269	16,741	27.9
2018[b]	24,031	32,593	57.6

[a] FirstLight manipulated bypassed reach flows as part of a shad movement study.
[b] FirstLight manipulated bypassed reach flows and installed an ultrasound array as part of a study.
(Source: FirstLight, 2019).

Anadromous Species

Comparing the maximum hydraulic capacity of the Turners Falls Project to the minimum required flow and median flow of the bypassed reach provides information about the potential for anadromous fish to be attracted to the tailrace of Project No.

2622.[37] During the upstream fish passage season, which typically runs from early April through July 15, FirstLight is required to release 400 cfs into the bypassed reach. The median flow in the bypassed reach is 12,500 cfs in April and 400 cfs in May and June. In July, flow exceeds 120 cfs 50 percent of the time and exceeds 400 cfs approximately 45 percent of the time. Project No. 2622's maximum hydraulic capacity of 289 cfs represents 72.3 percent of the required minimum flow and median flow in May, June, and the first half of July. For April, the maximum hydraulic capacity represents 72.3 percent of the required minimum flow and 2.3 percent of the median flow. To attract fish to upstream fish passage facilities, FWS (2019) recommends an attraction flow that is 5 percent of the total station hydraulic capacity. The 289-cfs maximum hydraulic capacity of the Turners Falls Project is similar to the attraction flow range (64 to 400 cfs) of Project No. 1889's Spillway fishway (FirstLight, 2016a), so there is potential for the Turners Falls Project tailrace to attract shad during the upstream migration period. Further, this potential would exist until flow in the bypassed reach exceeds 5,780 cfs, at which point Project No. 2622's maximum hydraulic capacity would be less than 5 percent.[38]

In 2015, FirstLight conducted an adult American shad upstream and downstream passage study using radio-tagged shad. As part of the study, FirstLight evaluated shad migration movements within the Project No. 1889 bypassed reach under different test flows. The results of the study indicated that the operation of the Station No. 1 Development did not significantly affect the amount of time required for shad to migrate upstream through the bypassed reach (FirstLight, 2017b). While the Turners Falls Project operated during part of the 2015 study, FirstLight did not install radio receivers near the Turners Falls Project and did not analyze the effects of the Turners Falls Project on shad movements. The maximum discharge of the Turners Falls Project (289 cfs) is less than that of Station No. 1 Development (2,210 cfs), but the discharge of the Turners Falls Project is similar to the attraction flow of the Spillway fishway (64 to 400 cfs), which may be more attractive to migration anadromous fish than the higher discharge of the Station No. 1 Development.

Shad spawning habitat occurs in the bypassed reach, so there is the potential for delayed shad to spawn successfully without passing upstream of Project No. 1889's dam. However, Carscadden and Leggett (1975) found evidence that shad return to their natal tributaries within a river basin to spawn, and Jessop (1994 cited in NOAA (2009)) found

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[37] American shad is the most common anadromous species that migrates past the project tailrace, but staff assume that the project would have similar effects on blueback herring and sea lamprey.

[38] Flow in the bypassed reach exceeds 5,780 cfs approximately 68 percent of the time in April, 25 percent of the time in May, 12 percent of the time in June, and 9 percent of the time in July.

that the closely-related alewife return to specific spawning sites within their natal rivers. Furthermore, shad migrating to the Project No. 1889 dam use 56 to 84 percent of their energy reserves that are available at the beginning of their upstream migration (Leggett et al., 2004), and energy expenditures in the range of 60 to 70 percent appear to be lethal (Leggett et al., 2004). This information suggests that any delay migrating upstream through the bypassed reach could negatively affect the part of the shad population that spawns upstream of Project No. 1889's dam. Any delay that occurs while searching for and using upstream fishways increases energy costs, which reduces energy reserves, spawning success, and post-spawning survival (Castro-Santos and Letcher, 2010).

Currently, project operation during the shad upstream migration period varies annually.[39] From May 6 through July 15, 2015, TFH operated for 28.7 days (688 hours). In 2016, Project No. 2622 did not operate from May 5 through June 16. From May 14 through June 12, 2018, Project No. 2622 operated for only 0.5 days (12 hours). Therefore, the potential for Project No. 2622 to delay migrating anadromous species varies each year under the current Water Use Agreement. However, if TFH does not renew the water use agreement, there is sufficient water available in the power canal for the Turners Falls Project to operate continuously during the shad upstream migration season, which would make the discharge from the Turners Falls Project more consistent, increase the amount of time that anadromous fish could be attracted to the tailrace, and increase the potential for those fish to be delayed.

While the operation of the Turners Falls Project has the potential to delay shad migrating upstream through the bypassed reach, the agencies did not provide any information about: (1) how they would identify delays caused by Project No. 2622 during the term of a new license (*e.g.*, studies that would be needed to determine passage times); (2) how they would determine when to provide notification to the licensee that measures are needed to minimize delays (e.g., specific thresholds for delays caused by Project No. 2622); or (3) any specific measures for reducing delays. Without specifying a method for identifying project delays, thresholds for determining when to implement measures, or specific measures that would be used to minimize delay, there is no basis for determining whether an upstream migration delay minimization plan would or would not provide benefits to anadromous fish.[40]

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[39] Staff issued an additional information request on April 4, 2019 for operation data for time periods corresponding to shad upstream passage studies conducted by FirstLight. TFH provided operation data for those time periods in a letter filed July 3, 2019.

[40] Below, staff evaluates the effectiveness of installing a tailrace screen to reduce the project effects on upstream migration.

American Eel

American eels, which are catadromous, migrate upstream through the project area and appear to use the upstream fish passage facilities at Project No. 1889. Currently, there are no dedicated upstream eel passage facilities at the Turners Falls Project or Project No. 1889. In 2014, FirstLight conducted 11 visual surveys from July 11 to October 9 to identify where upstream-migrating eels congregate around Project No. 1889, including the Cabot Station Development's tailrace and fishway, the Station No. 1 Development's tailrace, and the Project No. 1889's dam and Spillway fishway (FirstLight, 2016a). FirstLight observed 94 percent of the 6,263 eels counted during the survey at the Spillway fishway.

In 2015, FirstLight conducted an additional study that built upon the results of the 2014 study and installed temporary eel passes in the Spillway fishway, the Cabot Station fishway, and the Cabot Station emergency spillway (FirstLight, 2016a). In addition, FirstLight installed two "Medusa" traps, consisting of submerged 5-gallon buckets containing mop heads, in the Station No. 1 Development's tailrace to monitor eels in that area. The Medusa traps are designed to passively collect juvenile eels seeking refuge. The ramps and Medusa traps were operated continuously between July 10 and November 2, 2015, with collections quantified every 2-3 days. Eel collections peaked toward the end of July. The majority, 87.7 percent (n=5,235), were collected at the Spillway fishway, followed by the Cabot Station emergency spillway and Cabot Station fishway, which collected 7.1 percent (n=424) and 5.2 percent (n=319), respectively. No eels were collected at the Medusa traps deployed at the Station No. 1 Development.

As described above, the maximum hydraulic capacity of the Turners Falls Project is similar to the attraction flow range of the Spillway fishway, so there is potential for the Turners Falls Project tailrace to attract juvenile eels during the upstream migration period. Given that FirstLight collected over 5,000 eels at the Spillway fishway, but no eels at the Station No. 1 Development, the potential for false attraction of juvenile eels to the Turners Falls Project tailrace appears low.

Attraction of eels to the Turners Falls Project tailrace rather than the Spillway fishway would delay eels during their upstream migration to suitable feeding and rearing habitat. In addition, eels attracted to the Turners Falls Project tailrace could be exposed to additional predation mortality than they would experience in more suitable habitat.

TFH did not provide any operation data for the juvenile eel upstream migration period, which runs from approximately early-July through October. However, as described for anadromous species, TFH's proposal to operate continuously would increase the potential for Project No. 2622 to attract juvenile eels to the tailrace compared to the current, intermittent operation under the Water Use Agreement.

No entity has proposed any specific measures for reducing the effects of Project No. 2622 on upstream eel passage. However, staff evaluates the potential benefits of a tailrace screen below.

Tailrace Screen

Article 402 of the current license requires TFH to implement measures, such as installing a tailrace screen or other structure, as needed to minimize delays to upstream migrating anadromous fish at Project No. 2622 if such delays are identified by the resource agencies. As discussed in section 2.1.5, no tailrace screen or other structure has been installed at Project No. 2622 since the issuance of the license in 1990.

During the previous relicensing proceeding, Massachusetts DFW was concerned that anadromous fish could be attracted to Project No. 2622 tailrace flows and delayed during their upstream migration.[41] Massachusetts DFW stated that tailrace screens were not necessary at the time, but recommended that the licensee install tailrace screens upon notification by Massachusetts DFW, FWS, and the CRASC.

Based on the information in the previous license, it is unclear where a tailrace screen would be installed. Water exiting the turbine draft tube enters a 50-foot long flume under the mill complex before reaching the 80-foot-long, 10-foot-wide tailrace. Screening the tailrace at the building would prevent shad from swimming toward the draft tube but would not prevent shad from being attracted to the flow in the bypassed reach. Based on a review of satellite imagery, discharge from the tailrace appears to extend up to halfway across the bypassed reach depending on the flow in the bypassed reach (Figure 9a). Therefore, shad may still be attracted to the discharge flow even if TFH installs a screen at the end of the tailrace. Furthermore, the tailrace appears to be submerged at some bypassed reach flows based on satellite imagery, which suggests that a screen installed at the end of the tailrace would not prevent shad from entering the tailrace when it is submerged (Figure 9b). Overall, it is uncertain how the installation of a screen anywhere in the tailrace would reduce attraction of shad to the discharge flow and prevent delay during the upstream migration season.

[41] *See International Paper Company*, 51 FERC ¶ 62,330, at 63,584 (1990).

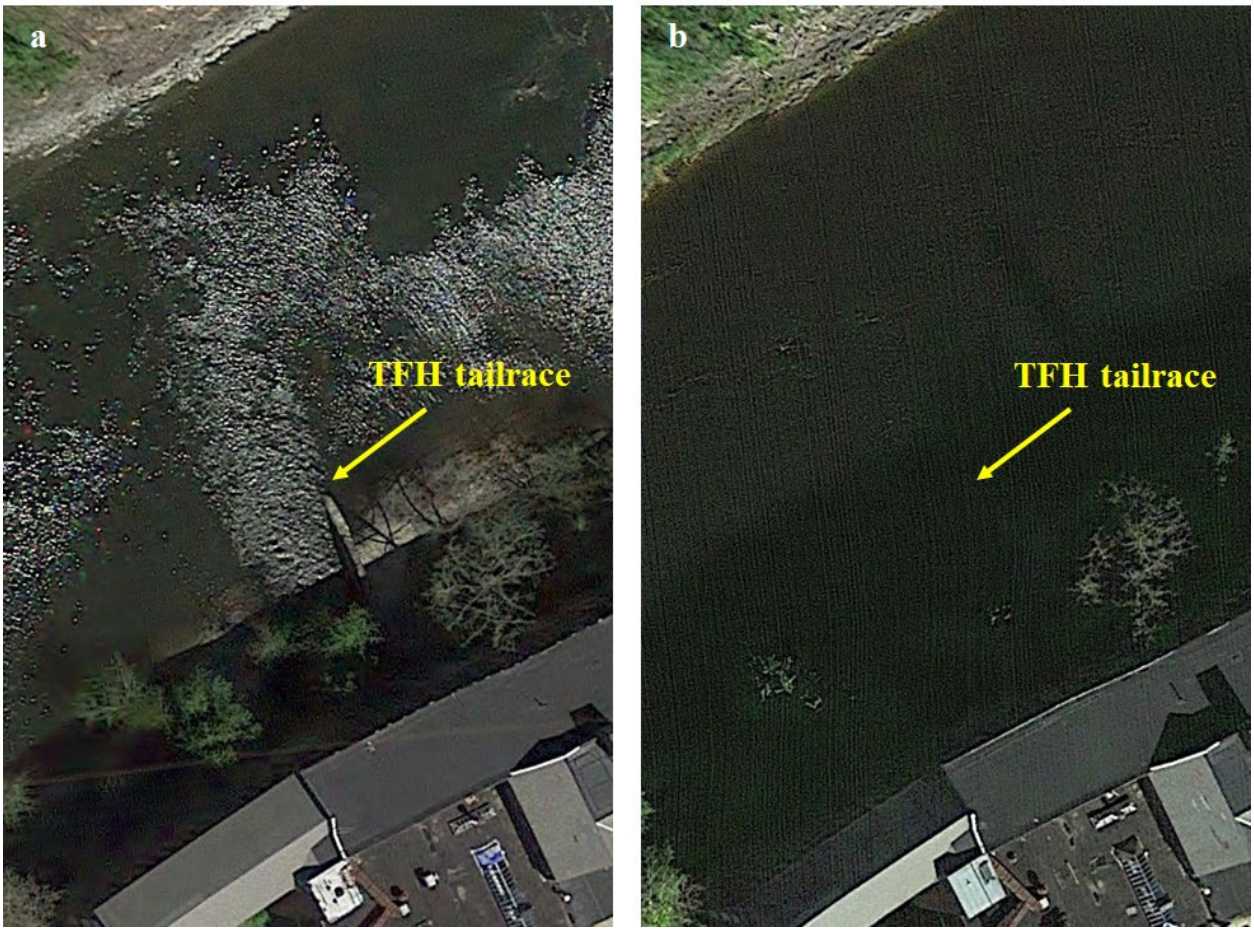

Figure 9. Satellite imagery showing the TFH tailrace on two different dates: (a) May 10, 2014 and (b) October 4, 2018. (Source: Google Earth, as modified by staff)

Regarding juvenile eels, it may not be feasible to design a screen with small enough spacing to exclude juvenile eels without severely restricting the discharge flow and negatively affecting project generation.

Downstream Fish Passage

TFH proposes to develop a trashrack replacement plan, in consultation with resource agencies, that includes a measure for replacing the existing trashrack that has

1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing to protect fish from turbine entrainment and mortality.[42] NMFS supports TFH's proposal.

Massachusetts DFW and Interior recommend under section 10(j) that TFH replace the existing trashrack with a trashrack having 0.75-inch clear bar spacing within one year of license issuance.

Our Analysis

The Turners Falls Project intake is located in the Project No. 1889 power canal, upstream of the Station No. 1 and Cabot Station Developments. There are no downstream fish passage facilities at the Turners Falls Project. Possible downstream fish passage routes in the power canal (from upstream to downstream) include the Turners Falls Project powerhouse, the Station No. 1 Development powerhouse (approximately 0.4 mile downstream of the Turners Falls Project), and the Cabot Station Development emergency spillway, powerhouse, and downstream fish passage facility (approximately 1.9 miles downstream of the Turners Falls Project). Because there are no downstream fish passage facilities at the Turners Falls Project, fish attracted by the intake flow may attempt to pass downstream through the powerhouse.

Attraction to the Intake

There are multiple factors that could affect the potential for fish entrainment and impingement at Project No. 2622. One such factor is the volume of flow through the intake entrance compared the flow volume in the power canal. As shown in Table 5, the Turners Falls Project's maximum hydraulic capacity is 1.7 to 19.3 percent of the capacity of the power canal, depending on the magnitude of flow in the power canal. FWS recommends an attraction flow of a minimum 5 percent of Project No. 2622's maximum hydraulic capacity or 25 cfs, whichever is larger, for downstream fish passage facilities (FWS, 2019). Because the proportion of power canal flow withdrawn by the Turners Falls Project intake exceeds 5 percent at times, fish could be attracted to the intake entrance, particularly migratory species moving downstream. This effect would be

[42] In Exhibit E of its February 4, 2019 license application, TFH proposes to develop the trashrack replacement plan only if the new license for Project No. 1889 does not require the installation of a fish screen near the power canal entrance, upstream of the intake for the Turners Falls Project. However, TFH includes the cost of trashrack installation, operation, and maintenance in the average annual cost of power for the proposed project in Exhibit H of the license application. Therefore, for purposes of our analyses herein, we assume that TFH is proposing to develop a trashrack replacement plan to install a new trashrack with 0.75-inch clear bar spacing at the project.

greatest during low flow periods in late summer and fall (Table 5) when juvenile American shad and adult American eels migrate downstream.

