CONNECTICUT RIVER BASIN ANADROMOUS FISH RESTORATION: Coordination and Technical Assistance F-100-R-37

Annual Progress Report
October 1, 2019 - September 30, 2020

U.S. Fish and Wildlife Service
Connecticut River Fish and Wildlife Conservation Office
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Executive Summary

Federal Aid Project # F-100-R-37

States: Connecticut, Massachusetts, New Hampshire and Vermont

Project Title: Connecticut River Basin Anadromous Fish Restoration: Coordination and Technical Assistance

Period Covered: October 1, 2019 - September 30, 2020

This annual report provides an opportunity to organize and document, to varying degrees, all work activities conducted by the Connecticut River Fish and Wildlife Conservation Office (CTRFWCO), formerly the Connecticut River Coordinator's Office, which includes work outside of the Connecticut River basin and activities not funded by this grant.

In mid-March 2020, it became clear the Covid-19 situation was going to dramatically impact nearly all FWCO work plans. The evolving situation resulted in not conducting any of the ongoing spring population assessment work that this office has worked to develop for long-term monitoring data. In addition, the planned Adult Blueback Herring Movement and Migration Study, to be cooperatively conducted with USGS Conte Lab and other partners was cancelled. Seasonal paid intern and volunteer intern worker agreements were canceled. Other non-field work related activities of importance were subsequently given more focus/time and are described in this report.

Cover photo credit- U.S. Forest Service in the Green Mountain National Forest, White River basin (VT), 2020.

Objectives:

- Coordinate the Connecticut River Anadromous Fish Restoration Program as a unified effort of State and Federal fishery agencies
- Provide technical assistance to the fishery agencies and other program cooperators
- Represent the Service on Commissions, Technical Committees, and work cooperatively with State agencies and other partners
- Identify fishery program priorities, design and implement projects to address issues and opportunities, and develop plans
- Administer grant programs to address fish habitat, passage, management, and research projects

Accomplishments:

Program Coordination

- Organized two Connecticut River Atlantic Salmon Commission (CRASC) meetings.
- Organized CRASC American Shad Fish Passage Plan Team meetings to address and respond to review comments received for the Addendum on Fish Passage Performance and oversee the response products (individual and broader memorandum)
- Coordinated the third season of the fall juvenile alosine survey with MADFW, VTDFW and other partners.
- Submitted CRASC Shad Plan Addendum on Fish Passage Performance to FERC as an update to the existing Comprehensive Management Plan status of the CRASC Shad Management Plan.
- Organized a meeting of the Holyoke Cooperative Consultation Team to address Holyoke Project fish passage items among members.
- Provided annual upstream and downstream fishway operations letters (for CRASC) to hydropower owner/operators and the Federal Energy Regulatory Commission (FERC).
- Worked with main stem power companies to ensure fish passage facilities operated during Covid-19 outbreak and various shutdowns/restrictions.

Technical Assistance

- Continued in role as Chair of the ASMFC Shad and River Technical Committee over the course of the report year. Worked with ASMFC staff and Vice Chair to plan meetings/calls with the Technical Committee, subcommittee work groups, and individual members over the year. Work of the TC and its sub committees focused on addressing a number of Board charges that were worked on over the year. The development, review, approval of state and other jurisdictional management plans also occurred for both American Shad and river herring.
- Participated in ASMFC American Shad Stock Assessment Analyses Workshop (3rd week November 2019) in Charleston SC, served as member of the American Shad Stock Assessment Subcommittee and working groups (Fish Passage, Stock Structure).
- Presented ASMFC Shad and River Herring Technical Committee work item updates and fishery management plan reviews to the Commission at their October 2019 Meeting (New Castle, NH).
- Served as contributing author for the American Shad Stock Assessment Report through its final draft version in June 2020.
- Served with other ASMFC Shad SAS members on the Peer Review Panel process in the 1st week of June. The Peer Review accepted the Assessment report with some minor edits and comments. Identified analytical items were edited. The Peer Review complemented the SAS on the work done for this large scale stock assessment.
- Presented updates and recommendations to the ASMFC Commission at their virtual August 2020 meeting. Alternative Management Plans from agencies were reviewed with TC recommendations. An update on work to date regarding Board task charges was also reviewed with plans to continue working to completion of those items.
- ASMFC approved the 2020 American Shad Benchmark Stock Assessment and Peer Review

Report at the August Meeting, the SAS Chair presented the report and answered questions. The 2020 Assessment and Peer Review Report is 1,188 pages and can be found at: http://www.asmfc.org/uploads/file/5f999ba1AmShadBenchmarkStockAssessment_PeerReviewReport_2020_web.pdf

- An Overview of the 2020 Assessment Report was also developed and is 8 pages and can be found at: http://www.asmfc.org/uploads/file/5f47c8dbAmShadAssessmentOverview_Aug2020.pdf
- The Assessment Report includes status and trend information for approved data on the Connecticut River and a status determination based on total mortality estimates in relation to a conservation benchmark threshold value. Later in this Annual Report text and explanation of these analyses will be presented.
- Participated in interagency/stakeholder group as well as power company related confidential agreement work on facility operations of Great River Hydro main stem projects. This work occurred in the late spring through end of the report year.
- Participated in a Federal Agency work group (USFWS and NOAA) started in June and ongoing to develop Section 18 Fish Passage Prescriptions in a coordinated effort (Fish Passage Engineers, Regulatory Biologists, Field Biologist).
- Participated in study planning reviews for a new proposed fish transport system by a commercial firm and power company that ultimately was not located in the Connecticut River basin.
- Completed the Annual Sport Fish Restoration Grant Report for FY19, in January 2020 and posted on CTRFWCO web site.
- As Chair of CRASC TC Shad subcommittee, organized meetings, work assignments and served as lead writer for the CRASC Addendum – Fish Passage Performance to the 2017 Connecticut River American Shad Management Plan. Work on this occurred fall through winter with the strong support and engagement of the other noted co-contributors (refer to Addendum) that made this large-scale technical effort possible.
- Following an initial and then second extended public review period for comment submission on the Addendum in the fall of 2019, work was started by CRASC team members on review of received comments. The team developed a response memorandum to CRASC covering key critical reviews of the Addendum and the basis for its support as well as individual responses to questions raised by the power companies and others. The packet of information (reviewer questions/comments, team responses, team summery memo) was provided to CRASC in the winter 2020.
- CRASC approved the Addendum to the Shad Plan at their February 2020 meeting.
- Developed an updated document consisting of: CRASC 2017 Connecticut River American Shad Management Plan, the Addendum on Fish Passage Performance, Memorandum to CRASC on Review of Comments Received on the Addendum, and a table of individual comment items by all parties submitting comments with the Addendum Teams' responses. That document was posted to the CTRFWCO web site: https://www.fws.gov/r5crc/pdf/CRASC-Shad-Plan-and-Addendum-3_2_2020.pdf
- Submitted the updated CRASC American Shad Plan (Addendum and comments/responses) to FERC requesting that the Addendum be included in their existing designation of the 2017 CRASC Plan as a FERC Comprehensive Management Plan. The updated CRASC Plan was so designated by FERC.

- Conducted the cooperative Juvenile Alosine Production Assessment with primary partner MA Division of Fisheries and Wildlife in the fall of 2019 and assistance from the Connecticut River Conservancy and VTDFW.
- Completed a total of 18 sampling date events in the Bellows Falls to Vernon Dam reach and the Vernon to Turners Falls Dam reach, concluding on 29 October 2019. A total of 653 juvenile shad were sampled in 90 standardized sample runs that were from selected from random stratified zones and cell.
- Seasonal Student Conservation Association intern Jake Rawlings, provided by the SCA at no cost, worked full-time September through early December 2019 playing a key role in juvenile alosine project work, data entry and analyses.
- Co-project leaders for the juvenile alosine project, Steven Mattocks (MADFW) and Brian Keleher (MADFW), complied our data and completed an updated analyses of the three years of data for this project. The information was submitted/given as a poster presentation at the January 2020 Southern New England Chapter of the American Fisheries Society Meeting. The poster is posted on the CTRFWCO website: https://www.fws.gov/r5crc/pdf/Mattocks_SNEC_winter_2020_shad_poster.pdf
- CTRFWCO Biologist Darren Desmarais completed river herring otolith digital image reading and age assignments from the spring lab processed fish: Blueback Herring (n= 1,474) and Alewife (n= 217).
- Data from 2019 field season and otolith age assignments updated in program database. Analyses on catch-at-age using relative abundance was completed for years 2013-2019 with Blueback Herring for Wethersfield Cove and Farmington River (due to time constraints for presentation).
- Platform presentation developed and given at January 2020 Southern New England Chapter of American Fisheries Society Winter Meeting entitled "**Blueback Herring Stock Assessments in the lower Connecticut River basin: age structure, catch-at-age and relationships to Juvenile Index 2013-2019**." Highlights of those analyses will be presented later in this report.
- Provided program information and requested data (e.g., fish counts) to cooperators, researchers, power companies, and the public.
- Administered grant/program agreements for two SCA interns that were to serve from 1 April through late August. Due to Covid-19, ongoing efforts were made to attempt to start these interns later. It was decided in June to cancel these positions and work was then started to amend these grant agreements for the following year.
- Conducted the cooperative Juvenile Alosine Production Assessment with primary partner MA Division of Fisheries and Wildlife starting in the last week of August 2020. Due to Covid protocols, methods were modified. Only a single evening sample event per week (vs. two) by USFWS was conducted, with one rather than two bow netters. Sample work continued into the next fiscal year (October 2020).
- Standard data were recorded, entered, and summarized during the season and shared with MADFW. In 2021, with two netters allowed hopefully, we intend to determine whether a correction factor for one netter vs. two netters can be determined to account for the method shift in 2020.

Cooperative Research

- Served as USFWS project officer and cooperator the for U. S. Geologic Survey University of Massachusetts Cooperative Fish and Wildlife Research Unit and Conte Fish Research Laboratory (CAFRC) study, "Environmental Factors Controlling Juvenile River Herring Productivity and Emigration (2019-2022)", partially supported by the USFWS Science Support Program.
- The planned acoustic tag study with Blueback Herring was postponed as noted. A total of 58 tags were received in March 2020. Work to prepare for the study in 2021 was completed including; acquiring a surplus USFWS electrofishing boat and ordering an additional 42 acoustic tags using base funds (total available tags 100). The office competed for unobligated funds from the regional budget and was able to purchase an additional 60 tags. The two additional tags orders totaling 102, will be delivered in March of 2021 and makes a grand total of 160 tags available for the study in 2021.

Outreach

- Provided a slide presentation on the migratory fish programs/activities the office is involved with to the Southern Vermont Chapter of Trout Unlimited in November.
- Represented the USFWS at the Westfield State University Career night in the Science Department in December.
- Produced the CT River Basin Fishway Counts report and distributed 2-3 times a week in spring season (frequently later in year) electronically and posted updates on the Office web site maintained databases (Appendix A).
- Connecticut River Conservancy organized remote outreach events for the rescheduled Migratory Fish Day events (canceled from spring due to Covid-19). The CRC had a professional videographer create a video on the fall juvenile alosine assessment program. Filming occurred in September (live on-line video event in following month).

Acknowledgements

Many people have contributed to the work accomplished by this office in the report period that I want to recognize and thank. Darren Desmarais served as the sole permanent staff (Fish Biologist) for the CTRFWCO and contributed greatly to the office's accomplishments in many areas, particularly on the river herring project. Jacob Rawlings was a paid intern (SCA) starting in September 2019 through December 2019, assisting in all aspects of the juvenile alosine survey including data management and analyses of 2019 and previous years. Jacob also worked in preparing gear for the planned Blueback Herring acoustic tag study (creating mooring anchor systems).

Don Pugh has continued to provide significant technical support for the resource agencies' efforts on hydropower relicensings and ongoing fish passage activities at facilities like Holyoke Dam. Don's contributions in data analyses, review of power company reports and plans and discussion are highly valued by the agencies. Katie Kennedy (The Nature Conservancy) also continued to make important technical contributions on FERC activities and other aquatic conservation initiatives. Katie had a very important role in the negotiations with Great River Hydro on an operations plan that after 6 months was successfully agreed to by all parties. The Connecticut River Conservancy, from the Director Andy Fisk to its field staff (Andrea Donlon and Kathy Uffer), have provided ongoing staff support for field activities and important technical support (FERC and other areas) over the course of the year. Kathy was a key member of the stakeholder negotiation team with Great River Hydro.

Other thanks for assisting in the accomplishments over this report period go to:

State fishery agencies -

- Connecticut: Steve Gephard, Kevin Jobs, Tim Wildman, Jacque Roberts, and staff
- Massachusetts: Caleb Slater, Ben Gahagan, Steven Mattocks, and Brian Keleher
- New Hampshire: Matt Carpenter, Gregg Comstock
- Vermont: Lael Will (and her seasonal technicians), Hannah Harris, Jeff Crocker, Eric Davis

Federal agencies –

- USFWS: Melissa Grader, Phil Herzig, Brett Towler, Julianne Rosset, Andy French, and David Perkins
- NOAA Fisheries: Bill McDavitt, Sean McDermott, Bjorn Lake, and Julie Crocker
- USGS Conte Lab: Ted Castro-Santos, Alex Haro, Steve McCormick, Micah Kieffer

The Anadromous Fish Program and The Connecticut River Atlantic Salmon Commission

The administration of the interjurisdictional cooperative effort to restore diadromous fish species to the Connecticut River basin is accomplished through the Connecticut River Atlantic Salmon Commission (the Commission). During the period from 1967-1983 (prior to the Commission), restoration of anadromous fish, primarily Atlantic Salmon and American Shad, on the Connecticut River was guided by the Policy Committee and the Technical Committee for Fisheries Management of the Connecticut River Basin. The importance of this formally-structured, coordinating and regulatory body to the restoration program was recognized in 1983 when Congressional consent was given to the Connecticut River Basin Atlantic Salmon Compact, Public Law 98-138. The enabling legislation was re-authorized for another 20 years in 2002. This law, originally passed by the legislative bodies in each of the four basin states, created the Commission and conveys Congressional support to an interstate compact for the restoration of anadromous fish to the Connecticut River Basin. The Commission is comprised of ten Commissioners (Table 1) including a high-level government employee and a public sector representative appointed by the governor of the appropriate state, and the Northeast Regional Directors of both the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) also referred to as NOAA Fisheries.