Other characteristics of the Turners Falls Project intake entrance that could affect impingement and entrainment rates are the size and orientation of the entrance. The entrance to the Turners Falls Project is 12 feet high by 20 feet wide, oriented parallel to the mainstream direction of flow in the power canal of Project No. 1889 and located in the walled section of the power canal. The relatively small size of the intake entrance compared to the power canal width (approximately 130 feet near the intake of Project No. 2622) reduces the likelihood of fish encountering the intake entrance, especially since the intake is oriented parallel to flow. However, FERC (1995) found for intakes oriented parallel to flow, the first intake in a series of intakes often entrains more fish than subsequent intakes. The Turners Falls Project is currently the first operational intake in the power canal.[43] In addition, an intake located along a wall can entrain more fish than centrally-located intakes because schooling fish, such as juvenile and adult American shad, may orient along walls as they swim downstream. FirstLight (2016d) used hydroacoustics to quantify entrainment of juvenile shad into the generating units at Project No. 1889's Cabot Station Development, and found the highest entrainment occurred for the unit closest to the power canal wall (Unit 6). FirstLight (2016d) suggested that the juvenile shad were orienting along the power canal wall, which increased the likelihood of entrainment into Unit 6. Therefore, the orientation of the Turners Falls Project intake entrance may result in schooling fish, such as American shad, to be entrained at Project No. 2622 despite the small size of the intake entrance relative to the width of the power canal.

In contrast, adult American eels may be less inclined to orient along the canal wall, which would reduce the likelihood of entrainment. In 2015 and 2016, FirstLight quantified the route selection and survival of eels migrating downstream at Project No. 1889's dam, Station No. 1 Development, and Cabot Station Development (FirstLight, 2017a). To quantify downstream passage route selection, FirstLight tagged eels with radio tags and released them in the Project No. 1889 impoundment. As relevant here, FirstLight installed radio receivers that monitored: (1) the upper power canal; (2) the Station No. 1 forebay and tailrace; and (3) the Cabot Station forebay, downstream bypass, and tailrace.[44] Of the 87 viable tagged eels that entered the power canal, 72 passed downstream through the Cabot Station powerhouse, 7 through the downstream bypass, 3

[43] The Southworth Paperlogic mill is located just upstream of the Turners Falls Project. However, the mill closed in 2017, and is currently not operating.

[44] FirstLight did not monitor the Turners Falls Project's intake during the study.

through the Station No. 1 powerhouse, and 5 through an unknown route.[45] Given that the intake entrance for the Turners Falls Project is narrower (20 feet versus 100 feet) than the Station No.1 entrance and the Turners Falls Project's maximum hydraulic capacity is 13.1 percent of the maximum hydraulic capacity of Station No. 1 (289 cfs versus 2,210 cfs, respectively), the Turners Falls Project would likely attract fewer adult American eels than Station No. 1.

Entrainment and Impingement

Fish that are attracted to the intake of Project No. 2622 could become impinged on the trashrack or entrained in the turbine, which could cause injury or mortality. To protect resident and anadromous fish species from injury and mortality associated with turbine entrainment, Article 401 of the current license required the licensee to install a trashrack with clear bar spacing that does not exceed 1 inch and an intake velocity that does not exceed an average of 0.68 foot per second (fps), as estimated within 3 inches of the face of the trashrack. However, as described in section 2.1.1, *Existing Project Facilities*, the existing trashrack at Project No. 2622 has a clear bar spacing of 1.5 inches, not 1 inch.

To evaluate the likelihood of fish becoming entrained or impinged, TFH calculated the through-rack water velocity at the intake for the current 1.5-inch clear spaced trashrack and the proposed 0.75-inch clear spaced trashrack. TFH estimated the through-rack velocity for the current trashrack configuration to be 0.96 fps and the velocity for the 0.75-inch trashrack to be 1.13 fps. Comparing these figures to prolonged or burst swimming speeds suggests that involuntary entrainment or impingement is unlikely for all but the smallest fish, such as juvenile bluegill, based on the current or proposed trashrack configuration (Table 10).[46]

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[45] FirstLight (2017a) stated that 88 eels entered the power canal, but only provided route selection information for 87 of the eels. In addition, TFH did not provide any information about project operation during the eel study. Therefore, staff assumes that the project was not operating.

[46] The prolonged swimming speed (5 body lengths per second) is the speed a fish can maintain for a specific period of time (*i.e.*, up to 200 minutes). The burst swimming speed (7 body lengths per second) is the fastest swimming speed, which can only be maintained for a short duration (*i.e.*, approximately 20 seconds).

Table 10. Swimming speeds for species* commonly found in the power canal.

Species	Life Stage	Speed Type	Speed (fps)	Source
American eel	yellow	prolonged	1.4	Quintella *et al*., 2010
American shad	silver	burst	3.1 to 4.3	Bell, 1991
	juvenile	burst	1.25 to 2.5	Bell, 1991
	adult	burst	11.0 to 14.8	Haro *et al*., 2004
Bluegill	juvenile	prolonged	0.33 to 1.2	Schuler, 1968; King, 1969; Gardner *et al*., 2006
	adult	burst	4.3	Webb, 1978
Smallmouth bass	juvenile	prolonged	1.3 to1.8	Webb, 1978
	adult	prolonged	1.6-3.9	Bunt *et al*.,1999

(Source: Great River Hydro, 2016 as modified by staff)
*Prolonged and burst swimming speeds were not available for all species.

Although most fish species and life stages could escape the flows at the intake and avoid injury and mortality associated with impingement or entrainment, downstream migrating species (such as juvenile and adult shad and adult eels) would be seeking downstream passage and may attempt to pass downstream through the intake of Project No. 2622. The current 1.5-inch clear-spaced trashrack physically excludes bluegill, shad, and smallmouth bass over 9 inches long, based on the body width proportions reported by Smith (1985). However, adult eels in New England range in size from 24 to 30 inches long (ASMFC, 2000; Haro *et al*., 2000) and 0.9 to 1.1 inches wide (Great River Hydro, 2016) and would not be excluded. The 0.75-inch clear-spaced trashrack that Interior and Massachusetts DFW recommend and TFH proposes would physically exclude all adult eels and prevent them from attempting to pass downstream through the project intake. The 0.75-inch clear spaced trashrack would physically exclude bluegill, shad, and smallmouth bass over 5 inches long. Since juvenile shad migrating downstream are approximately 3.5 to 4.3 inches long, the 0.75-inch clear spaced track would not prevent them from attempting to pass downstream through the intake.

Turbine Passage Survival

TFH did not conduct any turbine passage survival studies. The Turners Falls Project has one vertical Francis turbine with a hydraulic capacity of 60 to 289 cfs, a rotational speed of 225 revolutions per minute (rpm) at 289 cfs, and a runner diameter of

38.5 inches. There is relatively little information about turbine passage survival available for turbines of this configuration. However, Winchell *et al*. (2000) compiled some turbine passage survival data and found trends in survival related to fish size, turbine type, rotational speed, and turbine size. Winchell *et al*. (2000) found that survival was higher for smaller fish and for turbines with rotational speeds less than 250 rpm (Table 11).

Table 11. Average 48-hour turbine fish passage survival rates for Francis turbines.

RPM	Hydraulic Capacity	Size (inches)	Number of Studies	Mean Survival (percent)	Survival Range* (percent)
< 250	440 to 1,600	< 3.9	11	90.4	80.9 to 101.1
	370 to 2,450	3.9 to 7.8	17	87.8	73.7 to 101.8
	440 to 2,450	7.9 to 11.8	15	80.4	47.4 to 96.4
	440 to 1,600	> 11.8	13	66.8	33.8 to 94.1
> 250	275 to 695	< 3.9	3	72.4	63.6 to 86.3
	275 to 695	3.9 to 7.8	5	45.9	16.1 to 77.5
	275 to 695	7.9 to 11.8	5	32.3	12.3 to 64.6
	275 to 450	> 11.8	2	6.0	3.5 to 8.4

*If a higher percentage of test fish survive than control fish during the study, the adjusted survival estimates can exceed 100 percent.
(Source: Winchell *et al*. (2000) as modified by staff)

With a rotational speed of 225 rpm and a hydraulic capacity of 289 cfs, the Francis turbine at the Turners Falls Project does not fit in perfectly with Winchell *et al*.'s summarization shown in Table 10. However, 225 rpm is only slightly slower than 250 rpm, and Project No. 2622's hydraulic capacity is closer to the hydraulic capacity range for the greater than 250 rpm category, which suggests that survival for fish passing through the Turners Falls Project's turbine might be more similar to the survival rates observed for the greater than 250 rpm category because those turbines may have a similar diameter as Project No. 2622's turbine.

Based on the results shown in Table 10, smallmouth bass and bluegill less than 9 inches long that could pass through the current trashrack would experience survival rates between 16.1 and 86.3 percent, with the largest fish having a mean survival of approximately 32.3 percent. Excluding fish over 5 inches long by replacing the current trashrack with the 0.75-inch clear spaced trashrack would reduce the mean entrainment mortality at Project No. 2622 by excluding the large size classes of fish that experience the lowest turbine passage survival. For the fish less than 5 inches long that a 0.75-inch

clear spaced trashrack would not exclude, overall turbine passage survival is likely to be between 16.1 and 86.3 percent as described for fish less than 9 inches long (Table 10). However, the mean survival for fish less than 5 inches long is likely closer to that for fish less than 3.9 inches long (i.e., 72.4 percent) than that for fish 3.9 to 7.8 inches long (i.e., 45.9 percent). Based on the FWS's turbine strike analysis model, which includes blade strike equations developed by Franke et al. (1997), Interior estimates that juvenile shad survival through the Turners Falls Project's turbine would be approximately 86 percent,[47] which is consistent with the survival estimates for fish less than 3.9 inches long shown in Table 11 for both rpm categories.

While eel passage survival was evaluated at eight of the hydropower projects included in Winchell *et al*.'s analysis, Winchell *et al*. (2000) did not provide any information about whether those studies evaluated eel passage through Francis turbines. Because of their length, adult eels often experience high injury and mortality rates passing through turbines. Interior estimates that eel passage survival through the Turners Falls Project turbine with the current trashrack would be between 4 and 90 percent.[48] However, the upper limit for survival is likely closer to 62.1 percent based on data FirstLight (2017a) collected at the Station No. 1 Development during a downstream eel passage survival study.[49] In contrast, installing a trashrack with a 0.75-inch clear spacing would prevent adult eels from entering the intake and prevent injury and mortality from downstream passage through the turbine.

Timing of Trashrack Installation

In the license application, TFH states that, as part of the relicensing effort for Project No. 1889, FirstLight is considering the installation of a screen at the Project No. 1889 gatehouse to prevent juvenile shad from emigrating through the power canal. TFH states that this screen would also protect adult American eel from entering the power canal and would mitigate adverse effects associated with the Turners Falls Project. However, TFH states:

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[47] *See* Interior's letter filed November 11, 2019.

[48] *Id.*

[49] FirstLight (2017a) also evaluated eel passage survival for the other two units in the Station No. 1 powerhouse using balloon tags. Unit 2 is similar to the Turners Falls Project turbine and has a diameter of 38.88 inches and rotational speed of 257 rpm. However, Unit 2 shares a penstock with Unit 3, which rotates at 200 rpm and has a diameter of 55.3 inches. While there is no definitive way to determine if an eel released in the Unit 2/3 penstock passed through Unit 2 or 3, the combined passage survival rate for Units 2 and 3 was 62.1 percent.

> "In the event FirstLight is not required to install a screen at the Power Canal during the next license term for the Turners Falls Hydroelectric Project (FERC No. 1889), TFH proposes to develop in consultation with the resource agencies a Trashrack Replacement Plan to replace the existing trashrack with a trashrack with ¾-inch clear spacing to mitigate entrainment, impingement, and turbine mortality of migratory species at the Project."

In its November 26, 2019 comments, FirstLight states that it "has not agreed to install a fish screen at the head of the canal and has no present intention to propose one."

As discussed above, migratory fish species attempting to migrate downstream through the Turners Falls Project turbine are currently susceptible to entrainment-related mortality at Project No. 2622. The migratory species would benefit from a construction schedule that reduces the ongoing project effects in a timely manner, while also conducting construction activities at a time that would minimize the effects on migrating species. Interior and Massachusetts DFW recommend that TFH install the trashrack within one year of license issuance. The agencies' schedule would reduce the risk of fish entrainment at Project No. 2622 in a timely manner.

Trashrack Replacement Plan

TFH proposes to develop a trashrack replacement plan, in consultation with resource agencies, if FirstLight is not required to install a fish screen in the Project No. 1889 power canal. TFH states that the plan would include a measure for replacing the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing to protect fish from turbine entrainment and mortality. However, TFH provides no other information about measures that would be included in the plan. Furthermore, it is unclear what additional measures would be included in a trashrack replacement plan because TFH would be required to submit design plans to the Commission prior to the replacement of the trashrack if required by any new license. Therefore, it is unclear how TFH's proposed trashrack replacement plan would benefit fisheries resources.

Operation Compliance Monitoring Plan

TFH manually operates the project after being notified by FirstLight that water is available from the power canal for hydropower generation, pursuant to the existing Water Use Agreement. Monitoring equipment at Project No. 2622 consists of a call-out device that alerts the operator if there is a problem at the project. The operator also maintains a station logbook, which includes information and conditions that affect operations.

TFH proposes to operate Project No. 2622 "continuously" when flows in the power canal are within the operating range of the project, without the limitations that are currently implemented under the off-license Water Use Agreement (*i.e.*, without the 15,000-cfs threshold for flows in the power canal).

NMFS, Interior, and Massachusetts DFW recommend under section 10(j) that TFH develop a plan for monitoring project operation, including a description of the mechanisms and structures that would be used for monitoring, the level of manual and automatic operation, the methods used for recording data, and a plan for maintaining the data for inspection by the resource agencies. In addition, the agencies state that the plan should, at a minimum, stipulate that project generation will be recorded hourly during the upstream anadromous fish passage season (April 4 through July 15).

In its January 13, 2020 response to comments, TFH states that, upon request, it would provide a plan that includes a description of the mechanisms and structures that will be used, the level of manual and automatic operation, the methods used for recording data, and a plan for maintaining the data for inspection by the agencies.

Our Analysis

Although compliance measures do not directly affect environmental resources, they do allow the Commission to ensure that a licensee complies with the environmental requirements of a license. Therefore, operation compliance monitoring is a typical requirement in Commission-issued licenses. However, it is unclear what purpose an operation compliance monitoring plan would serve for the Turners Falls Project because TFH is not proposing and no entities are recommending any operating measures that would need to be monitored for compliance, such as a minimum flow release. Rather, the agencies appear to be interested in having access to operational data to assess the potential effect of Project No. 2622 on delaying the upstream migration of anadromous fish.[50] However, the Commission's standard license articles for projects require the licensee to collect and provide to the Commission the operation data necessary to determine the amount of electricity generated, as stated below:

> "The Licensee shall install and thereafter maintain gages and stream-gaging stations for the purpose of determining the stage and flow of the stream or streams on which the project is located, the amount of water held in and withdrawn from storage, and the effective head on the turbines; shall provide for the required reading of such gages and for the adequate rating of such stations; and shall install

[50] *See* NMFS's November 22, 2019 comments at 3, stating that data generated from the operation compliance monitoring plan would "inform the need for modifications to project operations for the protection of migrating diadromous fish."

and maintain standard meters adequate for the determination of the amount of electric energy generated by the project works…. The Licensee shall keep accurate and sufficient records of the foregoing determinations to the satisfaction of the Commission, and shall make return of such records annually at such time and in such form as the Commission may prescribe."

Therefore, TFH would be required to collect the operational data the agencies would need to determine the frequency and magnitude of project generation, and it is unclear what additional environmental benefit an operation and compliance monitoring plan would provide. However, including an administrative requirement in any subsequent license for TFH to provide this operational data to the agencies upon written request would ensure that the data would be available to the agencies when needed to achieve the agencies' management objectives.

Cumulative Effects

Based our review of the license application, as well as agency and public comments, we have identified resident fish species and migratory fish species (*i.e.*, alewife, American eel, American shad, blueback herring, sea lamprey, and shortnose sturgeon) as resources that could be cumulatively affected by the continued operation and maintenance of the Turners Falls Project, in combination with other hydroelectric projects and other past, present, and foreseeable future activities in the Connecticut River Basin.[51]

Our Analysis

Resident Fish Species

Entrainment

The Turners Falls Project's powerhouse, in combination with the Project No. 1889 Station No. 1 and Cabot Station powerhouses in the power canal have the potential to kill or injure fish that are moving downstream to find additional habitat or that are involuntarily entrained, due to unsafe passage through turbines and other flow-regulating equipment (*e.g.*, sluice gates and spillways).

TFH proposes to develop a trashrack replacement plan to replace the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar

[51] The cumulative effects of the project on shortnose sturgeon are discussed in section 3.3.3, *Threatened and Endangered Species*.

spacing to protect fish from turbine entrainment and mortality.[52] Massachusetts DFW and Interior recommend under section 10(j) that TFH replace the existing trashrack with a trashrack having 0.75-inch clear spacing within one year of license issuance. Installing a trashrack with 0.75-inch clear spacing at the Turners Falls Project, combined with the relatively low intake velocity at Project No. 2622, would reduce the entrainment of all but the smallest resident fish. Therefore, installing a trashrack with 0.75-inch clear spacing would reduce the cumulative effects of entrainment on resident fish in the Project No. 1889 power canal.

Aquatic Habitat

Power Canal

Fish, such as smallmouth bass, bluegill, and minnows, are found in the Project No. 1889 power canal. The operation of the Turners Falls Project, in conjunction with the Project No. 1889 Station No. 1 and Cabot Station powerhouses affect the amount of aquatic habitat in the power canal by raising or lowering the water level in the power canal. Lowering the water level during generation can dewater aquatic habitat, especially in the pond-like area in the downstream reach of the power canal, which would reduce the amount of habitat available for foraging and spawning. In addition, FirstLight conducts an annual canal drawdown to inspect the power canal. Resident fish species can become stranded during the drawdown.

Aquatic habitat availability in the Project No. 1889 power canal is determined by the amount of flow needed for the operation of the Cabot Station and Station No. 1 developments. Under the current Water Use Agreement, TFH operates the Turners Falls Project only after there is sufficient flow for the operation of the Cabot Station and Station No. 1 developments. During current operation, the Turners Falls Project removes less than 2 percent of the water in the power canal, which likely has a minimal effect on foraging, spawning, and nursery habitat used by resident fish species in the lower portion power canal. However, if the Turners Falls Project were to operate continuously, as proposed by TFH, then Project No. 2622 could remove nearly 20 percent of the water

[52] In Exhibit E of its February 4, 2019 license application, TFH proposes to develop the trashrack replacement plan only if the new license for Project No. 1889 does not require the installation of a fish screen near the power canal entrance, upstream of the intake for the Turners Falls Project. However, TFH includes the cost of trashrack installation, operation, and maintenance in the average annual cost of power for the proposed project in Exhibit H of the license application. Therefore, for purposes of our analyses herein, we assume that TFH is proposing to develop a trashrack replacement plan to install a new trashrack with 0.75-inch clear bar spacing at the project.

from the canal under low-flow conditions (Table 5), which could dewater spawning, nursery, and foraging habitat used by resident fish species. Therefore, under a continuous-operation scenario, the proposed project could increase cumulative effects on resident fish in the power canal relative to the existing project operation where hydropower generation is limited by the Water Use Agreement.

Bypassed Reach

In contrast to Project No. 2622's effect on the aquatic habitat in the power canal, the operation of the Turners Falls Project increases habitat availability for resident fish (*e.g.*, fallfish, longnose dace, walleye, white sucker, and tessellated darter) in the bypassed reach. However, the amount of additional habitat provided by discharges from the Turners Falls Project depends on the amount of flow spilling into bypassed reach from Project No. 1889's dam and the amount of flow being discharged from Project No. 1889's Station No. 1 Development. Further, stranding and disruption of spawning activity in the bypassed reach could occur when project generation ceases. Therefore, operating Project No. 2622 intermittently pursuant to the current Water Use Agreement could adversely affect aquatic habitat availability.

As discussed above, TFH proposes to operate Project No. 2622 "continuously" (*i.e.*, operate Project No. 2622 anytime flow to the project intake is greater than or equal to the 60-cfs minimum hydraulic capacity of the project), instead of limiting project operation to when flow in the power canal is greater than 15,000 cfs, as stipulated in the off-license Water Use Agreement that is currently in place between TFH and FirstLight.[53] Operating Project No. 2622 continuously would reduce flow variability associated with the project in the bypassed reach, which would be cumulatively beneficial for aquatic habitat in the bypassed reach.

Migratory Fish Species

<u>Fish Passage</u>

[53] In section 1.3 of Exhibit A of the February 6, 2019 license application, TFH states that it "proposes to continue operating the Project as currently licensed during the next license term, with the flexibility to operate up to continuously or to operate under the current or a modified Water Use Agreement between [TFH] and FirstLight." In its July 3, 2019 response to Commission staff's request for additional information, TFH explains that it is "considering operating the Project as currently licensed (*i.e.*, continuously), or under the existing off-license Water Use Agreement, or a modified off-license Water Use Agreement between TFH and FirstLight."

Upstream Migration

As discussed above, there are 11 dams on the mainstem Connecticut River that are used for hydropower generation (Table 1), and that have the potential to adversely affect fish migration. The migrations of alewife, American eel, American shad, blueback herring, and sea lamprey in the Connecticut River have been disrupted since the construction of the dam at Turners Falls, Massachusetts (RM 122) in 1800. The construction of the dam at Holyoke, Massachusetts (RM 87) in 1849 essentially eliminated anadromous fish runs between Holyoke and Turners Falls until 1955 when the first effective fish lift was installed at the Holyoke Project No. 2004 (Leggett *et al.*, 2004).[54] In addition, the former dam at Enfield, Massachusetts (RM 68), constructed in 1880, further delayed upstream migrations. Spring flows generally overtopped the Enfield dam, which still allowed fish to pass upstream except during low flow conditions (Leggett et al., 2004). The Enfield dam deteriorated until a large section of the dam washed out in 1978, which allowed unobstructed passage to the Holyoke Project No. 2004 dam.

The installation of an upstream fishway at the Project No. 1889 dam in 1980 provided access to an additional 20 miles of mainstem habitat for American shad and blueback herring for the first time in nearly 200 years.[55] The completion of the upstream fishway at the Vernon Project No. 1904 (RM 142) in 1981 provided access to the Bellows Falls Project No. 1855 (RM 174), which is considered the historical upstream limit of these species. An upstream fishway was completed at the Bellows Fall Project in 1984, which allowed American shad to extend their range upstream beyond their historic range. Blueback herring are currently rare near Project No. 2622 and in upstream areas, but sea lamprey appear to use the upstream fishways and now inhabit the Connecticut River up to the Wilder Project (RM 217). Similarly, eels were found upstream of the Vernon Project dam in the 1980s and 1990s and appear to use the upstream fishways at the Vernon, Bellows Falls, and Wilder Projects (Great River Hydro, 2017).

The upstream fishways at the Holyoke Project, Project No. 1889, Vernon Project, and Bellows Falls Project vary in their effectiveness at passing migratory fish, and studies are currently underway to quantify bottlenecks within the fishways and the fishway entrances. In addition, FirstLight (2016g) found that some adult shad were delayed by attraction to the Northfield Mountain Pumped Storage Project's intake. In contrast, FirstLight (2017b) found that the operation of the Station No. 1 Development did not

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[54] A fish passage facility was first constructed at the dam in 1893 but was ineffective.

[55] Gephard and McMenemy (2004) state that the dam at Enfield, Massachusetts, represented the historical upstream extent of alewives in the Connecticut River mainstem.

significantly affect the amount of time required for shad to migrate upstream through the bypassed reach.

The Turners Falls Project is located in the bypassed reach of Project No. 1889, approximately 2.2. miles upstream of the fish passage facility located at Project No. 1889's Cabot Station Development and approximately 0.4 mile downstream of Project No. 1889's Spillway fishway that is located at the Project No. 1889 dam. Upstream fish passage through the bypassed reach of Project No. 1889 is primarily affected by the operation of Project No. 1889. During the upstream fish passage season (generally from early April through July 15), the license for Project No. 1889 requires 400 cfs to be released over the dam to the bypassed reach.[56] However, discharge from the dam to the bypassed reach is greater than or equal to 400 cfs approximately 42 percent of the time (Figure 6). The exceedance rate of 400 cfs declines from approximately 81 percent in April to approximately 17 percent in July (Table 2).

Discharge from the Turners Falls Project has the potential to delay shad, blueback herring, and eels migrating upstream through the bypassed reach. The maximum discharge of the Turners Falls Project (289 cfs) is less than that of Station No. 1 (2,210 cfs), but the discharge of the Turners Falls Project is similar to the attraction flow of Project No. 1889's Spillway fishway (64 to 400 cfs) that is located upstream of the discharge of Project No. 2622. The effect of the Turners Falls Project is likely more pronounced at low flows when the Turners Falls Project's discharge represents a larger proportion of total streamflow in the bypassed reach.

As discussed above, TFH proposes to operate Project No. 2622 "continuously" (*i.e.*, operate Project No. 2622 anytime flow to the project intake is greater than or equal to the 60-cfs minimum hydraulic capacity of the project), instead of limiting project operation to when flow in the power canal is greater than 15,000 cfs, as stipulated in the off-license Water Use Agreement that is currently in place between TFH and FirstLight. Relative to the current intermittent project operation, operating Project No. 2622 continuously would increase the potential for project discharges to attract fish and delay upstream migration, which would increase the cumulative effects on upstream fish migration in the basin.

Downstream Migration

While downstream passage facilities exist at some projects (*e.g.*, at Holyoke Project No. 2004, Turners Falls Project No. 1889, Vernon Project No. 1904, and Bellows

[56] For a detailed discussion of the minimum flow requirements in the bypassed reach of Project No. 1889, see section 3.3.1.1, *Affected Environment, Water Quantity, Project No. 1889's Power Canal Flows*.

Falls Project No. 1855), downstream migration delay may still occur at each project. Furthermore, some entrainment of shad, blueback herring, and eels migrating downstream also occurs at each project, and varying proportions of each species are killed during turbine passage at each project. The Turners Falls Project does not have downstream fish passage facilities, and the current trashrack configuration allows juvenile shad and adult eels to enter the intake, which results in some entrainment mortality. Though rare in the project area, any blueback herring migrating downstream through the power canal would likely experience similar effects. Furthermore, there is the potential for some adult shad to be attracted to the intake area and delayed during the downstream migration until they find another route downstream.

TFH proposes to develop a trashrack replacement plan to replace the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing to protect fish from turbine entrainment and mortality.[57] Massachusetts DFW and Interior recommend under section 10(j) that TFH replace the existing trashrack with a trashrack having 0.75-inch clear spacing within one year of license issuance. Installing a trashrack with 0.75-inch clear bar spacing would prevent entrainment of adult eels, but would still allow juvenile shad to enter the intake. Therefore, installing a trashrack with 0.75-inch clear spacing would reduce the cumulative effects of entrainment on eels, but would not significantly alter the cumulative effects of Project No. 2622 on other downstream migrating fish.

Aquatic Habitat

Shad, eels, and sea lamprey use aquatic habitat in Project No. 1889's power canal and bypassed reach for one or more life stages. The bypassed reach is used as spawning habitat for shad and sea lamprey, as rearing habitat for shad, eels, and sea lamprey, and as a migratory corridor for all three species. As described earlier for resident fish species, fluctuations in flow caused by natural flow variability and the operation of Project No.

[57] In Exhibit E of its February 4, 2019 license application, TFH proposes to develop the trashrack replacement plan only if the new license for Project No. 1889 does not require the installation of a fish screen near the power canal entrance, upstream of the intake for the Turners Falls Project. However, TFH includes the cost of trashrack installation, operation, and maintenance in the average annual cost of power for the proposed project in Exhibit H of the license application. Therefore, for purposes of our analyses herein, we assume that TFH is proposing to develop a trashrack replacement plan to install a new trashrack with 0.75-inch clear bar spacing at the project.

1889 and the Turners Falls Projects, as well as the annual canal drawdown, affect habitat in the bypassed reach and power canal.

Power Canal

As described above for resident fish species, operation of the Project No. 1889 Cabot Station and Station No. 1 developments drives aquatic habitat availability in the power canal. Under the current Water Use Agreement, the operation of the Turners Falls Project contributes relatively little to the cumulative effects of flow variability on shad, eel, and sea lamprey habitat in the power canal. If the Turners Falls Project were to be operated more regularly without the restrictions implemented under the Water Use Agreement, as proposed by TFH, the larger proportion of water removed from the canal would still be unlikely to contribute to the cumulative effects on juvenile and adult shad and eels occupying habitat in the power canal because these species and life stages have sufficient swimming ability to avoid stranding caused by the Turners Falls Project, which would be most likely to occur in the perimeter of pond-like lower reach of the power canal. However, any sea lamprey ammocetes occupying shallow habitat near shore in this area could be stranded by continuous project operation during low-flow conditions. Under these conditions, the Turners Falls Project could increase the cumulative effects, including the effects of the annual canal drawdown, on migratory fish species in the power canal.

Bypassed Reach

In the bypassed reach of Project No. 1889, spawning, incubating, and nursery habitat availability for migratory species, including American shad and sea lamprey, is primarily affected by the operation of Project No. 1889. A substantial portion of the flows in the Connecticut River that are in excess of the minimum flow release requirements to the bypassed reach[58] are diverted from the mainstem of the Connecticut

[58] The current license for Project No. 1889 requires FirstLight to release 120 cfs over the dam to the bypassed reach for most of the year, except during the upstream fish passage season (generally from early April through July 15) when the minimum flow release requirement is 400 cfs. For a detailed discussion of the minimum flow requirements in the bypassed reach of Project No. 1889, see section 3.3.1.1, *Affected Environment, Water Quantity, Project No. 1889's Power Canal Flows*.

River to the power canal of Project No. 1889 to provide flow to the Station No. 1 and Cabot Station developments.[59]

Discharges from the Turners Falls Project can increase habitat availability for migratory species in the bypassed reach, especially during minimum flow conditions in the bypassed reach when project discharge represents a large proportion of total flow (*e.g.*, up to 72.3 percent during the upstream fish passage season).[60] However, Project No. 2622 currently only operates intermittently pursuant to the Water Use Agreement between TFH and FirstLight.[61] Flow variability associated with intermittent project operation could adversely affect fish spawning and incubating success if eggs are laid in areas that are later dried out when Project No. 2622 stops operating. Therefore, current project operation could contribute to the cumulative effects on migratory species in the Connecticut River Basin.

As discussed above, TFH proposes to operate Project No. 2622 "continuously" (*i.e.*, operate Project No. 2622 anytime flow to the project intake is greater than or equal to the 60-cfs minimum hydraulic capacity of the project), instead of limiting project operation to when flow in the power canal is greater than 15,000 cfs, as stipulated in the off-license Water Use Agreement that is currently in place between TFH and FirstLight. Relative to the current intermittent project operation, operating Project No. 2622 continuously would increase the amount of shad and sea lamprey habitat that would be available on a consistent basis. As a result, continuous operation of the Turners Falls Project would reduce flow variability in the bypassed reach relative to existing project operation, and reduce the cumulative effects on migratory fish in the Connecticut River Basin.

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[59] The Station No. 1 and Cabot Station developments have maximum hydraulic capacities of 2,210 cfs and 13,728 cfs, respectively. Based on the annual flow duration curve for 1941 to 2010 at the dam (Figure 4), Connecticut River flow exceeds Project No. 1889's capacity (*i.e.*, 15,938 cfs) approximately 29 percent of the time. As discussed above for upstream migration, discharge from the dam to the bypassed reach is greater than or equal to 400 cfs approximately 42 percent of the time (Figure 5).

[60] The project's maximum hydraulic capacity of 289 cfs represents 72.3 percent of the required minimum flow and median flow in the bypassed reach in May, June, and the first half of July.

[61] Based on the power canal flow duration curves provided by FirstLight (2012a) for 2000 to 2009, flow in the power canal exceeds 15,000 cfs, and the Turners Falls Project could operate, based on the Water Use Agreement, approximately 23 percent of the time on an annual basis (Figure 4).

3.3.2 Terrestrial Resources

3.3.2.1 Affected Environment

Project No. 2622 is located in the Connecticut Valley area of the Northeastern Coastal Zone ecoregion (Griffith *et. al.*, 2009), which is characterized by relatively rich soils, level terrain, and deciduous forests. Project No. 2622 is located within an existing mill complex on an island that is entirely commercially developed and situated between the power canal and bypassed reach of Project No. 1889. Wetlands within the project boundary are limited to riverine habitat within the power canal and the bypassed reach of the Connecticut River. The closest terrestrial wetland is a 0.98-acre forested/shrub wetland located just over 0.5 mile downstream of the project on the opposite shore of the bypassed reach from the project (FWS, 2020b).