The Commissioners develop and act on policy matters and are advised on scientific and technical matters by a Technical Committee. The Technical Committee is comprised of senior staff biologists from each Commission member agency, the U.S. Forest Service (USFS), and the Massachusetts Division of Marine Fisheries (Table 2). The Technical Committee has eight subcommittees, with specific areas of responsibility (American Shad, River Herring, Atlantic Salmon, American Eel, Sturgeon, Sea Lamprey, Fish Passage, and Habitat). Other experts and cooperators from the member agencies including the U.S. Geological Survey, Conte Anadromous Fish Research Center (CAFRC), Trout Unlimited, The Nature Conservancy, Connecticut River Conservancy, private industry, and others participate with the subcommittees and Technical Committee as needed. The Connecticut River Coordinator (Coordinator), also the Connecticut River Fish and Wildlife Conservation Office Project Leader, is an employee of the USFWS, acts as the Executive Assistant to the Commission and the Secretary for the Technical Committee and is the USFWS Technical Committee representative.

The Coordinator is responsible for assisting on coordination of state and federal activities, providing; technical expertise, project development and implementation of fish population assessments, restoration, management, and research programs, program evaluation, assist the USFWS Ecological Services Division on Federal Power Act with select FERC projects, and conduct advocacy and outreach of the cooperative diadromous fish restoration program in the Connecticut River watershed (Figure 1). The Coordinator also organizes meetings, identifies priorities, develops initiatives and plans, implements them, and maintains and develops partnerships to accomplish objectives. The Coordinator serves as the USFWS representative to the Atlantic States Marine Fisheries Commission's Shad and River Herring Technical Committee (Chair through this report period) and on other committees as needed.

Fish species under restoration and enhancement in the Connecticut River basin include American Shad, Blueback Herring, Sea Lamprey, American Eel, and Alewife, primarily addressed by efforts to provide safe, timely, and effective upstream and downstream passage to historic habitats as well as measures to improve habitat quality (e.g., address rapid, large scale fluctuations in sub-daily discharge from hydropower operations). Shortnose Sturgeon, a federally endangered species, is under recovery and continues to be monitored, studied, and protected in a variety of ways, some of which will be covered in later text. Atlantic Sturgeon are also present in the lower river and are federally protected.

In 2020, there were no documented adult Atlantic Salmon returns to the basin. The CTDEEP continues fry stocking with its Atlantic Salmon Legacy Program. In 2020, a total of 150,354 salmon fry were stocked in the West Branch of the Farmington River in May. Fry were reared at the Kensington State Hatchery. The Salmon River and several of its tributaries were stocked with a total of 72,000 fry in March with fry from the Tripp Streamside Incubation Facility. This effort maintains a presence of this species in the basin and serves many other CTDEEP objectives including popular outreach and school education programs.

The CRASC continues to serve as an important mechanism to maintain communication and coordination on migratory fish restoration and management activities in the Connecticut River basin. Given the current status of diadromous species (both in-basin and coast wide), the main stem hydropower facilities in FERC relicensing process, and recent Holyoke Dam downstream passage (Settlement Agreement) measures being completed and under evaluation, there is a need and value of a basin-wide coordinated management approach.

The CRASC meets at least twice each year and the Technical Committee (and its subcommittees) meets as frequently as needed. This report period, the Commission met on December 11, 2019 and on February 28, 2020. At the December 11, 2020 CRASC meeting the following members were unanimously voted into the following Commission positions; Dr. Andy Fisk as the Chair of the Commission, Mr. Eric Palmer as Vice Chair, and Ms. Wendi Weber as Secretary/Treasurer. At the February 28, 2020 CRASC meeting Mr. Don McGinley was introduced as the new New Hampshire Public Commissioner. Mr. McGinley replaces Mr. Duncan McInnes who served the Commission and the resource over many decades representing New Hampshire Fish and Game and then in his retirement as the Public Commissioner. In addition, the New Hampshire Fish and Game Director Glenn Normandeau retired from his position in the spring of 2020. The new Director, Mr. Scott Mason was appointed in the summer of 2020.

The Technical Committee did not formally meet in this report period but rather conducted work through its subcommittees. The Shad Subcommittee's Plan Team meet numerous times fall through the Commission's adoption of the Fish Passage Performance Addendum for the Shad Plan at their February 2020 meeting. The Sea Lamprey Subcommittee also had meetings to plan for nest survey work in the spring. The Fish Passage Subcommittee members were by default addressing ongoing FERC relicensings items on the main stem, tributary FERC projects, and ongoing passage activities at the Holyoke Project.

CRASC scheduled meetings (Commission and Technical) are open to the public, contact Ken Sprankle at ken_sprankle@fws.gov or at 413-548-9138 ext. 8121, to receive notices for scheduled meetings. Interested citizens are given the opportunity to provide input and area news publishers are notified of scheduled Commission meetings via email. Minutes of both Commission and Technical Committee meetings, once approved are available and posted on the Connecticut River FWCO website, https://www.fws.gov/r5crc/. Any one requiring hearing assistance or any other considerations should contact Ken Sprankle at least 3 weeks in advance of scheduled meetings, so appropriate arrangements can be made.

Table 1. Connecticut River Atlantic Salmon Commission Membership (as of September 2020).

Connecticut River Atlantic Salmon Commission	
Federal	**U.S. Fish and Wildlife Service** *Wendi Weber (Secretary/Treasurer)* Regional Director, Region 5 *Sherry White, alternate*
	National Marine Fisheries Service *Michael Pentony* Northeast Administrator *Kimberly Damon-Randall, alternate*
Connecticut	**Connecticut Dept. of Energy and Environmental Protection** *Rick Jacobson* Chief, Bureau of Natural Resources *Stephen Gephard, alternate*
	Public Sector Representative Tom Chrosniak
Massachusetts	**Massachusetts Division of Fisheries and Wildlife** *Mark Tisa* Director *Todd Richards, alternate*
	Public Sector Representative *Andrew Fisk (Chair)*
New Hampshire	**New Hampshire Fish and Game Department** *Scott Mason* Executive Director *Scott Decker, alternate*
	Public Sector Representative *Donald McGinley*
Vermont	**Vermont Department of Fish and Wildlife** *Louis Porter* Commissioner *Eric Palmer (Vice Chair), alternate*
	Public Sector Representative *Peter H. Basta*

Table 2. Connecticut River Atlantic Salmon Commission Technical Committee Membership.