A forested ridge is located across the bypassed reach of the Connecticut River from Project No. 2622. Plant species on the opposite shoreline of the bypassed reach include silky dogwood, sandbar willow, sandbar cherry, dogbane, and beggarticks. Because the area is heavily developed, wildlife habitat is limited to the shoreline of the bypassed reach of the Connecticut River. Mammals common to the local area include woodchuck, muskrat, beaver, rabbit, weasel, squirrel, mice, bats, opossum, and raccoon. Bird species include rock dove, mourning dove, sparrows, blue jay, water fowl (*e.g.*, mallard, wood duck, common merganser), gulls, red-tailed hawk, owls, crow, king fisher, and the occasional osprey. The federally-protected and state-threatened bald eagle has been observed near Project No. 2622.[62] Reptiles and amphibians that could occur near Project No. 2622 include garter snakes, snapping turtles, toads, and frogs.

Oriental bittersweet (*Celastrus orbiculatus*), a non-native invasive species, is found along the opposite shoreline of the bypassed reach downstream from the Project No. 1889 dam for about 0.5 river mile. The coverage of oriental bittersweet in this stretch of the shoreline of the bypassed reach is 25 to 50 percent.

3.3.2.2 Environmental Effects

TFH proposes to operate Project No. 2622 "continuously" when flows in the power canal are within the operating range of the project, without the limitations that are currently implemented under the off-license Water Use Agreement (*i.e.*, without the

[62] The bald eagle was delisted from the ESA in 2007 but remains federally protected under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act (FWS, 2007a).

15,000-cfs threshold for flows in the power canal).[63] TFH is not proposing any construction or ground-disturbing activities. TFH is also not proposing any protection, mitigation, or enhancement measures concerning terrestrial resources. No recommendations for terrestrial resources were received from stakeholders.

Our Analysis

Under the current license, Project No. 2622 does not control flow or storage within the power canal. It only operates intermittently when flows within the power canal are greater than 15,000 cfs, and water supply is sufficient for Project No. 1889 to produce hydropower. TFH proposes to operate Project No. 2622 "continuously" when flows in the power canal are within the operating range of Project No. 2622, without the limitations that are currently implemented under the off-license Water Use Agreement (*i.e.*, without the 15,000-cfs threshold for flows in the power canal). The proposed operation would more consistently increase the wetted area of the bypassed reach of Project No. 1889, but would not likely affect any terrestrial habitat, including wetlands, given that: (1) the nearest terrestrial wetlands are over 0.5 mile downstream of the project; and (2) the 289-cfs maximum outflow from the project is much less than the 2,210-cfs maximum outflow from the Station No. 1 Development, which is located approximately 0.35 mile downstream of the project and closer in proximity to the nearest terrestrial wetland.

Bald eagles (*Haliaeetus leucocephalus*) are known to occur in the vicinity of Project No. 2622 and to use the Connecticut River for foraging. A nest has been documented approximately 0.75 mile from Project No. 2622, on Barton's Island in the impoundment for the Turners Falls Project No. 1889 (FirstLight, 2016, page E-272). The licensee is not proposing any measures to protect bald eagles, and no comments regarding bald eagles were received by stakeholders. Project No. 2622 does not appear to be affecting bald eagle, and the proposed action and action alternatives do not include any construction activities such as tree clearing or tree thinning that would be expected to

[63] In section 1.3 of Exhibit A of the February 6, 2019 license application, TFH states that it "proposes to continue operating the Project as currently licensed during the next license term, with the flexibility to operate up to continuously or to operate under the current or a modified Water Use Agreement between [TFH] and FirstLight." In its July 3, 2019 response to Commission staff's request for additional information, TFH explains that it is "considering operating the Project as currently licensed (*i.e.*, continuously), or under the existing off-license Water Use Agreement, or a modified off-license Water Use Agreement between TFH and FirstLight."

affect bald eagles. There are also no project transmission lines that would require regular vegetation maintenance that would affect bald eagles.

There is no evidence that invasive species are currently affecting project operation or other environmental resources at Project No. 2622. Oriental bittersweet is a non-native invasive species that is found on the opposite side of the bypassed reach of the Connecticut River from the project. No oriental bittersweet is found within the project boundary and there is no information in the record to indicate that the proposed project or any alternatives would affect the spread of oriental bittersweet. Vegetation maintenance activities at Project No. 2622 are limited because of the industrial nature of the project. Further, no new ground-disturbing activities have been proposed that could facilitate the spread of invasive plant species. The licensee is not proposing any measures for Oriental bittersweet, and no comments on non-native invasive species were received from stakeholders.

3.3.3 Threatened and Endangered Species

FWS's IPaC system indicates that the federally endangered northeastern bulrush and threatened northern long-eared bat (NLEB) could occur in the vicinity of Project No. 2622. In addition, shortnose sturgeon occupy the Connecticut River from Rock Dam in the bypassed reach of Project No. 1889 to downstream of the Holyoke Project (FERC No. 2004). No critical habitat has been designated for these species.

3.3.3.1 Affected Environment

Shortnose Sturgeon

Life History

Shortnose sturgeon is a federally listed endangered species (listed in March 1967) that typically inhabits slow-moving riverine waters or near-shore marine waters and periodically migrates into faster moving freshwater areas to spawn. Individuals live for 30 to 40 years and mature at late ages (5 to 13 years for males and 7 to 18 years for females) in the northern extent of their range (Dadswell *et al*., 1984; SSSRT, 2010). Shortnose sturgeon exhibit three distinct movement patterns associated with spawning, feeding, and overwintering activities. In spring, as water temperatures rise above 46 ºF, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Shortnose sturgeon spawning migrations are characterized by rapid, directed, and often extensive upstream movement (NMFS, 1998). Female shortnose sturgeon are thought to spawn every three to five years while males spawn every two years, but males may spawn annually in some rivers (Kieffer and Kynard, 1996). Fecundity estimates range from 27,000 to 208,000 eggs per female (Dadswell *et al*., 1984).

Sturgeon eggs become adhesive after fertilization, and larvae move downstream when they are about 15-mm long (Kynard, 1997; SSSRT, 2010). The egg incubation period is about two weeks when water temperatures are between 46.4 ºF and 53.6 ºF. Upon hatching, larval shortnose sturgeon hide for about 15 days under available cover at the spawning site while absorbing the yolk-sac before migrating downstream to deeper water (SSSRT, 2010). Laboratory studies suggest that young sturgeon move downstream in two steps. First, larvae move downstream for two to three days before beginning a residency period as young-of-the-year (YOY). Juveniles then resume downstream movement as yearlings during the second summer of life and continue to foraging areas located in slow-moving riverine waters where they mature to adults (Kynard, 1997).

Adults normally depart from their spawning grounds soon after spawning. Movements include rapid, directed movements to downstream feeding areas in spring followed by local meandering in summer and fall (Dadswell *et al.*, 1984; Buckley and Kynard, 1985; O'Herron *et al*. 1993). Post-spawning migrations are associated with rising spring water temperature and river discharge (Kieffer and Kynard, 1993).

Habitat in the Connecticut River

The former, naturally-occurring falls, at present-day Turners Falls, Massachusetts, is believed to be the historic upstream extent of the range of sturgeon due to the height of the natural falls.[64] Completion of the dam in Holyoke, Massachusetts, in 1849 blocked sturgeon from migrating beyond RM 87. [65] The first successful fishway to pass fish upstream, a fish lift, was installed at the tailrace of the Holyoke Project in 1955. In 1976, the existing tailrace fish lift at the Holyoke Project was improved, and a lift was installed in the bypassed reach at the Holyoke Project. These improvements allowed shortnose sturgeon to pass above the Holyoke Project and access the Connecticut River up to their historic limit at Project No. 1889.

Shortnose sturgeon have not been observed in the Turners Falls fishways. However, a recreational angler caught a shortnose sturgeon downstream of the Vernon Project dam in August 2017, which was the first documented shortnose sturgeon upstream of the Turners Falls Dam (Crocker, 2017). However, FirstLight found no additional evidence of shortnose sturgeon upstream of the Project No. 1889 dam based on an environmental DNA survey conducted in the Turners Falls impoundment (FirstLight,

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[64] The first constructed dam at Turners Falls, Massachusetts was located at the existing dam for Project No. 1889. Further information on the history of Turners Falls is located in section *3.3.4 Cultural Resources*.

[65] This dam was constructed at approximately the same location as the Holyoke Project.

2018b).[66] The results of the survey suggest that the likelihood of a shortnose sturgeon population being present in the Project No. 1889 impoundment is very low.

Researchers found five distinct sites used year after year by wintering shortnose sturgeon in the Connecticut River between the Holyoke Project and Project No. 1889: Whitmore (RM 113.7), Second Island (RM 111.8), S-turn (RM 105.6), Hatfield (RM 105.6), and Elwell Island (RM 98.2; SSSRT, 2010; Kynard et al., 2012). Among the five areas, the most prominent was the Whitmore site.

Adult fish in the Connecticut River congregate in reaches where natural or artificial features cause a decrease in river flow, possibly creating suitable substrate conditions for freshwater mussels (Kieffer and Kynard, 1993), a major prey item for adult sturgeon (Dadswell et al., 1984). Both adults and juveniles have been found to use the same river reaches in the Connecticut River and have ranges of about 6.2 miles during the spring, summer, and fall (Savoy, 1991; Seibel, 1991). In the winter, sturgeon move less than 1.2 miles and assemble together in deep water (Seibel, 1991). The migration of juvenile and adult shortnose sturgeon from the Holyoke Project impoundment to points downstream of the Holyoke Project dam appears to be a natural event coincidental with increased river discharges (Seibel, 1991; Kynard, 1997).

The population of shortnose sturgeon that is located between the Holyoke Project impoundment and the Project No. 1889 dam spawn from the last week of April to mid-May, after the spring freshet (Taubert, 1980; Buckley and Kynard, 1985; Kynard, 1997). The spawning period is estimated to last from three to 17 days during the same 26-day period each year (April 27 – May 22), which corresponds to the time of year when photoperiod ranges from 13.9 to 14.9 h (Kynard *et al.*, 2012). Shortnose sturgeon are believed to spawn at discrete sites within the river (Kieffer and Kynard, 1993) in channel habitats containing gravel, rubble, or rock-cobble substrates (Dadswell *et al*., 1984; NMFS, 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the spring freshet, water temperatures ranging from 43.7 to 60.6 ºF, daily mean discharge ranging from 4,273 to 31,818 cfs, depth ranging from 3.9 to 17.1 feet, and bottom water velocities of 1.0 to 3.9 fps (Dadswell *et al*., 1984; NMFS, 1998; SSSRT, 2010). The Shortnose Sturgeon Status Review Team (SSSRT) (2010) indicated that while temperature and river discharge affect spawning, photoperiod was the dominant factor influencing the timing of spawning.

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[66] Fish release DNA into their surrounding environment via mucus, scales, skin cells, or feces. This genetic material is referred to as environmental DNA, and water samples can be analyzed for the presence of environmental DNA. Environmental DNA surveying is a scientifically accepted method for collecting information about species presence, abundance, and distribution without having to collect the fish.

Successful spawning has been documented at two sites on the Connecticut River near Montague, Massachusetts. The main site near the tailrace of Project No. 1889's Cabot Station Development, is located about 2.5 miles downstream of Project No. 1889's dam and estimated to be about 6.7 acres in size (SSSRT, 2010; Figure 3). The smaller spawning site is located at Rock Dam, approximately 1.5 miles downstream from the Turners Falls Project tailrace (Figure 3). This site was estimated to be about 1 acre in area. These sites are just downstream of the species' historical limit in the Connecticut River at Turners Falls (RM 122) (NMFS, 2005). Sturgeon eggs and larvae were captured at the sites in 1993, 1994, and 1995 (Vinogradov, 1997). Much of the river bottom in these spawning areas is rock and rubble. The 0.3-mile-long reach downstream of Cabot Station contains rubble/boulder shoals that can be exposed briefly in spring during low flow conditions (Kieffer and Kynard, 2007).

Northeastern Bulrush

The northeastern bulrush is a perennial sedge that was listed as endangered in 1991 (FWS, 1993; and Mass DFW, 2015). It is known to occur in most states from Vermont to Virginia and inhabits a variety of wetland types with organic soils and fluctuating water levels and full sun (Massachusetts DFW, 2015). In Massachusetts, the northeastern bulrush only occurs in Franklin County (Massachusetts DFW, 2015), and the nearest occurrence of northeastern bulrush to Project No. 2622 is at the Montague Plains Wildlife Management Area, which is located approximately 3 miles from Project No. 2622 (Mass Audubon, 2020).

Northern Long-Eared Bat

The NLEB was listed as a federally threatened species under the ESA on May 4, 2015. Massachusetts has also designated the NLEB as an endangered species. In January 2016, the FWS finalized the 4(d) rule for this species, which focuses on preventing effects on bats in hibernacula associated with the spread of white-nose syndrome[67] and effects of tree removal on roosting bats or maternity colonies (FWS, 2016b). As part of the 4(d) rule, FWS proposes that take incidental to certain activities conducted in accordance with the following habitat conservation measures, as applicable, would not be prohibited: (1) occurs more than 0.25 mile from a known, occupied hibernacula; (2) avoids cutting or destroying known, occupied maternity roost trees during the pup season (June 1 – July 31);[68] and (3) avoids cutting or destroying any tree

[67] A hibernaculum is where a bat hibernates over the winter, such as in a cave. White-nose syndrome is a fungal infection that agitates hibernating bats, causing them to rouse prematurely and burn fat supplies. Mortality results from starvation or, in some cases, exposure.

[68] Pup season refers to the period when bats birth their young.

within a 150-foot radius of a known, occupied maternity tree during the pup season. The 4(d) rule provides flexibility to landowners, land managers, government agencies, and others as they conduct activities in areas that could be NLEB habitat.

Traditional ranges for the NLEB include most of the central and eastern U.S., as well as the southern and central provinces of Canada, coinciding with the greatest abundance of forested areas. The NLEB, whose habitat includes large tracts of mature, upland forests, typically feeds on moths, flies, and other insects. These bats are flexible in selecting roost sites, choosing roost trees that provide cavities and crevices, and trees with a diameter of 3 inches or greater at breast height.[69] Human-made structures, such as buildings, barns, bridges, and bat houses can be considered potential summer habitat. However, trees found in highly developed urban areas (*e.g.,* street trees, downtown areas) are unlikely to be suitable NLEB habitat (FWS, 2014). Winter hibernation typically occurs in caves and areas around them and can be used for fall-swarming[70] and spring-staging.[71]

Project No. 2622 is located within Franklin County, where white-nose syndrome has been detected (FWS, 2016a). There is no documentation of NLEB at Project No. 2622, and no known NLEB hibernacula sites occur within over 15 miles of Project No. 2622. The immediate project vicinity does not contain mature trees that could provide suitable habitat for NLEB summer roosting and foraging activities.

3.3.3.2 Environmental Effects

Shortnose Sturgeon

TFH proposes to operate Project No. 2622 "continuously" when flows in the power canal are within the operating range of the project, without the limitations that are

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[69] Diameter at breast height refers to the tree diameter as measured about 4 to 4.5 feet above the ground.

[70] Fall-swarming fills the time between summer and winter hibernation. The purpose of swarming behavior may include introduction of juveniles to potential hibernacula, copulation, and gathering at stop-over sites on migratory pathways between summer and winter regions.

[71] Spring-staging is the time period between winter hibernation and migration to summer habitat. During this time, bats begin to gradually emerge from hibernation and exit the hibernacula to feed but re-enter the same or alternative hibernacula to resume daily bouts of torpor (*i.e.*, a state of mental or physical inactivity).

currently implemented under the off-license Water Use Agreement (i.e., without the 15,000-cfs threshold for flows in the power canal).[72]

No entity provided any comments or recommendations for shortnose sturgeon.

Our Analysis

Potential Effects of Project No. 2622 at Downstream Spawning Areas

Sturgeon spawn near the Cabot Station tailrace, approximately 2.2 miles downstream of the Turners Falls Project's tailrace, and, to a lesser extent, at Rock Dam, which is located in the bypassed reach of Project No. 1889, approximately 1.5 miles downstream of the Turners Falls Project's tailrace (Kieffer and Kynard, 2012; Figure 3). There are several sources of contributing flow to the spawning site near the Cabot Station tailrace, including flow from Project No. 1889's Cabot Station and Station No. 1's developments. Based on the exponentially greater discharges from Cabot Station and Station No. 1 (13,728 cfs and 2,210 cfs, respectively) compared with the 289-cfs discharge from the Turners Falls Project, staff conclude that the effects of the Turners Falls Project on sturgeon near the Cabot Station tailrace are insignificant, and the project is not likely to adversely affect sturgeon near the Cabot Station tailrace.

Because habitat availability in the bypassed reach from Project No. 1889's Station No. 1 Development tailrace to the Cabot Station Development tailrace is affected by the operation of the Station No. 1 and Cabot Station developments (FirstLight, 2016f), the current or proposed operation of the Turners Falls Project is not likely to adversely affect the amount of habitat available for spawning, incubating, or larval sturgeon at Rock Dam. However, the contribution of flow from the Turners Falls Project to the Rock Dam spawning site could potentially have a significant effect on sturgeon spawning behavior at Rock Dam. Kieffer and Kynard (2012) found three conditions that must occur simultaneously for sturgeon spawning to be successful at Rock Dam. First, day length must be between 13.9 and 14.9 hours, which occurs from April 27 through May 22.

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[72] In section 1.3 of Exhibit A of the February 6, 2019 license application, TFH states that it "proposes to continue operating the Project as currently licensed during the next license term, with the flexibility to operate up to continuously or to operate under the current or a modified Water Use Agreement between [TFH] and FirstLight." In its July 3, 2019 response to Commission staff's request for additional information, TFH explains that it is "considering operating the Project as currently licensed (*i.e.*, continuously), or under the existing off-license Water Use Agreement, or a modified off-license Water Use Agreement between TFH and FirstLight."

Second, flow in the bypassed reach at Rock Dam must be between 2,472 and 14,126 cfs.[73] Third, water temperature must be between 48 and 55 °F.

Given the flow range required for successful spawning, the 289-cfs discharge from the Turners Falls Project is not likely to affect sturgeon spawning at Rock Dam unless flow in the bypassed reach is near the 2,472-cfs threshold and the addition or loss of 289 cfs affects sturgeon spawning behavior. Considering the 289-cfs project discharge, Project No. 2622 could potentially affect spawning when other flows in the bypassed reach (either discharge from the Turners Falls Dam, Station No. 1 Development, or the Fall River)[74] are between 2,183 cfs and 2,472 cfs.

Figure 10 shows the flow duration curves in the bypassed reach for April, May, and June from 2000 to 2009. Flows in April drop rapidly from approximately 2,472 cfs (approximately 75 percent exceedance) to 400 cfs (*i.e.*, the minimum flow in the bypassed reach in April during the upstream fish passage season; approximately 81 percent exceedance). The difference in exceedance rate between 2,472 cfs and 2,183 cfs (*i.e.*, 2,472 cfs – 289 cfs) is difficult to discern on Figure 10, but the decline in the exceedance rate between approximately 2,472 cfs and 400 cfs is relatively linear. Therefore, staff assumes that flow declines by approximately 345 cfs with each 1-percent increase in exceedance rate.[75] Assuming that 345 cfs and 289 cfs are roughly equivalent in terms of the effect of additional flow on sturgeon spawning behavior, an additional 289-cfs discharge from the Turners Falls Project operating continuously would provide 36.5 days over the 10-year period shown in Figure 10, or 3.65 days per year, of additional time with flows suitable for spawning at Rock Dam in April.[76] However, there is no way to determine when those 3.65 days would occur during April of a particular year based on the data shown in Figure 10. Those 3.65 days may occur outside the sturgeon spawning

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[73] At flows less than 2,472 cfs, sturgeon stopped spawning, headed to downstream foraging habitat, and did not return. In addition, spawning failed during years when flow exceeded 21,119 cfs during the spawning period.

[74] The Fall River discharges into the bypassed reach just downstream of the dam and has an annual median flow of 44 cfs.

[75] Staff estimated this rate by dividing the difference between 2,472 cfs and 400 cfs (*i.e.*, 2,072 cfs) by 6 (*i.e.*, the difference in the percent of time the flow is exceeded between 2,472 cfs and 400 cfs).

[76] Staff estimated the number of days during the 10-year period during which project operation could increase flow in the bypassed reach to 2,472 cfs (or decrease flows from 2,472 cfs) by multiplying 10 years x 365 days/per year x 1 percent change in exceedance, which equals 36.5 days during the 10-year period.

period (*i.e.*, April 27 through May 22) given that only four days of the sturgeon spawning period occur in April.

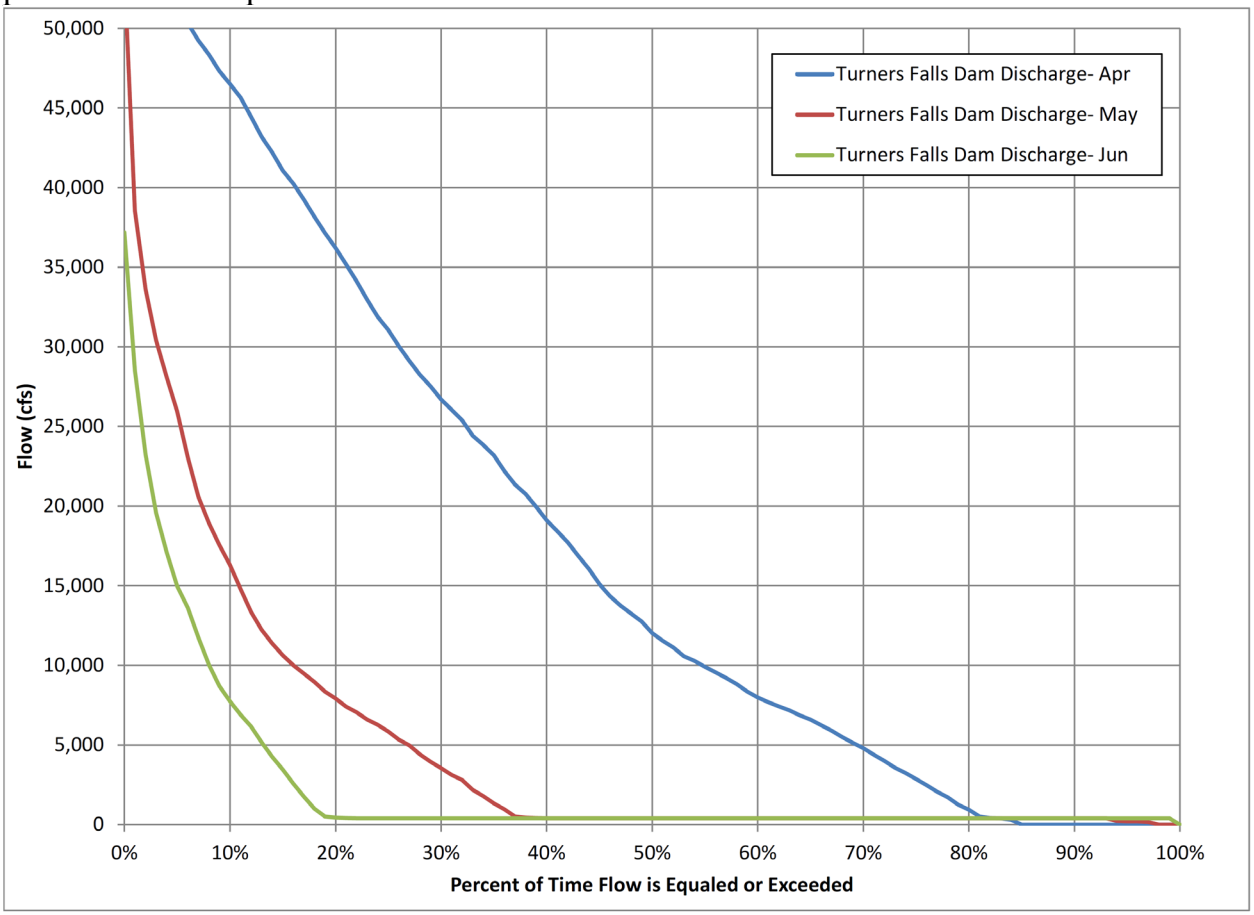

Figure 10. Flow duration curves in the bypassed reach for April, May, and June from 2000 to 2009. (Source: FirstLight, 2012a)

Similarly, Figure 10 shows that flows in May drop rapidly from 2,472 cfs (approximately 32 percent exceedance) to 400 cfs (approximately 37 percent exceedance). For May, flow declines by 414 cfs per 1-percent increase in exceedance rate, or 207 cfs per each 0.5-percent in exceedance. Assuming again that 207 cfs and 289 cfs are roughly equivalent in terms of the effect of additional flow on sturgeon spawning, continuous operation of the TFH Project would provide 18.3 days of additional spawning time at Rock Dam in May over the 10-year period shown in Figure 10, or 1.83 days per year. Because 22 days of the sturgeon spawning period occurs in May, there is a greater chance, compared to April, of an additional 1.83 days of suitable flow falling within the sturgeon spawning period during May of any given year under TFH's proposal to operate Project No. 2622 continuously, assuming Figure 10 represents current flow conditions in the bypassed reach.

Based on the information described above, operating Project No. 2622 continuously, as proposed by TFH, could provide a few additional days of suitable flow

conditions for spawning during the sturgeon spawning period. Therefore, TFH's proposal to operate Project No. 2622 continuously would have a beneficial effect on sturgeon at Rock Dam, and Project No. 2622 may affect, but is not likely to adversely affect, sturgeon spawning conditions at Rock Dam.

When flows in the bypassed reach are near 2,472 cfs, intermittent operation under the current Water Use Agreement could cause fluctuations in flow that affect successful sturgeon spawning. However, these flow conditions occur for only 3.65 days in April and 1.83 days in May, and Project No. 2622 would have to start and stop operating during these days to affect sturgeon spawning at Rock Dam. While TFH did not provide operating data for the entire sturgeon spawning period, TFH did provide some operation data for May in 2015, 2016, and 2018.[77] Based on these data, the only time the Turners Falls Project operated from early or mid-May through May 22 for these years was 12 hours on May 14, 2018. Assuming these data are generally representative of project operation during the sturgeon spawning period and that flow is only near 2,472 cfs for 1.83 days in May, there is a low likelihood that Project No. 2622 would cease operation and cause bypassed reach flow to drop below 2,472 cfs during the sturgeon spawning season. Therefore, operating the Turners Falls Project under the current Water Use Agreement may affect, but is not likely to adversely affect, sturgeon spawning conditions at Rock Dam.

Potential Effects of Project Upstream of Rock Dam

Under current conditions, there is little evidence of shortnose sturgeon occupying the bypassed reach upstream of Rock Dam, including in the immediate vicinity of the Turners Falls Project. Kynard et al. (2012) tagged 411 sturgeon with radio tags and 2,177 sturgeon with passive integrated transponder (PIT) tags from 1990 to 2015 and tracked them during the upstream migration from the mouth of the Connecticut River. Kynard et al. (2012) observed 375 of the tagged sturgeon at spawning areas in the Cabot Station tailrace or at Rock Dam during the study period. No tagged sturgeon moved upstream of Rock Dam during the 15 years of study. Since shortnose sturgeon have not been observed spawning upstream of Rock Dam, no spawning adults, eggs, or larvae would be present to be affected by the Turners Falls Project upstream of Rock Dam under the current or proposed operation conditions.

The only instance of sturgeon occupying habitat upstream of Rock Dam reported by Kynard et al. (2012) was two non-tagged sturgeon observed at the base of Turners Falls Dam on one occasion during one summer after the spawning period had ended. Kynard et al. (2012) provided no other information about these fish. However, all the

[77] *See* EA footnote 39 and accompanying discussion in section 3.3.1.2, *Environmental Effects, Upstream Migration Delay*.

tagged sturgeon that Kynard et al. tracked during the 15-year study foraged and over-wintered in habitat well downstream of the Turners Falls Project after spawning. Therefore, based on the 15 years of data on sturgeon movement in the Connecticut River indicating that sturgeon do not utilize the bypassed reach in the vicinity of Project No. 2622 for spawning or foraging, staff concludes that operating the proposed project (either intermittently or continuously) would have no effect on shortnose sturgeon in the bypassed reach upstream of Rock Dam.

Conclusions

Overall, Turners Falls Project would have no effect on spawning adult sturgeon, eggs, or larvae upstream of Rock Dam and would have no effect on adult sturgeon outside of the spawning period. However, the current and proposed operation of the Turners Falls Project may affect, but is not likely to adversely affect, sturgeon spawning at Rock Dam.

Cumulative Effects

The migratory and spawning behavior of shortnose sturgeon have been affected by hydropower projects and a former nuclear power plant in the Connecticut River Basin. Two hydropower projects that have and continue to adversely affect shortnose sturgeon are the Holyoke Project and Project No. 1889. Relatively little spawning activity occurs downstream of the Holyoke Project, but Project No. 2622 historically and currently affects sturgeon migrating upstream and downstream (Kynard *et al*., 2012). Project No. 1889 does not impede migration because it is at the historic upstream extent of the range of shortnose sturgeon in the Connecticut River; however, the operation of Project No. 1889 has been observed to affect sturgeon spawning success (Kieffer and Kynard, 2012). In addition, the Vermont Yankee Nuclear Power Plant (Vermont Yankee Plant), located approximately 21 miles upstream of the Turners Falls Project tailrace, and U.S. Army Corps of Engineers (Corps) flood control dams on the mainstem Connecticut River and its tributaries alter the downstream temperature gradient of the river (Kieffer and Kynard, 2012), which affects sturgeon spawning behavior.

The construction of the dam in Holyoke, Massachusetts in 1849 completely obstructed the migration of sturgeon upstream of RM 87 and divided the population into two parts. The construction of the fishlift at the Holyoke Project No. 2004 in 1955 and subsequent improvements to the fishlift have allowed sturgeon to migrate upstream past the Holyoke Project on a volitional basis and reconnect the population. However, downstream passage survival at the Holyoke Project has historically been low (53.2 percent survival; Kynard *et al*., 2012). The downstream fish passage facilities at the Holyoke Project were modified in 2015 to improve downstream passage efficiency and survival for sturgeon, which are currently being evaluated. Improved upstream and

downstream passage at the Holyoke Project allows sturgeon to access spawning, foraging, and over-wintering habitat in a more consistent and natural manner.

As described in section 3.3.3.1 *Threatened and Endangered Species, Affected Environment*, the primary spawning habitat for shortnose sturgeon in the Connecticut River is in the tailwater of Project No. 1889's Cabot Station Development. A smaller spawning area is located at Rock Dam in the bypassed reach of Project No. 1889, approximately 1.5 miles downstream of the Turners Falls Project's tailrace. Kieffer and Kynard (2012) collected data on sturgeon spawning at these locations from 1993 to 2001 and 2003 to 2007 and documented spawning failures due to both natural conditions[78] and operation of Project No. 1889. At the Cabot Station spawning area, spawning failed during 4 of the 14 survey years. During those years, flow exceeded Project No. 1889's maximum hydraulic capacity of 15,938 cfs. Kieffer and Kynard (2012) found that peaking operation associated with Project No. 1889 did not disrupt female spawning behavior but suggested that the change in water velocity near the river bottom caused by peaking could be deleterious to eggs and larvae. In addition, Kieffer and Kynard (2012) suggested that releases from the Cabot Station emergency spillway could cause spawning sturgeon to leave the area and displace eggs and larvae or cover them with sediment.

Spawning at Rock Dam was much less successful than at Cabot Station, and failed 11 out of 14 years (Kieffer and Kynard, 2012). Sturgeon spawned successfully in 1993, 1994, and 2004, when flow in the bypassed reach stabilized below 21,189 cfs before April 30. Spawning failed in 1996, 1997, 2001, and 2005, due to high flows during the spawning period beyond the hydraulic capacity of Project No. 1889 and the Turners Falls Project. Flows below 2,472 cfs in the bypassed reach caused spawning failure in 1995, 1998, 1999, and 2006. Kieffer and Kynard (2012) stated that spawning failure due to operation of Project No. 1889 was evident in 1995 and 1999 when sturgeon at the Cabot Station area produced large numbers of eggs and larvae, but spawning failed at Rock Dam. During these two years, diverting water from the bypassed reach to the power canal caused the flow in the bypassed reach to drop below the 2,472-cfs threshold required for successful spawning at Rock Dam. Flow diversions to the power canal also appear to have reduced the overlap between adequate temperature and suitable flow when sturgeon were present.