Connecticut River Atlantic Salmon Commission Technical Committee	
Federal	**U.S. Fish and Wildlife Service** *Kenneth Sprankle*
	National Marine Fisheries Service *William McDavitt*
	U.S. Forest Service *Dan McKinley*
Connecticut	**Connecticut Dept. of Energy and Environmental Protection** *Stephen R. Gephard*
Massachusetts	**Massachusetts Division of Fisheries and Wildlife** *Caleb Slater** (Chair)
	Massachusetts Division of Marine Fisheries *Ben Gahagan*
New Hampshire	**New Hampshire Fish and Game Department** *Matthew Carpenter*
Vermont	**Vermont Department of Fish and Wildlife** *Lael Will*

*Mr. Steven Mattock (MADFW) took on many responsibilities of Dr. Caleb Slater as he assumed another position in the MADFW. A formal role shift came after this report period,

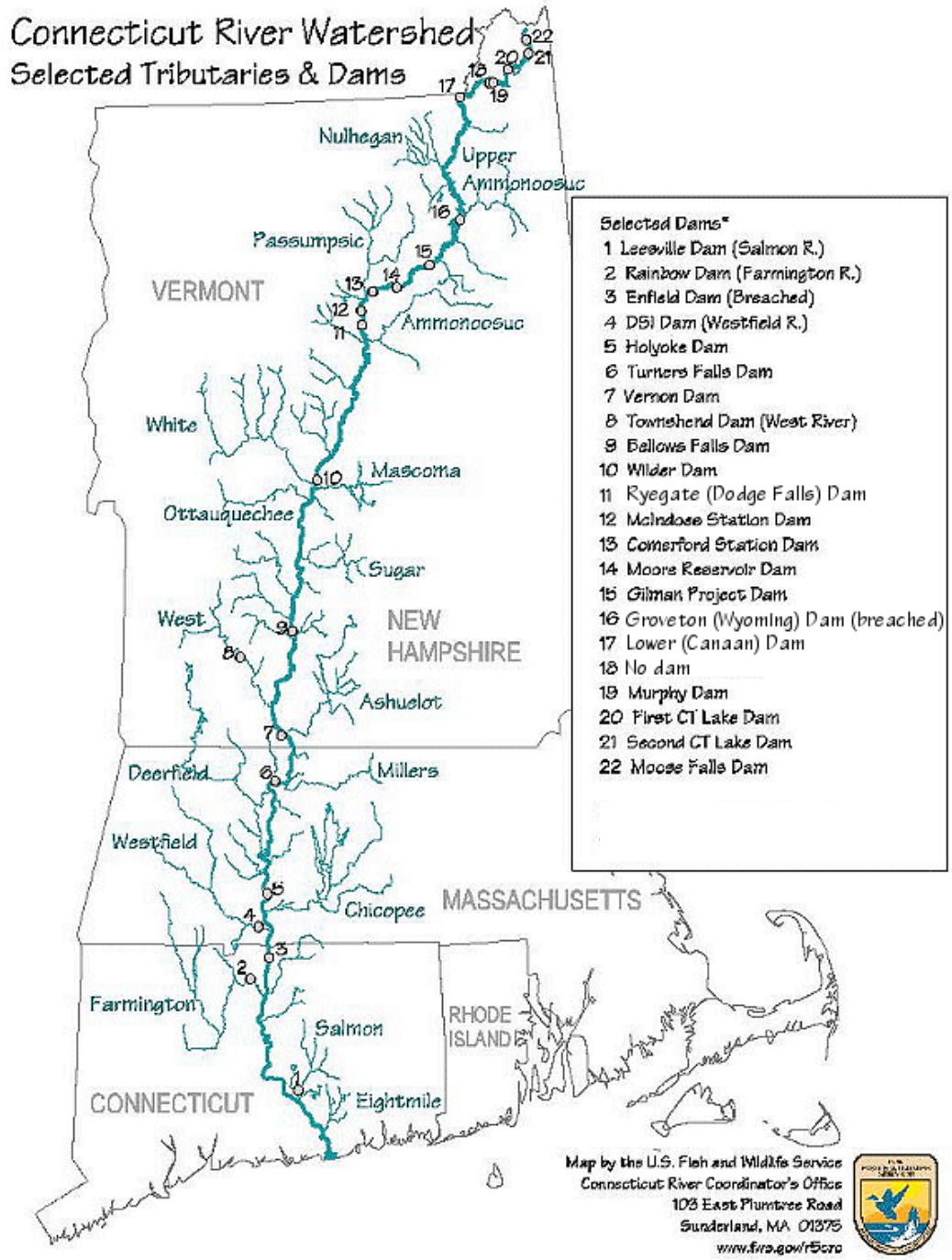


Figure 1. Connecticut River basin with major tributaries and main stem dams.

Coordination and Technical Assistance Funding

The Connecticut River Fish and Wildlife Conservation Office (CTRFWCO), under the USFWS' Wildlife and Sport Fish Restoration Program's F-100-R-37, for this report period, received $15,000 from three state fishery agencies through their annual Sport Fish Restoration Program apportionment (F-100-R). The Massachusetts Division of Fisheries and Wildlife (MADFW) has opted to reimburse the USFWS via the signed Memorandum of Understanding, using agency-generated funds ($5,000). The grant project was assessed an USFWS administrative overhead fee leaving $16,270 available. The Office utilized the Sport Fish Restoration funds, MADFW funds, an award of $20,000 of Regional Fisheries Office funds (tag purchases for 2021 study) and USFWS Fisheries Program base funding for an operational budget totaling $402,643 for fiscal year 2020. The Sport Fish Restoration and MADFW funds were fully drawn down to assist in partial expenses for the CTRFWCO building/grounds maintenance, office/operations (electricity, phone/data), storage facility and vehicle maintenance expenses, allowing USFWS non-salary funds to be applied in other operational areas.

Station total: $402,643 **States (F-100-R):** $16,270 **FWS Federal:** $386,373

Project Accomplishments

The Connecticut River Fish and Wildlife Conservation Office enhanced the Commission and States' ability to plan, coordinate, manage, evaluate, and implement restoration programs through a variety of activities, some of which are described in greater detail in the following sections. Please note that data presented in this report have been reviewed to the extent possible, but is subject to change and should be considered provisional. **Use of any presented data should be discussed with the Coordinator to avoid potential issues with use, analyses, and/or interpretation**.

Coordination activities, select details:

The Coordinator provided administrative support to the CRASC Commission and Technical Committee as the Executive Assistant and Secretary respectively, making meeting arrangements, establishing agendas, developing reports, distributing information, drafting correspondences, tracking finances, and recording and distributing minutes of Commission and Technical Committee meetings. The Coordinator participated on the CRASC Fish Passage, Shad and River Herring, Sea Lamprey subcommittees during this report period. The Coordinator served as the Chair for Shad and River Herring subcommittees and issued the Annual Fish Passage Notification letters on behalf of CRASC to main stem hydropower operators by March. The Coordinator also served as Chair of the Atlantic States Marine Fisheries Commission's Shad and River Herring Technical Committee and as a member on the Shad Stock Assessment Committee. Highlights of the 2020 American Shad Stock Assessment and Peer Review Report for the Connecticut River will follow.

Fisheries Management, Restoration, Assessment, and Technical Assistance: additional select information.

Due to Covid-19 there was no spring River Herring Spawning Stock Assessment conducted. This would have been the 8th season of assessment work adding important data to the time series, particularly given data needs on the 2016 Blueback Herring cohort that had the lowest juvenile index value in CTDEEP long-term Juvenile Alosine Seine Survey. The 2016 cohort would have been age-4 in the spring of 2020 and was important for its representation at that age in the time series data set. The highest proportional age-class representation with our data has been age-4 (43%; Table 3). The 2016 cohort is not expected to be as informative for analyses at age-5 in 2021 when we plan to be able to resume this assessment.

An analyses of the River Herring Spawning Stock Assessment data, focusing on whether any relationships exists to the CTDEEP Juvenile Index was completed and presented at the January 2020 Southern New England Chapter of the American Fisheries Society. The USFWS adult assessment's relative abundance catch rates (fish/minute) and age structure determinations (sexes combined) were combined to generate a catch-at-age (CCA) matrix (Table 3). The analyses was limited to Wethersfield Cove and Farmington River Blueback Herring (BBH) data as the 2019 otoliths as the other sample areas were still in review at the time. These two sites represent ~75% of the BBH data over the time series.

Table 3. Annual CAA for Wethersfield Cove and Farmington River bluebacks, sexes combined. Summary excludes infrequent age-2 males and fish > age-8. The following JI relationship examinations are limited to age-3, 4 and 5.

Sample Yr	age-3	age-4	age-5	age-6	age-7	age-8
2013	0.868	1.061	0.634	0.510	0.028	0.012
2014	2.090	6.334	1.685	0.635	0.197	0.000
2015	0.160	1.194	1.562	0.321	0.136	0.038
2016	0.437	0.186	0.936	0.950	0.134	0.035
2017	2.433	0.845	0.210	0.677	0.336	0.037
2018	2.418	2.187	0.531	0.090	0.277	0.119
2019	0.347	4.510	2.089	0.478	0.139	0.093
Column %	**23.1**	**43.0**	**20.2**	**9.6**	**3.3**	**0.9**

The dramatic decline in BBH counted passing Holyoke Fish Lift is plotted with the annual CTDEEP Juvenile Index value for BBH (Figure 2). Whether there were any relationships between the USFWS adult monitoring program and the CTDEEP JI was examined. The yellow highlighted group of JI values represent the year classes that have been sampled by the USFWS assessment program, from 2013 – 2019 (Figure 2). For example, in 2013 the age-3 fish from that year would be from the 2010 cohort. The last year of adult assessment data available was from 2019, so we expect representation from the age-4 fish, or the 2015 cohort.

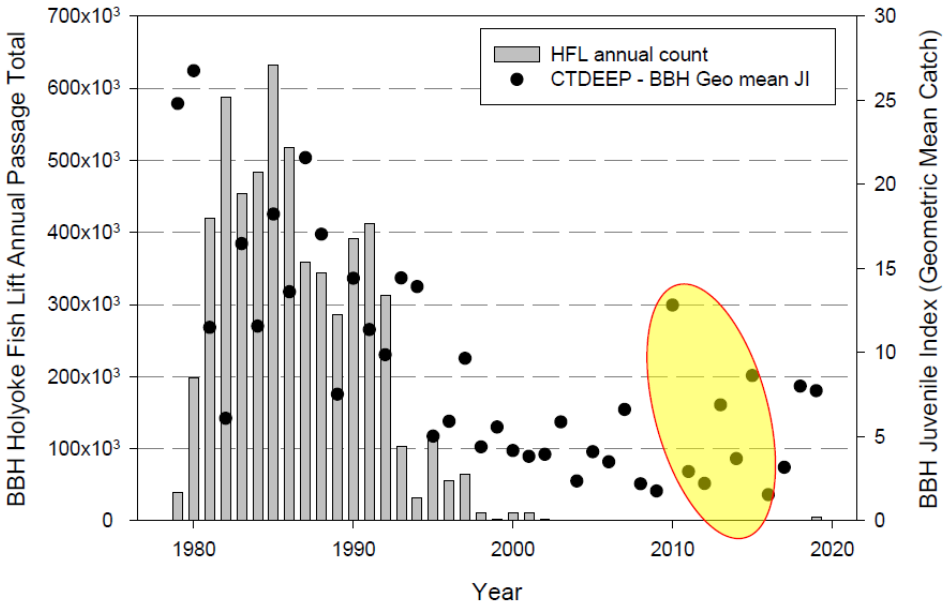


Figure 2. A plot of adult Blueback Herring counted passing the Holyoke Lift Fish from 1979-2019 with the CTDEEP annual geometric mean catch rate for young-of-the year Blueback Herring from their Juvenile Alosine Seine Survey. Yellow highlighted values represent year classes (cohorts) that have been sampled by the USFWS adult river herring surveys.

Pearson's Correlation analyses were run to explore whether any relationships could be detected between adult CCA from the USFWS adult monitoring program and the CTDEEP JI Survey. The most prevalent adult years classes were examined (age-3, age-4, age-5). There were no detected relationship for age-3 and age-5 individually. However, a highly significant relationship (P=0.008; R=0.888) was detected for age-4 fish that comprised the greatest representation by a single age cohort (all years 43%) in the data set (Table 3). An analyses tracking one cohort from age-3 to age-5 inclusive was also conducted with no relationship detected.

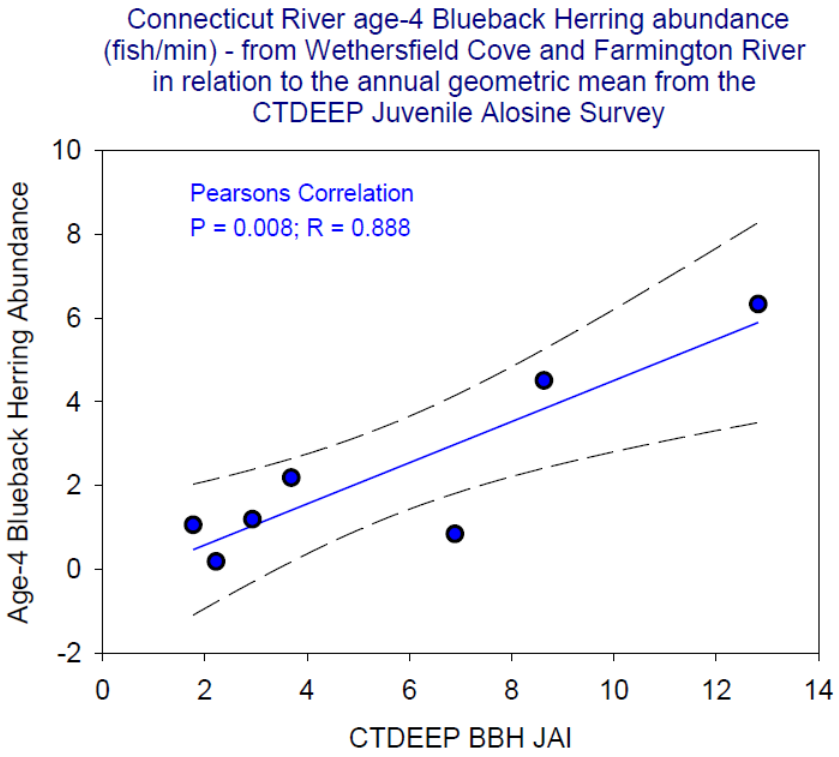


Figure 3. USFWS' CAA values for age-4 Blueback Herring (refer to Table 3) plotted against the cohort's juvenile index value for that age from CTDEEP.