Kieffer and Kynard (2012) studied sturgeon spawning while the Vermont Yankee Nuclear Plant, which was located immediately upstream of the Vernon Project. Vermont

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[78] For example, Kieffer and Kynard (2012) stated that the sturgeon migration to the Cabot Station and Rock Dam spawning locations failed in 2002. Kieffer and Kynard (2012) suggested that the spawning migration may have failed because of poor foraging and overwintering conditions the previous year, which may not have allowed sturgeon to build sufficient energy reserves to support spawning.

Yankee commenced operation in 1972 and ceased operation in 2014. When it was operating, Vermont Yankee increased water temperature in the impoundments of the Vernon Project and Project No. 1889. When it ceased operating in December 2014, the resulting change in the downstream temperature gradient could have shifted the overlap among daylength, streamflow, and water temperature that determines when sturgeon spawn. In addition, Kieffer and Kynard (2012) suggest that the releases from Corps flood control dams on the Connecticut River could artificially extend the cool, high-flow period during the spring season. Without the Vermont Yankee Plant discharging heated water into the river, the temperature window for successful spawning may occur later in the year, beyond the known April 27 to May 22 spawning period.

As discussed in section 3.3.3 *Threatened and Endangered Species, Environmental Effects*, there is no record of sturgeon spawning upstream of Rock Dam, and the Turners Falls Project is unlikely to adversely affect sturgeon spawning at Rock Dam. Therefore, both the current and proposed operation of the Turners Falls Project are unlikely to contribute to the cumulative effects of hydropower project operation on shortnose sturgeon.

Northeastern Bulrush

Northeastern bulrush is not present within the project boundary and the closest known occurrence is approximately 3 miles south of Project No. 2622. Project No. 2622 is located in a highly developed industrial area and does not contain suitable habitat for the northeastern bulrush. The presence of buildings and other infrastructure in the vicinity of Project No. 2622 would block the full sun that this species requires. Therefore, the continued operation of Project No. 2622 would have no effect on the northeastern bulrush.

Northern Long-Eared Bat

There is no documentation of NLEB at Project No. 2622, and no known NLEB hibernacula sites occur within over 15 miles of the project. The immediate project vicinity does not contain mature trees that could provide suitable habitat for NLEB summer roosting and foraging activities. Additionally, no large mature trees are likely to grow in the project area during the term of a license because of the industrial nature of

the vicinity of Project No. 2622. Therefore, project operation and maintenance during the term of a subsequent license would not affect NLEB.

3.3.4 Cultural Resources

3.3.4.1 Affected Environment

Section 106 of the NHPA requires that the Commission take into account the effects of its actions on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking.[79] Historic properties are those that are listed or eligible for listing on the National Register. The regulations implementing Section 106 of the NHPA also require that the Commission seek concurrence with the SHPO on any finding involving effects or no effects on historic properties, and consult with interested Indian tribes or Native Hawaiian organizations that attach religious or cultural significance to historic properties that may be affected by an undertaking. In this document, we also use the term "cultural resources" for properties that have not been determined eligible for listing on the National Register. Cultural resources represent things, structures, places, or archaeological sites that can be either prehistoric or historic in origin. In most cases, cultural resources less than 50 years old are not considered historic.

Area of Potential Effects

Under section 106 of the NHPA of 1966, as amended, the Commission must take into account whether any historic properties within the proposed project's APE could be affected by the issuance of a license for Project No. 2622. The Advisory Council on Historic Preservation defines an APE as the geographic area or areas in which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist (36 C.F.R. § 800.16(d)).

TFH did not define an APE in its license application. As described in section 2.1.2 of this EA, the existing project boundary covers 0.2 acre. TFH is not proposing any modifications to the existing project boundary.

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[79] An undertaking means "a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license, or approval." 36 C.F.R. § 800.16 (2019). Here, the undertaking is the potential issuance of a subsequent license for the Turners Falls Project.

Cultural History Overview

Pre-contact Period

Throughout the Northeast, evidence for the earliest period of human occupation in western Massachusetts, the Paleoindian Period, is extremely rare. Most sites of this period have been identified from isolated diagnostic artifact types. Fluted projectile points, the diagnostic artifact type of the period, have been reported from several locations along the Connecticut Valley in western Massachusetts. Based on ethnographic analogy, it is assumed that peoples of this time were seasonally nomadic, following the movement of game with the changing weather conditions of the year. Similarities in artifact forms among Paleoindians across North America argue for a generalized character of adaptation, with few specializations to local conditions evident (Haynes, 1980).

The period following the Paleoindian occupation, but predating the use of pottery and horticulture, has been designated the archaic period by North American archaeologists. The Archaic Period is further divided into at least three sub periods: Early, Middle, and Late.

In the Northeast region, archaeological sites from the Early Archaic period (10,000-8,000 years before present (BP)) are rare. The diagnostic artifacts most closely associated with the Early Archaic period are bifurcate-base projectile points and, less commonly, stemmed or corner-notched points of the Palmer and Kirk types (Braun and Braun, 1994).

During the Middle Archaic Period (8,000-6,000 BP), environmental conditions in the area began to approach those of present day. Archaeological materials from New England provide evidence of significant local populations at this time, indicating that a substantial degree of population growth had occurred by the end of this period (Mulholland, 1984).

Late Archaic Period (6,000-3,000 BP) sites in New England are much more numerous than sites in previous periods. Peoples of New England at this time occupied a wide variety of environmental settings (Mulholland, 1984), and a significant diversity in site type and function is documented. Modern environmental conditions were present and the wild resources available were the same as those observed by the early European settlers and explorers.

The Woodland Period in the Northeast is defined by the onset of new technologies, such as ceramics, the bow and arrow, and horticulture involving non-native plants, like corn. Based mainly on technological diversification in pottery use and

subsistence strategies, archaeologists have divided the Woodland Period into three stages: Early, Middle, and Late.

The Early Woodland Period (3,000-2,000 BP) has generally been considered a period of population decline following a cultural florescence during the Late Archaic. This millennium witnessed the first widespread use of ceramics across the Northeast.

The Middle Woodland Period (2,000-1,000 BP) is characterized as a continuation of trends of the Early Woodland period. Subsistence trends of the Early Woodland continued, and large, semi-permanent, or perhaps year-round settlements were used by this time. A significant amount of non-local lithic material was utilized in the Middle Woodland Period, which may indicate an expanding trade network (Talmage, 1982).

It is during the Late Woodland Period and the preceding period that the pattern of settlement witnessed by the first European explorers became established. The Late Woodland Period dates from approximately 1,000 BP to European contact. Also, during this time, horticulture, including exotic domesticates such as corn and beans, became a widespread and occasionally important dietary element. More evidence is present of permanent settlements, or at least locations where sites were used for much of the year, especially on the coasts (Carlson, 1986; Yester, 1988). Late Woodland Period sites are more numerous throughout the Northeast than Early and Middle Woodland Period Sites.

Post-contact Period

The area of present-day Montague was first settled by Europeans in 1715, and later incorporated as the Town of Montague in 1754. The primary occupations of the colonial settlers included livestock production and lumbering. At least eight sawmills were established by 1790 (MHC, 1984). The Proprietors of the Locks and Canals of the Connecticut River was granted a charter to build canals at the former naturally occurring falls at present-day Turners Falls in 1792 to improve transportation along the river.[80] Construction included a log crib dam extending across the Connecticut River (the location of the present-day Turners Falls Dam), a 2.5-mile-long canal, and a towpath on the east shore (MHC 1984, 1982). The usage of the canal significantly decreased as railroads became the main source of transportation in the 1840s.

The Connecticut Valley became home to several industrial communities between 1830 and 1870, including Turners Falls, a village within the town of Montague. The village of Turners Falls was founded in 1868, as a planned factory city, by Alvah

[80] The former naturally occurring falls were originally known as the Great Falls, and later renamed Turners Falls.

Crocker, a paper manufacturer and railroad promoter. By the 1890s, the village of Turners Falls continued to expand with a new paper mill, shoe factory, and leatherette manufacturer (MHC, 1984; 1982b). In 1904, the Turners Falls Company (owned by Alvah Crocker) extended the original canal by 1,000 feet to connect to an existing hydroelectric station on the Connecticut River.[81] Completion of the Cabot Station Development in 1915 gave the company the largest hydroelectric production capability in the Connecticut River Valley (MHC, 1982a)

Cultural Resources Investigations

TFH did not conduct any archeological surveys as part of the relicensing process for Project No. 2622. The project powerhouse is located within a portion of the former Keith Paper Mill, within the Turner Fall Historic District. The Turners Falls Historic District was listed on the National Register in 1980. The district is considered significant due to its association to the industrial development of the nation and the Connecticut River Valley (Jenkins and Webber, 1980). The Keith Paper Mill is a grouping of brick industrial buildings dating from 1877, with additions in 1892 and 1906. The Keith Paper Mill is a contributing resource to the Turners Falls Historic District.

3.3.4.2 Environmental Effects

In a letter filed on June 24, 2019, the Massachusetts SHPO stated that the proposed project would have no adverse effect on the significant historic characteristics of the Keith Paper Mill and Turners Falls Historic District. The Massachusetts SHPO stated that if project plans change in the future, information should be submitted to the Massachusetts SHPO for review and comment.

Our Analysis

As discussed in section 2.2.2, TFH proposes to replace the existing trashrack. The existing trashrack is located on the intake facility of Project No. 2622 in the power canal. The replacement trashrack would be installed in the same location as the existing trashrack. The replacement trashrack would not be located on the Keith Paper Mill, or any other known historic properties, and therefore would not affect historic properties.

The APE includes the existing project boundary along with any land or properties outside of the project boundary where Project No. 2622 may affect historic properties. The project boundary includes portions of the Turners Falls Historic District.

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[81] The existing hydroelectric station was constructed in 1886 and owned by the Franklin Electric Light Company.

Specifically, the powerhouse is located inside the historic Keith Paper Mill, which is a contributing resource to the Turners Falls Historic District.

Continued operation and maintenance of Project No. 2622 could have adverse effects on the Keith Paper Mill if there are no protective measures in place. Specifically, adverse effects could occur in the event repairs are needed to maintain the structure and function of Project No. 2622, or to fix structural damage that occurs in the course of project operation. Failure to maintain individual contributing resources to the Turners Falls Historic District could have adverse effects on the integrity of the historic property. Consulting with the Massachusetts SHPO on standard protocol to be implemented prior to conducting project-related repairs that could affect the Keith Paper Mill would ensure that historic resources are not adversely affected.

During the term of any subsequent license, the applicant would occasionally need to conduct maintenance activities in the project area or on project facilities. These activities could include general landscaping and ground-disturbing maintenance within the project boundary. These activities would not require prior Commission approval; however, they could affect known historic properties in the project area. Consulting with the Massachusetts SHPO on standard protocol to be implemented prior to conducting these activities would ensure that known historic properties are not adversely affected.

Previously unidentified archaeological or historic resources could be discovered during any land-disturbing activities that may occur during the term of any license that is issued. Notifying the Commission and the Massachusetts SHPO if previously unidentified archaeological or cultural artifacts are encountered would ensure that any previously unidentified archaeological or historic resources are not adversely affected. In the event of any such discovery, the applicant would discontinue all exploratory or construction-related activities until the proper treatment of any potential archaeological or cultural resources is established.

4.0 DEVELOPMENTAL ANALYSIS

In this section, we look at the project's use of the Connecticut River for hydropower purposes to see what effects various environmental measures would have on the project's costs and power generation. Under the Commission's approach to evaluating the economics of hydropower projects, as articulated in *Mead Corp.*,[82] the Commission compares the current project cost to an estimate of the cost of obtaining the same amount of energy and capacity using a likely alternative source of power for the region (cost of alternative power). In keeping with Commission policy as described in

[82] *See Mead Corp., Publ'g Paper Div.*, 72 FERC ¶ 61,027 (1995). In most cases, electricity from hydropower would displace some form of fossil-fueled generation, in which fuel cost is the largest component of the cost of electricity production.

Mead Corp., our economic analysis is based on current electric power cost conditions and does not consider future escalation of fuel prices in valuing the hydropower project's power benefits.

For each of the licensing alternatives, our analysis includes an estimate of: (1) the cost of individual measures considered in the EA for the protection, mitigation, and enhancement of environmental resources affected by the project; (2) the cost of alternative power; (3) the total project cost (*i.e.*, construction, operation, maintenance, and environmental measures); and (4) the difference between the cost of alternative power and total project cost for the project. If the difference between the cost of alternative power and total project cost is positive, the project helps to produce power for less than the cost of alternative power. If the difference between the cost of alternative power and total project cost is negative, then the project helps to produce power for more than the cost of alternative power. This estimate helps to support an informed decision concerning what is in the public interest with respect to a proposed license. However, project economics is only one of many public interest factors the Commission considers in determining whether, and under what conditions, to issue a license.

4.1 POWER AND ECONOMIC BENEFITS OF THE PROJECT

Table 12 summarizes the assumptions and economic information we use in our analysis for the project. This information was provided by TFH in its license application or estimated by staff. We find that the values provided by TFH are reasonable for the purposes of our analysis. Cost items common to all alternatives include: taxes, net investment, estimated future capital investment required to maintain and extend the life of facilities, relicensing costs, and normal operation and maintenance cost.

Table 12. Parameters for economic analysis of the Turners Falls Project.

Parameters	Values (2019 dollars)	Sources
Period of analysis	30 years	Staff
Term of financing	20 years	Staff
Escalation rate	0 percent	Staff
Alternative energy value	$30.24/MWh[a]	Staff
Capacity Value	$159.70/ kilowatt-year[a]	Staff

Parameters	Values (2019 dollars)	Sources
Power Value (energy and capacity)	$51.70/MWh[a]	Staff
Federal tax rate	21 percent	Staff
Local tax rate	8 percent	Staff
Interest rate	7 percent	Staff
Discount rate	7 percent[b]	Staff
Net remaining investment	4,100,000	TFH
Relicensing cost	$103,000	TFH
Annual operation and maintenance cost	$195,000[c]	TFH

[a] Source: Energy Information Administration using rates obtained from Annual Energy Outlook 2019 at http://www.eia.gov/outlooks/aeo/index.cfm.
[b] Assumed by staff to be the same as the interest rate.
[c] Operation and maintenance costs are based on TFH's current average annual generation of 1,512,009 kWh. Operation and maintenance costs may be greater when generating 7,755,000 kWh as proposed by TFH; however, Commission staff assume any increase in operation and maintenance costs would be minimal.

4.2 COMPARISON OF ALTERNATIVES

Table 13 summarizes the installed capacity, annual generation, annual cost of alternative power, annual project cost, and difference between the cost of alternative power and project cost for each of the alternatives considered in this EA: no-action, TFH's proposal, and the staff alternative.

Table 13. Summary of the annual cost of alternative power and annual project cost for the three alternatives for the Turners Falls Project.

	No Action	TFH's Proposal	Staff Alternative
Installed capacity (kW)	937	937	937
Annual generation (MWh)	1,512[a]	7,755	7,755
Annual cost of alternative power ($ and $/MWh)	$78,171 $51.70	$400,934 $51.70	$400,934 $51.70
Annual project cost ($ and $/MWh)	$697,153 $461.08	$711,521 $91.75	$711,521 $ $91.75
Difference between the cost of alternative power and project cost ($ and $/MWh)	($618,983) ($409.38))	($310,588) ($40.05)	($310,588) ($40.05)

[a] Pursuant to the Water Use Agreement, the Turners Falls Project currently only operates when flow in the power canal exceeds 15,000 cfs, and the maximum hydraulic capacity of the power canal is approximately 18,000 cfs.

4.2.1 No-Action Alternative

Under the no-action alternative, the project would continue to operate as it does now. The project would have an installed capacity of 937 kW and generate an average of 1,512 MWh of electricity annually. The average annual cost of alternative power would be $78,171, or about $51.70/MWh. The average annual project cost would be $697,153, or about $461.08/MWh. Overall, the project would produce power at a cost that is $618,983, or $409.38/MWh, more than the cost of alternative power.

4.2.2 TFH's Proposal

Table 13 gives the cost of each of the environmental mitigation and enhancement measures considered in our analysis. We convert all costs to equal annual (levelized) values over a 30-year period of analysis to give a uniform basis for comparing the benefits of a measure to its cost.

Table 14 lists all environmental measures, and the estimated cost of each, considered for the Turners Falls Project. Under TFH's proposal, the Turners Falls Project would have an installed capacity of 937 kW and generate an average of 7,755 MWh of electricity annually. The average annual cost of alternative power would be $400,934, or about $51.70/MWh. The average annual project cost would be $711,521, or about $91.75/MWh. Overall, the project would produce power at a cost that is $310,588, or $40.05/MWh, more than the cost of alternative power.