The establishment of a science based, statistical relationship between the CTDEEP Juvenile Index and the USFWS adult assessment validates both monitoring programs, their management value and the importance to continue them for stock status and trends given the depleted status of this stock and its need for restoration. The current USFWS adult assessment data represents what is believed to be a severely depleted adult stock since 2013, but also has captured "relatively" substantial shifts in cohort abundance in that period (Table 3). Similarly, the CTDEEP JI survey has reported substantial shifts in its values that provided a range of values that increases the confidence of this finding even using only seven data points.

The following items are work activities that are annually conducted and provided in this report but had to be cancelled due to Covid-19:

- No trap and transport of any fish was allowed due to Covid at the HGE Holyoke Fish Lift.
- No biological sampling of any American Shad occurred at Holyoke due to restricted staff size/limitations.
- No Wild Fish Health samples for shad or other species were conducted.
- No sea-lamprey nest surveys by the agencies. However, the Connecticut River Conservancy did conduct some nest surveys in coordination with the CRASC in Massachusetts, Vermont, and New Hampshire. Those data have been included in a survey database the CRASC Sea Lamprey Subcommittee is maintaining.
- Pre-season fishway inspections by USFWS Fish Passage Engineers were canceled.
- Manhan Fish Ladder was not opened/operated

Other items:

- The West Springfield Fish Ladder on the Westfield River, was operated but only counts of American Shad were completed using a recorded digital system.
- The Vernon Fish Ladder was monitored by VTDFW with fishway counts ended on 30 June. The fish ladder was operated through 15 July.
- FWS Fish Passage Engineer Brett Towler and Ken Sprankle conduced site visits to the Turners Falls Project for the federal agencies fish passage planning work. A cooperative Turners Falls Project site visit with NOAA Fish Passage Engineer Bjorn Lake, Brett Towler, Ken Sprankle and FLP staff also took place later during the power canal drawdown, to assist in agency fish passage planning in September 2020.

This Office continued to maintain databases on migratory fish restoration activities. Daily fish counts at different dams were entered into databases. Fish counts were updated in-season at frequent intervals during the spring, with email notifications to individuals and postings to the office's web site (Appendix A).

Atlantic States Marine Fisheries Commission-

The Atlantic States Marine Fisheries Commission's 2020 American Shad Benchmark Stock Assessment and Peer Review Report included analyses of the Connecticut River stock.

- The report was developed over 2.5 years.
- The last coast wide shad assessment was in 2007.
- The 2020 assessment considered fishery dependent and independent data, with a ten-year minimum time frame, that was examined initially for statistical power. Based on time period and ability to detect changes with these data a suite of analyses were conducted examining whether any trends existed, whether there was a difference pre offshore mixed stock fishery and post closure (2005) of the mixed stock fishery. Some brief summary highlight for the Connecticut River stock follows. Stock status determinations were based on suitable data for mortality rate determination and/or abundance.

Adult run count, Holyoke passage: analysis did not detect any trend over the full time series, but did find an increasing trend in the period after 2005. Time series trends were examined for annual counts only. There was no index standardization performed on daily counts and there were no environmental variables provided for the time series (e.g. flow & temperature).

CTDEEP Juvenile Index: shows a considerable amount of inter-annual variation, with no apparent trend (Figure 97). A time series peak CPUE occurred in 2016, but returned to average levels in 2017. Mann-Kendall trend analysis did not detect any trend for either time period examined

CTDEEP Commercial Netter CPUE: Plots of the data showed an increase from 1995 through 2001, followed by a general decline through 2010, then subsequent return to average levels over the entire time series (Figure 98). Mann-Kendall analysis did not detect any trend for either time period examined. This is for trends with CPUE and not annual landings. Landings and number of participants in the fishery, have declined over time.

Mean length-at-age data: using scales were provided from two sampling programs: commercial

fishery monitoring and Holyoke Dam Fish Lift sampling. Fish aged ranged between ages 3 and 7 for both sexes. Mann-Kendall Trend analysis failed to detect any change in mean length-at-age over time in the commercial fishery monitoring, but did detect a decrease in mean length-at-age in age 6 females and males in the Holyoke Dam Fish Lift sampling (Table 55).

Mortality rates: of both sexes decreased from the highest levels observed in the early 2000s, increased in the late 2000s, and have varied without trend since (Table 33 and Figure 101). The three year average female estimate in 2017 (Z = 1.40) was above the reference threshold ($Z_{40\%}$ = 1.00). *Note – $Z_{40\%}$ is derived using spawning biomass per recruit (SBPR) modeling and represents the "total mortality" value that reduced the SBRP to 40% of unimpacted (unfished etc.) levels. This Z% was set higher (more conservative) for 2020, had been 30% in 2007 assessment.*

- Juvenile mortality (CTR) remains unknown due to a lack of data as is the case with most stocks [*This is noted as "…a significant source of uncertainty in assessment advice…maintaining sustainable adult mortality will not result in favorable abundance status if juvenile mortality is occurring at unsustainable levels"*]

The adult mortality estimate is for "Z" or total mortality (3 year average), meaning it is comprised of all sources of adult mortality, including fishing, fish passage, bycatch, and predation, which could not be estimated for each potential sources contributions. Connecticut River commercial landings data annually have not exceeded 15,000 fish since 2006. In fact, in 2017 a total of 537,000 shad were counting passing Holyoke while only 9,300 shad were reported landed from Connecticut commercial netters in that same year.

Recreational landings/catch and release were not included in the assessment because the time series is not continuous. The CT recreational fishery for Shad was monitored in CT portions of the river (Hartford to state line) from 1980-1996 and periodically (generally every 5 years) from 1996 to 2010. Recreational shad landings in CT began to fall dramatically after 1995 to a point where harvest estimates from creel surveys were unreliable and imprecise as reflected by high (> 80%) proportional standard errors about the mean harvest estimates. Because of the low precision around catch estimates due to a low incidence of positive intercepts in the creel survey, recreational creel survey have recently been limited to five year intervals (i.e. 2000, 2005 and 2010. After 2010, there have not been enough staffing resources at CT DEEP to conduct a survey.

In addition, the terminal year for examined data set included for the stock assessment and the CTR mortality estimates is 2017, which is the first year the extensive improvements to downstream passage and protections were in effect at the Holyoke Dam/Project.

ASMFC 2020 Habitat Assessment and Population Simulation Modeling Results (summary conclusions):

"Dams partly or completely blocked nearly 40% of the total habitat once used by this species (Figure 403). The loss of historical habitat due to migration barriers is greatest in the US portion of the northern iteroparous region (65% loss)… The US section of the northern iteroparous region has suffered a 65% (58% with current passage*) decline in its production potential…

**current passage: model used 50% upstream passage efficiency at barriers, 80% downstream passage efficiency for adults, and 90% downstream passage efficiency for juveniles*

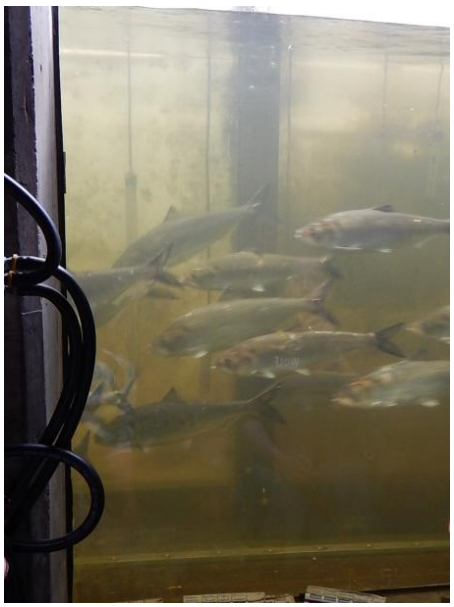
…Changes in available habitat have similarly influenced the theoretical spawning potential of American shad coastwide. Based on this modeling exercise, coastwide production potential is more than 72.8 million spawners per year compared with the no passage scenario of just under 42.8 million spawners, a reduction of 41%. It is estimated that fishway passage coastwide may alleviate the spawner potential by less than 3 million fish annually. This is evidence that even with extensive fish passage efforts, dams represent a fixed constraint of about 37% on the fishery potential of American shad."

The CRASC developed its Shad Fish Passage Performance Plan metrics to achieve passage efficiency rates greater than the modeled "realistic" values used for this analysis. The ASMFC modeled minor population gains with "realistic" or current efficiencies, further illustrate the need for substantial improvements in passage rate efficiencies range wide, to effectively address cumulative effects in multi-dam systems to achieve restoration/management goals and objectives.

The ASMFC Shad and River Board has charged the Technical Committee with reviewing the 2020 Assessment results and reporting back on potential management options or management needs based on findings.

Program Results

The Connecticut River Fish and Wildlife Conservation Office collected and reported information relating to the activities and accomplishments occurring in the Connecticut River basin diadromous fisheries restoration program. Note some of the data presented here are preliminary, not all counts were final at the time of this report (Appendix A).



Migratory Fish Returns

American Shad - A total of 368,482 adult American Shad were counted in 2019 at all first barrier passage facilities in the basin. A total of 362,423 American Shad were passed upstream of the Holyoke Dam, Massachusetts (river km 138), in 2020 through its two fish lifts, this is a 15% increase from 2019 (Figure 4). The mean passage count at Holyoke for the period 1976-2020 is 316,427 (±SD 129,058). The 25th and 75th percentile values for passage counts are 129,058 and 376,066 respectively. The Holyoke Fish Lift opened on 4/21/20, following some coordination calls with the agencies to understand the limitations for activities given Covid-19. The agencies and stakeholders appreciated the effort to open and operate the fishway facilities by Holyoke Gas and Electric (HGE). There were six dates of lift closure from normal conditions (high flow/turbidity). A digital image count system was operated with mixed live counts from the Fish Lift consultant biologist allowed to staff the facility. This season included new operational triggers based on discussions of Cooperative Consultation Team and HGE staff and its consultants. The following schedule was emailed to HGE by MADFW's Caleb Slater for new operation procedures effective for 2020:

1. Begin daily lifts one hour earlier than normal (7am) beginning the day after the daily American Shad total exceeds 12,500 individuals lifted. Return to normal lift day (8am start) the day after the daily American Shad passage drops below 10,000 individuals lifted.

2. HG&E may consider June 30 to be the last day of the normal fish passage season and may begin the Shortnose Sturgeon lifting schedule July 1 (rather than July 16).

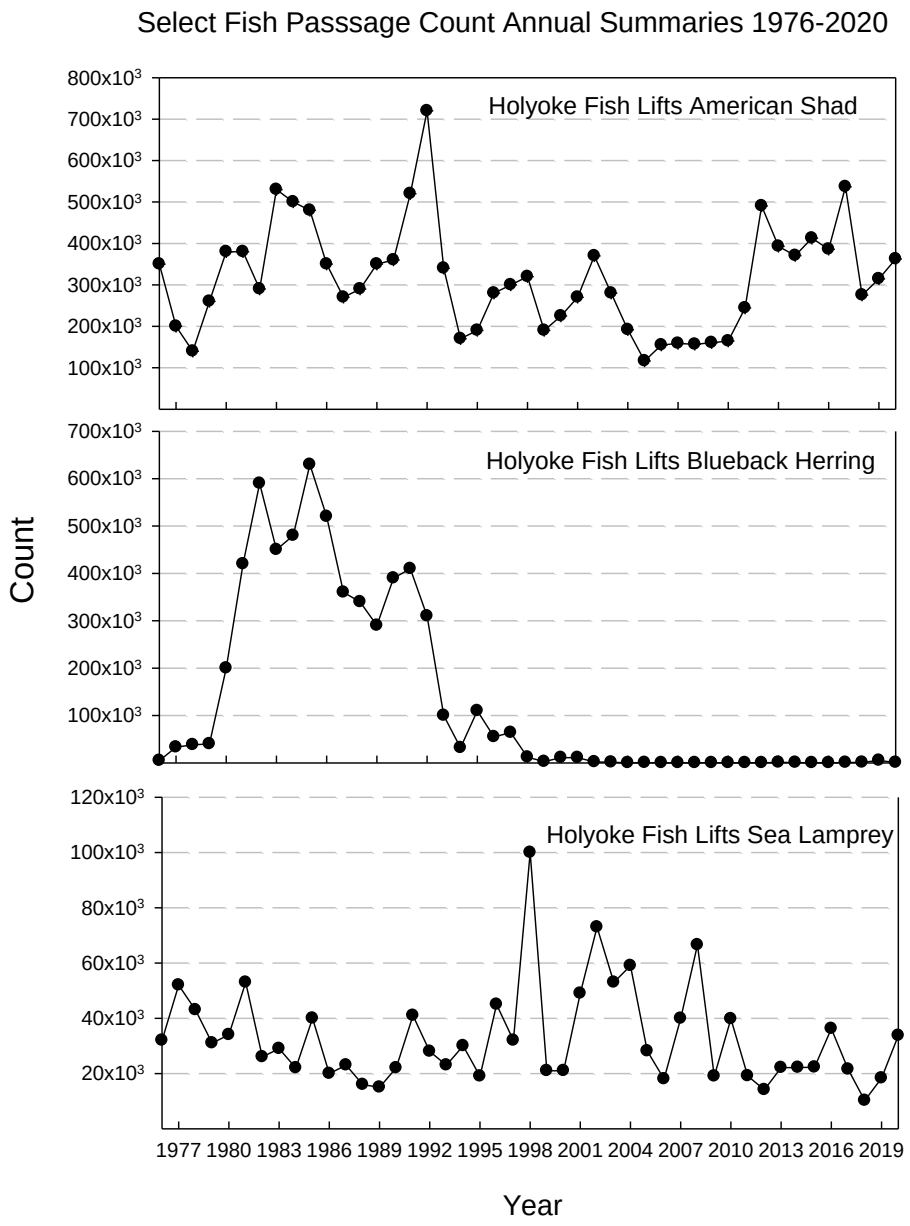


Figure 4. Select count summary of Holyoke Fish Lifts passage counts for American Shad, Blueback Herring and Sea Lamprey (1976-2020). Fish passage (counts) are affected by structural and operational changes at both dams and fishways and by environmental conditions (temperature and flow/spill) within year and among years.