4.2.3 Staff Alternative

The staff alternative is based on TFH's proposal with staff modifications and additional measures, as shown in Table 13. The staff alternative would have an installed capacity of 937 kW and an average annual generation of 7,755 MWh. The cost of alternative power would be $400,934, or about $51.70/MWh. The average annual project cost would be $711,521, or about $91.75/MWh. Overall, the project would produce power at a cost that is $310,588, or $40.05/MWh, more than the cost of alternative power.

4.3 COST OF ENVIRONMENTAL MEASURES

Table 14 gives the cost of each of the environmental mitigation and enhancement measures considered in our analysis. We convert all costs to equal annual (levelized) values over a 30-year period of analysis to give a uniform basis for comparing the benefits of a measure to its cost.

Table 14. Cost of environmental mitigation and enhancement measures considered in assessing the effects of operating the Turners Falls Project.

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Aquatic Resources				
Replace the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing.	TFH, Interior,[c] Massachusetts DFW,[c] Staff	$75,000	$5,500	$13,349
Develop a trashrack replacement plan that includes a measure for replacing the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing.	TFH	$5,000	$0	$630
Develop a plan to minimize delays for upstream migrating anadromous fish when notified by Interior, Massachusetts DFW, or NMFS.	NMFS,[c] Interior,[c] Massachusetts DFW[c]	Unknown[d]	Unknown[d]	Unknown[d]

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
Develop an Operation Compliance Monitoring Plan for maintaining and monitoring flow releases, including procedures for recording and reporting data to FERC and resource agencies.	NMFS,[c] Interior,[c] Massachusetts DFW[c]	$5,000	$0	$630
Provide operational data, including records of project generation and flow releases, to resource agencies upon written request from the agencies.	Staff	$0	$0	$0
Cultural Resources				
Consult with the Massachusetts SHPO to establish protocols to be implemented prior to conducting maintenance activities in the vicinity of Project No. 2622 that could affect cultural resources.	Staff	$0	$0	$0

Enhancement/Mitigation Measures	Entity	Capital cost	Annual cost[a]	Levelized annual cost[b]
If previously unidentified cultural resources are encountered during the course of constructing, maintaining, or developing project facilities, consult with the Massachusetts SHPO to ensure the proper treatment of these resources and discontinue all exploratory or construction-related activities until the proper treatment of the resources is established.	Staff	$0	$0	$0

[a] Annual costs typically include operational and maintenance costs and any other costs that occur on a yearly basis.
[b] All capital and annual costs are converted to equal annual costs over a 30-year period to give a uniform basis for comparing all costs.
[c] Section 10(j) recommendation.
[d] The recommendation lacks specificity needed to estimate a cost.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

Sections 4(e) and 10(a)(1) of the FPA require the Commission to give equal consideration to the power development purposes and to the purposes of energy conservation; the protection, mitigation of damage to, and enhancement of fish and wildlife; the protection of recreational opportunities; and the preservation of other aspects of environmental quality. Any license issued shall be such as in the Commission's judgment would be best adapted to a comprehensive plan for improving or developing a waterway or waterways for all beneficial public uses. This section contains the basis for, and a summary of, our recommendations for relicensing the project. We weigh the costs and benefits of our recommended alternative against other proposed measures.

Based on our independent review of agency and public comments filed on the project and our review of the environmental and economic effects of the proposed project and project alternatives, we selected the staff alternative as the preferred alternative. This alternative includes elements of the applicant's proposal and some additional staff-recommended measures. We recommend this alternative because: (1) issuing a new hydropower license for the project would allow TFH to continue operating its project as a dependable source of electrical energy for its customers; (2) the 937 kW of electric capacity comes from a renewable resource that does not contribute to atmospheric pollution; (3) the public benefits of the staff alternative would exceed those of the no-action alternative; and (4) the proposed and recommended measures would protect and enhance aquatic and cultural resources.

In the following sections, we make recommendations as to which environmental measures proposed by TFH or recommended by agencies or other entities should be included in any subsequent license issued for the project. We also recommend additional environmental measures to be included in any license issued for the project.

5.1.1 Measures Recommended by Staff

We recommend the following measures in any license that may be issued for the Turners Falls Project:

- Replace the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing to reduce fish injury and mortality associated with turbine entrainment, instead of developing a trashrack replacement plan as proposed by TFH;

- Provide operational data, including records of project generation and flow releases, to resource agencies upon written request from the agencies.

- Consult with the Massachusetts SHPO to establish protocols to be implemented prior to conducting maintenance activities in the vicinity of Project No. 2622 that could affect cultural resources; and

- If previously unidentified cultural resources are encountered during the course of constructing, maintaining, or developing project facilities, consult with the Massachusetts SHPO to ensure the proper treatment of these resources and discontinue all exploratory or construction-related activities until the proper treatment of the resources is established.

Below, we discuss the basis for our staff-recommended measures.

Trashrack Replacement

TFH proposes to develop a trashrack replacement plan, in consultation with resource agencies, that includes a measure for replacing the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing to protect fish from turbine entrainment and mortality.[83] NMFS states that TFH's proposal sufficiently addresses Project No. 2622's effects on migratory fish species that use the power canal as a migratory pathway. Massachusetts DFW's and Interior's section 10(j) recommendations would require TFH to replace the existing trashrack with a trashrack having 0.75-inch clear bar spacing within one year of license issuance.

The Turners Falls Project intake is located in the Project No. 1889 power canal, upstream of Project No. 1889's Station No. 1 and Cabot Station Developments. Fish in the power canal that are attracted by the intake flow of Project No. 2622 could attempt to pass downstream through the powerhouse, including fish that are migrating downstream (*e.g.*, American eel and American shad). As discussed in section 3.3.1.2, *Environmental Effects, Entrainment and Impingement*, the current 1.5-inch clear-spaced trashrack would exclude American shad and resident fish over 9 inches long; however, adult American eels and other fish less than 9 inches long could pass through the trashrack and be entrained by Project No. 2622's turbine. Eel passage survival through the turbine is estimated to be between 4 and 62 percent. In comparison to the existing trashrack, the 0.75-inch clear-spaced trashrack recommended by Interior and Massachusetts DFW would physically exclude all adult eels and prevent them from attempting to pass downstream through Project No. 2622's intake, thereby reducing eel mortality associated with turbine passage. Installing the 0.75-inch clear-spaced trashrack within one year of license issuance, as recommended by the resource agencies, would reduce the risk of entrainment in a timely manner. We conclude that the benefits of reducing fish mortality by replacing the existing trashrack with a trashrack that has 0.75-inch clear bar spacing

[83] Staff evaluates the costs and benefits of TFH's proposed trashrack replacement plan in section 5.1.2, *Measures Not Recommended.*

would be worth the annual levelized cost of $13,349, and we recommend the measure.

Recording and Distributing Operation Data

NMFS, Interior, and Massachusetts DFW recommend under section 10(j) that TFH develop a plan for monitoring project operation, including a description of the mechanisms and structures that will be used, the level of manual and automatic operation, the methods used for recording data, and a plan for maintaining the data for inspection by the agencies. In addition, the agencies state that the plan should, at a minimum, stipulate that project generation will be recorded hourly during the upstream anadromous fish passage season (April 4 through July 15). TFH states that it would provide such a plan upon request from the agencies.

Although monitoring measures do not directly affect environmental resources, they do allow the Commission to ensure that a licensee complies with the environmental requirements of a license. However, TFH is not proposing and stakeholders and Commission staff are not recommending any environmental measures that could be monitored during the term of a license, such as run-of-river operation or a minimum flow release requirement. As stated in section 3.3.1.2 *Environmental Effects, Operation Compliance Monitoring Plan*, without specific measures to monitor, the purpose and benefits of an operation compliance monitoring plan are unclear.

From their comments, the agencies appear to be interested in having access to operational data to assess the potential effect of Project No. 2622 on delaying upstream anadromous fish migration.[84] The Commission's standard license articles require the licensee to collect and provide to the Commission the operation data necessary to determine the amount of electricity generated and flows released from Project No. 2622. Therefore, TFH would be required as part of any license to collect the operational data the agencies would need to determine the frequency and magnitude of project generation and flow releases to the bypassed reach of Project No. 1889. Including an administrative requirement in any subsequent license for TFH to provide this operational data to the agencies upon written request would ensure that the data would be available to the agencies when needed to achieve the agencies' management objectives for migratory fish.

Staff estimates the levelized annual cost of an operation compliance monitoring plan to be $630. Based on the lack of apparent benefits of the plan, staff does not

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[84] *See* NMFS's November 22, 2019 comments at 3, stating that data generated from the operation compliance monitoring plan would "inform the need for modifications to project operations for the protection of migrating diadromous fish."

recommend it. However, there would be no cost associated with an administrative license requirement for TFH to provide operational data to the agencies upon written request. Based on the benefit of providing operational data to the agencies for migratory fish management, staff recommends it.

Cultural Resources

The Project No. 2622 powerhouse is located within a portion of the former Keith Paper Mill. The Keith Paper Mill is a contributing resource to the Turners Falls Historic District, which is a listed property on the National Register. During the term of any subsequent license, continued operation and maintenance of Project No. 2622 could have adverse effects on the Keith Paper Mill if there are no protective measures in place. Specifically, adverse effects could occur in the event repairs are needed to maintain the structure and function of Project No. 2622, or to fix structural damage that occurs in the course of project operation. Failure to maintain individual contributing resources to the Turners Falls Historic District could have adverse effects on the integrity of the historic property. Consulting with the Massachusetts SHPO on standard protocol to be implemented prior to conducting project-related repairs and other maintenance activities that could affect the Keith Paper Mill would ensure that known historic properties are not adversely affected. There would be no additional cost associated with this measure, and staff recommends it.

Previously unidentified archaeological or historic resources could be discovered during land-disturbing activities that may occur during the term of any license that is issued. We recommend that the applicant notify the Commission and the Massachusetts SHPO if previously unidentified archaeological or cultural artifacts are discovered during the course of operating and maintaining Project No. 2622. In the event of any such discovery, the applicant would discontinue all exploratory or construction-related activities until the proper treatment of any potential archaeological or cultural resources is established. There may be a future minimal cost associated with this measure.

5.1.2 Measures Not Recommended

Some of the measures proposed by TFH and recommended by NMFS, Interior, and Massachusetts DFW would not contribute to the best comprehensive use of Connecticut River's water resources, do not exhibit sufficient nexus to the project's environmental effects, or would not result in benefits to non-power resources that would be worth their cost. The following discussion includes the basis for staff's conclusion not to recommend such measures.

Upstream Migration Delay Minimization Plan

Interior, NMFS, and Massachusetts DFW recommend under section 10(j) that TFH develop a plan that includes unspecified measures for minimizing delays to upstream migrating anadromous fish at Project No. 2622, when notified by the agencies that such measures are needed.

As described in section 3.3.1.2 *Environment Effects, Upstream Migration Delay*, operation of the Turners Falls Project has the potential to delay shad that are migrating upstream through the bypassed reach of Project No. 1889. However, the agencies do not recommend any specific measures for minimizing delays or any thresholds for identifying when the measures would be needed. Without specifying a method for identifying project delays, thresholds for determining when to implement measures, or specific measures that would be used to minimize delay, there is no basis for determining whether the recommended measure would benefit anadromous fish. Moreover, we have not independently identified a need for mitigating any migration delay caused by Project No. 2622. Therefore, staff does not recommend the plan.

Trashrack Replacement Plan

TFH proposes to develop a trashrack replacement plan, in consultation with resource agencies, "[i]n the event FirstLight is not required to install a screen at the Power Canal during the next license term for the Turners Falls Hydroelectric Project (FERC No. 1889)." TFH states that the plan would include a measure for replacing the existing trashrack that has 1.5-inch clear bar spacing with a trashrack that has 0.75-inch clear bar spacing to protect fish from turbine entrainment and mortality.

While TFH conditionally proposes to develop a trashrack replacement plan based on the requirements of a new license for Project No. 1889, we cannot speculate on the outcome of the pending license proceeding for Project No. 1889, including whether FirstLight will be required to install a fish screen in the power canal as part of any new license for Project No. 1889. TFH included the cost of the trashrack in the license application for Project No. 2622 and, for purposes of our analysis here, we assume that TFH is definitively proposing to develop a trashrack replacement plan.

As to the merits of TFH's proposed trashrack replacement plan, TFH does not describe any measures that would be included in the plan outside of the installation of a trashrack with 0.75-inch clear bar spacing. As discussed in section 5.1.1, *Measures Recommended by Staff*, Commission staff is recommending that TFH install a trashrack with 0.75-inch clear bar spacing within one year of license issuance to reduce the risk of turbine-related mortality in a timely manner. Without any additional specified measures from TFH, it is unclear how the proposed plan would benefit aquatic resources.

Without further information about additional measures that would be included in the trashrack replacement plan, it is unclear how TFH's proposed trashrack replacement plan would provide additional benefits to fisheries resources that would be worth the $630 estimated levelized annual cost of the plan. Therefore, staff does not recommend the plan.

5.1.3 Conclusion

Based on our review of the comments filed on the project and our independent analysis pursuant to sections 4(e), 10(a)(1), and 10(a)(2) of the FPA, we conclude that licensing the Turners Falls Project, as proposed by TFH, with the staff-recommended measures, would be best adapted to a plan for improving the Connecticut River Basin.

5.2 UNAVOIDABLE ADVERSE IMPACTS

Some entrainment mortality is likely unavoidable for fish less than 5 inches long, including juvenile American shad. In addition, some shad, blueback herring, and juvenile American eels could be attracted to the project's tailrace and delayed during their upstream migration. Delay could increase the risk of predation and reduce spawning success and post-spawning survival for shad and blueback herring.

5.3 FISH AND WILDLIFE AGENCY RECOMMENDATIONS

Under the provisions of section 10(j) of the FPA, each hydroelectric license issued by the Commission shall include conditions based on recommendations provided by federal and state fish and wildlife agencies for the protection, mitigation, or enhancement of fish and wildlife resources affected by the project.

Section 10(j) of the FPA states that whenever the Commission finds that any fish and wildlife agency recommendation is inconsistent with the purposes and the requirements of the FPA or other applicable law, the Commission and the agency shall attempt to resolve such inconsistency, giving due weight to the recommendations, expertise, and statutory responsibilities of the agency.

In response to our September 30, 2019 notice soliciting comments, recommendations, preliminary terms and conditions, and preliminary fishway prescriptions, Massachusetts DFW filed three section 10(j) recommendations on October 25, 2019, NMFS filed two section 10(j) recommendations on November 22, 2019, and Interior filed three section 10(j) recommendations on November 26, 2019. Table 15 lists the recommendations filed pursuant to section 10(j) and indicates whether the recommendations are adopted under the staff alternative, as well as the basis for our preliminary determinations concerning measures that we consider inconsistent with section 10(j). Environmental recommendations that we consider outside the scope of

section 10(j) have been considered under section 10(a) of the FPA and are addressed in the specific resource sections of this document.

Table 15. Analysis of fish and wildlife agency recommendations for the Turners Falls Project.

Recommendation	Agency	Within scope of section 10(j)?	Levelized Annual Cost	Recommend Adopting?
Replace the existing trashrack with a trashrack having 0.75-inch clear bar spacing.	Massachusetts DFW, Interior	Yes.	$13,349	Yes.
Develop a plan to minimize delays for upstream migrating anadromous fish when notified by Interior, Massachusetts DFW, or NMFS.	Massachusetts DFW, NMFS, Interior	No.[a]	Unknown – recommendation lacks specificity needed to estimate a cost.	No.
Develop an Operation Compliance Monitoring Plan for maintaining and monitoring flow releases, including procedures for recording and reporting data to FERC and resource agencies.	Massachusetts DFW, NMFS, Interior	Yes.	$630	No. Measure is inconsistent with section 10(a) of the FPA because benefits do not outweigh costs. Staff is recommending an administrative requirement for the applicant to provide the agencies with operational data upon written request.

[a] The measure is based on the occurrence of a future event. There is no reserved authority under section 10(j) for future, uncertain actions such as modifying the design and operation of facilities if undefined events occur.

5.4 CONSISTENCY WITH COMPREHENSIVE PLANS

Section 10(a)(2)(A) of the FPA, 16 U.S.C. § 803(a)(2)(A), requires the Commission to consider the extent to which a project is consistent with federal or state comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project. We reviewed the following 20 comprehensive plans that are applicable to the Turners Falls Project. No inconsistencies were found.

Atlantic States Marine Fisheries Commission. 1998. Amendment 1 to the Interstate Fishery Management Plan for Atlantic sturgeon (*Acipenser oxyrhynchus oxyrhynchus*). (Report No. 31). July 1998.

Atlantic States Marine Fisheries Commission. 1999. Amendment 1 to the Interstate Fishery Management Plan for shad and river herring. (Report No. 35). April 1999.

Atlantic States Marine Fisheries Commission. 2000. Interstate Fishery Management Plan for American eel (*Anguilla rostrata*). (Report No. 36). April 2000.

Atlantic States Marine Fisheries Commission. 2000. Technical Addendum 1 to Amendment 1 of the Interstate Fishery Management Plan for shad and river herring. February 9, 2000.

Atlantic States Marine Fisheries Commission. 2008. Amendment 2 to the Interstate Fishery Management Plan for American eel. Arlington, Virginia. October 2008.

Atlantic States Marine Fisheries Commission. 2009. Amendment 2 to the Interstate Fishery Management Plan for shad and river herring, Arlington, Virginia. May 2009.

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Connecticut River Atlantic Salmon Commission. 2017. Connecticut River American Shad Management Plan. Sunderland, Massachusetts. June 9, 2017.

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6.0 FINDING OF NO SIGNIFICANT IMPACT

If the Turners Falls Project is issued a subsequent license as proposed with the additional staff-recommended measures, the project would continue to operate while providing protection and enhancements to aquatic resources and protection of cultural and historic resources in the project area.

Based on our independent analysis, we find that the issuance of a license for the Turners Falls Project, with additional staff-recommended environmental measures, would not constitute a major federal action significantly affecting the quality of the human environment.

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APPENDIX A

Table A1. Percentage of the maximum weighted usable area (WUA) for a range of flows at transects 10 and 11 for low backwater conditions.

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	120 cfs	150 cfs	200 cfs	250 cfs	400 cfs	500 cfs	600 cfs	700 cfs	800 cfs	1,000 cfs	1,200 cfs	1,400 cfs	1,600 cfs	1,800 cfs	2,000 cfs	3,000 cfs	4,000 cfs	5,000 cfs
American Shad	Spawning/ Incubation	May-June	7,500	20.0	9.5%	11.0%	13.3%	15.4%	18.9%	21.6%	24.1%	26.5%	28.8%	32.8%	37.9%	43.1%	47.5%	52.9%	58.2%	71.7%	81.6%	88.8%
American Shad	Juvenile	June-Oct	2,000	14.2	27.3%	29.7%	33.6%	36.9%	42.1%	43.8%	45.0%	46.1%	47.6%	52.8%	66.3%	78.8%	86.1%	93.8%	100.0%	96.9%	89.1%	80.4%
American Shad	Adult	May-June	7,500	14.4	10.8%	12.5%	14.8%	17.0%	18.8%	21.1%	23.5%	25.5%	27.5%	31.4%	35.7%	39.7%	42.2%	46.0%	49.7%	65.8%	80.6%	89.3%
Shortnose Sturgeon	Spawning/ Incubation	April-May	6,000	20.1	7.2%	10.1%	13.7%	16.3%	21.4%	23.8%	26.4%	28.6%	30.5%	33.0%	37.2%	43.0%	49.0%	56.7%	65.5%	84.2%	94.4%	98.8%
Shortnose Sturgeon	Egg-Larvae	May	3,000	31.2	20.3%	22.2%	25.1%	27.9%	32.4%	33.7%	35.1%	37.4%	41.4%	51.0%	67.4%	80.2%	87.5%	94.3%	99.4%	100.0%	99.9%	99.2%
Shortnose Sturgeon	Fry	May	700	1.4	57.3%	63.0%	71.0%	79.1%	89.9%	94.9%	98.2%	100.0%	100.0%	97.5%	95.4%	94.5%	91.5%	91.3%	91.8%	70.6%	52.7%	38.0%
Fallfish	Spawning/ Incubation	May-June	120	0.1	100.0%	91.1%	78.0%	66.5%	58.5%	44.5%	31.8%	20.3%	8.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fallfish	Fry	May-June	200	0.7	85.9%	96.3%	100.0%	97.6%	86.8%	82.2%	68.5%	53.3%	46.0%	33.6%	28.2%	25.4%	21.9%	18.5%	15.5%	4.8%	1.5%	0.7%
Fallfish	Juvenile	Year Round	2,000	5.4	49.6%	48.0%	50.7%	58.0%	67.2%	72.5%	73.0%	72.8%	75.5%	77.0%	80.6%	89.6%	95.2%	99.3%	100.0%	89.7%	67.8%	47.7%
Fallfish	Adult	Year Round	2,000	10.1	41.4%	44.3%	49.3%	52.4%	49.9%	48.0%	45.9%	44.6%	45.2%	49.3%	63.5%	78.3%	85.2%	94.3%	100.0%	93.2%	77.5%	64.7%
Longnose Dace	Juvenile	Year Round	2,000	4.5	13.0%	14.5%	17.5%	22.5%	44.0%	43.4%	35.0%	31.2%	29.0%	31.0%	49.1%	68.0%	83.9%	95.4%	100.0%	46.2%	17.1%	5.4%
Longnose Dace	Adult	Year Round	2,000	10.6	9.5%	10.1%	12.5%	14.4%	28.5%	29.8%	27.3%	26.7%	25.6%	23.3%	41.7%	62.0%	79.8%	93.0%	100.0%	68.6%	29.4%	8.8%
White Sucker	Spawning/ Incubation	April-May	120	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
White Sucker	Fry	May-June	1,200	14.7	38.2%	38.7%	42.1%	49.0%	39.4%	47.3%	58.4%	70.1%	79.3%	96.8%	100.0%	91.8%	73.5%	52.8%	28.4%	6.5%	1.4%	1.1%
White Sucker	Adult/Juvenile	Year Round	1,600	4.7	87.2%	82.8%	77.1%	73.5%	58.0%	47.4%	40.0%	35.2%	32.9%	43.5%	70.4%	95.9%	100.0%	97.6%	79.0%	38.5%	10.9%	3.4%
Walleye	Spawning/ Incubation	April-May	3,000	3.5	8.8%	9.9%	11.3%	12.5%	18.9%	23.4%	28.2%	34.5%	40.9%	50.0%	55.8%	57.6%	68.0%	69.1%	69.2%	100.0%	95.4%	86.4%
Walleye	Fry	April-May	120	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walleye	Juvenile	Year Round	150	0.0	71.4%	100.0%	100.0%	100.0%	71.4%	57.1%	57.1%	42.9%	28.6%	14.3%	5.7%	11.4%	8.6%	0.0%	0.0%	0.0%	0.0%	0.0%
Walleye	Adult	Year Round	3,000	0.1	38.2%	47.6%	53.3%	54.1%	47.6%	53.3%	58.2%	62.6%	65.9%	70.0%	74.7%	76.9%	77.7%	78.9%	83.4%	100.0%	39.0%	1.4%
Tessellated Darter	Adult/Juvenile	Year Round	2,000	3.9	8.6%	8.6%	11.5%	14.1%	32.9%	32.5%	21.5%	18.7%	19.4%	26.1%	47.4%	68.0%	85.3%	97.3%	100.0%	39.3%	5.5%	0.0%
Sea Lamprey	Spawning/ Incubation	May-June	2,000	2.2	30.9%	36.7%	46.3%	54.3%	72.7%	78.1%	82.4%	83.0%	83.9%	84.3%	85.8%	88.0%	90.9%	95.3%	100.0%	91.0%	70.6%	56.1%
Macroinverts	Larva	Year Round	4,000	22.1	1.9%	3.0%	4.9%	6.6%	13.8%	18.0%	21.7%	24.7%	26.7%	28.7%	31.5%	37.0%	45.1%	55.4%	68.0%	91.8%	100.0%	98.0%
Habitat Guild	Shallow Slow	Year Round	1,200	18.1	22.3%	25.5%	31.7%	46.9%	58.3%	62.2%	68.3%	70.7%	78.5%	92.4%	100.0%	88.6%	78.8%	75.9%	71.6%	20.7%	0.0%	0.0%
Habitat Guild	Shallow Fast	Year Round	1,800	12.8	15.8%	18.5%	21.5%	23.5%	30.8%	30.3%	26.6%	21.7%	22.2%	33.4%	64.6%	85.2%	96.0%	100.0%	96.1%	43.8%	12.0%	3.0%
Habitat Guild	Deep Slow	Year Round	1,400	8.9	49.4%	54.3%	60.7%	68.0%	37.5%	31.6%	25.5%	25.1%	37.3%	61.4%	83.7%	100.0%	84.7%	65.2%	54.3%	18.2%	3.5%	1.3%
Habitat Guild	Deep Fast	Year Round	3,000	2.9	25.0%	33.7%	47.3%	57.5%	71.1%	63.4%	61.0%	56.0%	49.3%	53.7%	74.7%	87.8%	89.4%	91.4%	93.9%	100.0%	86.0%	69.2%

(Source: FirstLight, 2016f and FirstLight, 2018a, as modified by staff).

Table A2. Percentage of the maximum weighted usable area (WUA) for a range of flows at transects 10 and 11 for high backwater conditions.

Species	Life Stage	Months Present	Flow @ Maximum WUA (cfs)	Area at Maximum WUA (acres)	120 cfs	150 cfs	200 cfs	250 cfs	400 cfs	500 cfs	600 cfs	700 cfs	800 cfs	1,000 cfs	1,200 cfs	1,400 cfs	1,600 cfs	1,800 cfs	2,000 cfs	3,000 cfs	4,000 cfs	5,000 cfs
American Shad	Spawning/ Incubation	May-June	7,500	20.6	17.6%	18.7%	20.6%	22.5%	27.2%	29.1%	30.6%	32.2%	33.7%	36.6%	40.9%	45.5%	49.8%	54.5%	59.8%	72.4%	81.9%	89.0%
American Shad	Juvenile	June-Oct	2,000	15.3	43.9%	47.7%	53.5%	58.6%	52.9%	55.3%	57.5%	59.2%	61.2%	64.6%	74.4%	83.0%	88.7%	94.4%	100.0%	95.5%	88.1%	80.6%
American Shad	Adult	May-June	7,500	16.0	23.1%	24.0%	25.7%	27.2%	29.1%	30.1%	31.1%	32.2%	33.3%	35.2%	37.7%	40.7%	43.1%	46.3%	50.3%	66.2%	80.2%	90.7%
Shortnose Sturgeon	Spawning/ Incubation	April-May	6,000	20.5	0.5%	1.6%	5.6%	9.7%	23.1%	27.9%	31.0%	32.6%	33.5%	35.0%	39.6%	45.4%	52.3%	60.8%	70.8%	87.7%	96.0%	99.5%
Shortnose Sturgeon	Egg-Larvae	May	3,000	31.2	38.9%	43.8%	51.1%	57.5%	42.9%	46.9%	51.0%	55.0%	59.3%	66.6%	77.6%	85.8%	91.5%	95.9%	99.9%	100.0%	100.0%	99.7%
Shortnose Sturgeon	Fry	May	500	1.5	44.5%	54.9%	71.4%	85.1%	99.3%	100.0%	99.9%	99.8%	99.9%	98.3%	94.8%	93.8%	91.8%	91.3%	92.4%	73.1%	56.9%	43.5%
Fallfish	Spawning/ Incubation	May-June	120	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fallfish	Fry	May-June	150	0.6	96.3%	100.0%	99.7%	98.5%	87.3%	82.4%	75.3%	61.6%	50.7%	39.0%	32.6%	28.2%	24.3%	20.9%	17.8%	6.1%	1.8%	1.0%
Fallfish	Juvenile	Year Round	1,800	6.0	57.8%	63.6%	71.2%	77.0%	73.3%	74.3%	76.2%	77.6%	79.5%	82.8%	89.5%	93.4%	98.0%	100.0%	99.5%	80.4%	61.6%	44.0%
Fallfish	Adult	Year Round	2,000	12.6	67.5%	70.9%	76.2%	80.6%	75.7%	75.7%	71.2%	67.1%	63.5%	59.8%	70.4%	80.6%	86.7%	93.4%	100.0%	89.6%	74.3%	60.5%
Longnose Dace	Juvenile	Year Round	1,800	3.6	13.0%	16.4%	22.0%	27.6%	23.1%	27.7%	31.3%	34.2%	37.4%	44.0%	64.0%	81.7%	95.7%	100.0%	94.9%	39.8%	12.7%	3.6%
Longnose Dace	Adult	Year Round	2,000	9.5	9.3%	11.7%	15.8%	19.8%	16.1%	18.5%	20.4%	22.8%	25.4%	31.5%	51.4%	69.4%	84.2%	94.0%	100.0%	54.4%	17.0%	4.2%
White Sucker	Spawning/ Incubation	April-May	120	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
White Sucker	Fry	May-June	120	23.0	100.0%	99.6%	97.6%	95.7%	84.7%	79.3%	75.2%	74.9%	76.4%	79.7%	75.7%	66.4%	51.8%	36.6%	20.8%	4.3%	1.0%	0.8%
White Sucker	Adult/Juvenile	Year Round	250	8.3	75.0%	85.5%	95.4%	100.0%	82.0%	71.1%	60.5%	50.9%	43.7%	45.5%	63.6%	77.0%	78.1%	73.4%	63.4%	29.9%	8.2%	2.6%
Walleye	Spawning/ Incubation	April-May	3,000	3.2	14.5%	14.9%	15.5%	16.2%	19.3%	21.4%	25.8%	29.8%	35.2%	45.0%	51.0%	55.9%	59.7%	64.4%	62.8%	100.0%	96.3%	85.7%
Walleye	Fry	April-May	120	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walleye	Juvenile	Year Round	120	0.0	100.0%	82.4%	52.9%	32.4%	26.5%	23.5%	17.6%	14.7%	11.8%	8.8%	4.7%	3.5%	3.5%	2.4%	2.9%	0.0%	0.0%	0.0%
Walleye	Adult	Year Round	120	0.8	100.0%	80.4%	48.8%	24.5%	19.4%	15.8%	13.0%	12.9%	12.9%	13.1%	13.5%	14.1%	14.6%	14.9%	15.6%	20.0%	14.3%	4.4%
Tessellated Darter	Adult/Juvenile	Year Round	1,800	3.1	12.2%	15.4%	20.9%	26.5%	18.0%	22.0%	26.7%	31.9%	36.7%	45.3%	66.1%	84.5%	98.2%	100.0%	96.7%	28.7%	0.9%	0.0%
Sea Lamprey	Spawning/ Incubation	May-June	2,000	2.2	15.0%	19.3%	26.5%	33.5%	53.7%	66.0%	77.9%	83.2%	83.8%	83.6%	84.6%	88.0%	91.7%	95.8%	100.0%	90.8%	70.2%	53.1%
Macroinverts	Larva	Year Round	4,000	21.1	0.0%	0.1%	0.4%	0.9%	6.0%	10.0%	14.0%	17.7%	21.3%	26.9%	30.4%	36.1%	44.7%	55.2%	67.1%	91.6%	100.0%	97.6%
Habitat Guild	Shallow Slow	Year Round	700	18.8	93.6%	94.1%	95.4%	97.1%	96.6%	97.5%	98.3%	100.0%	100.0%	93.0%	80.8%	78.2%	75.5%	71.7%	68.0%	21.5%	0.0%	0.0%
Habitat Guild	Shallow Fast	Year Round	1,600	12.3	24.8%	30.7%	40.4%	49.7%	26.1%	31.1%	36.2%	41.7%	49.0%	63.3%	83.5%	96.4%	100.0%	97.1%	88.9%	32.3%	9.1%	2.9%
Habitat Guild	Deep Slow	Year Round	500	14.1	90.7%	91.4%	93.3%	95.7%	96.1%	100.0%	88.5%	65.6%	59.0%	67.0%	73.3%	78.9%	80.3%	64.2%	54.8%	22.2%	3.6%	1.2%
Habitat Guild	Deep Fast	Year Round	3,000	2.9	2.4%	6.7%	15.0%	23.1%	37.8%	53.4%	69.1%	79.4%	82.8%	89.5%	88.3%	89.1%	91.6%	94.4%	99.6%	100.0%	89.8%	52.9%

(Source: FirstLight, 2016f and FirstLight, 2018a, as modified by staff).