The highest single passage date for shad occurred on 5/21/20 with 54,947 shad counted passing (Figure 5). The main stem river discharge decreased and persisted at well below typical levels from late May through July.

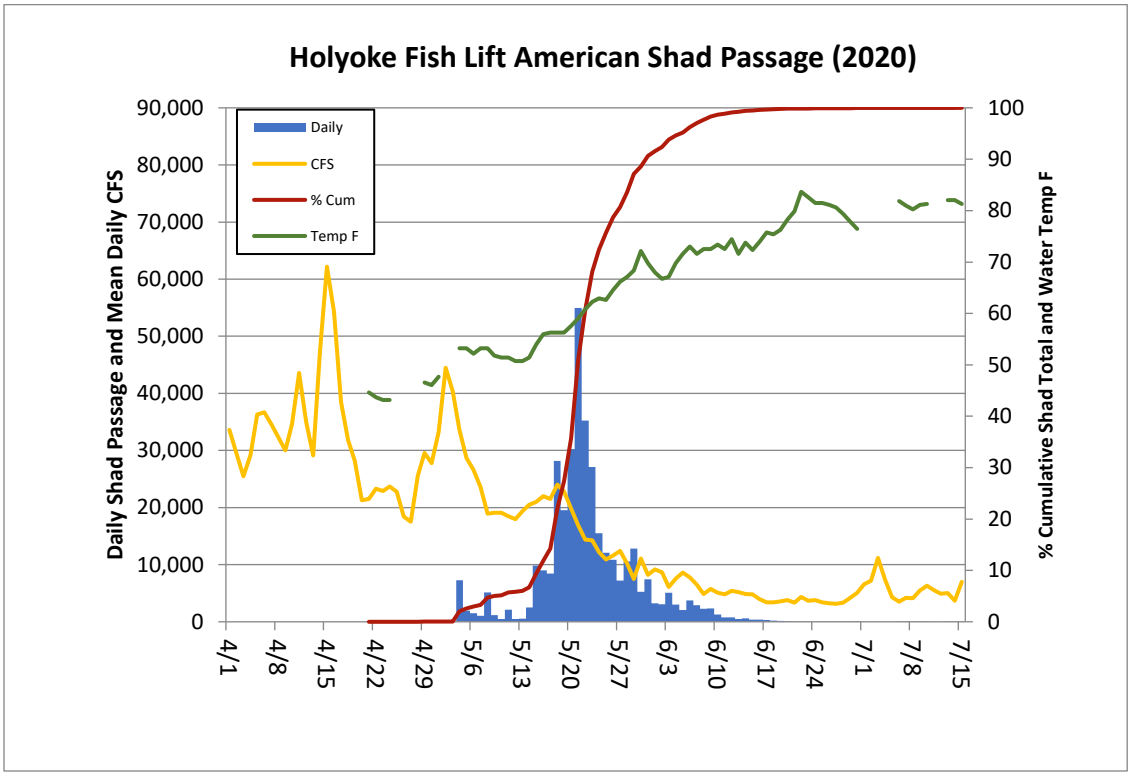


Figure 5. Daily American Shad passage counts from Holyoke Fish Lifts with water temperature and river discharge (USGS) data included for the period April 1 to July 15, 2020.

The three fish ladders at the Turners Falls Project were opened on 4/30/20 following the requested CRASC Fish Passage Operations Plan for 2020. Similar to Holyoke, the staff at FirstLight Power are thanked for working to get their fishways up and running on-time in 2020. Fishway counts were provided at regular intervals by FirstLight Power with a total of 41,252 shad passing the Gatehouse Ladder at Turners Falls Dam in 2020, a substantial increase from the 22,649 passed in 2019. The Turners Falls Dam and power canal is a three-fishway complex. Fish must first pass either the Cabot Station Ladder (into the power canal) or the Spillway Ladder, located at the base of the dam and upstream end of the "bypassed reach." Fish passing the Cabot Ladder exit into the lower power canal that requires finding one of two entrances to the Gatehouse Ladder at the upstream end of this 2.1 mile long canal. Spillway Ladder (at the dam) passed fish may go directly to the entrance of the Gatehouse Ladder, but as in the case of all ladders, have opportunities to drop back, including into the canal. A total of 34,868 shad were counted passing into the power canal from the Cabot Station Ladder. A total of 23,022 shad were counted passing the Spillway Ladder. Spillway Ladder counted shad are believed to have limited fall back/loss (<10%) vs. those in the power canal. Fish in the canal must locate and use the Gatehouse Ladder entrances that are effected by several dynamic factors (e.g., turbulence, entrance gates attraction flow/locations).

Overall, the 2020 passage number at Gatehouse Ladder (requiring passage at noted two other ladders) as a percentage of American Shad passed at Holyoke Dam was only 11.4% (Table 9). The 2017 CRASC Shad Management Plan has a minimum passage objective of 397,000 American Shad for the Turners Falls Project, or ~58% of the minimum target passage objective at Holyoke, based on upstream habitat.

Table 4. Annual American Shad upstream fish passage counts at listed fishways.

Year	Holyoke Dam Passed	Turners Falls Dam Passed	TF % of Holyoke Total	Vernon Dam Passed	Vernon % of TF Total	Farmington River, Rainbow Dam Passed	Westfield River, W. Springfield Dam Passed
1980	376,066	**298**	0.1			480	
1981	377,124	200	0.1	**97**	48.5	167	
1982	294,842	11	0.0	9	81.8	737	
1983	528,185	12,705	2.4	2,597	20.4	1,565	
1984	496,884	4,333	0.9	335	7.7	2,289	
1985	487,158	3,855	0.8	833	21.6	1,042	
1986	352,122	17,858	5.1	982	5.5	1,206	
1987	276,835	18,959	6.8	3,459	18.2	792	
1988	294,158	15,787	5.4	1,370	8.7	378	
1989	354,180	9,511	2.7	2,953	31.0	215	
1990	363,725	27,908	7.7	10,894	39.0	432	
1991	523,153	54,656	10.4	37,197	68.1	591	
1992	721,764	60,089	8.3	31,155	51.8	793	
1993	340,431	10,221	3.0	3,652	35.7	460	
1994	181,038	3,729	2.1	2,681	71.9	250	
1995	190,295	18,369	9.7	15,771	85.9	246	
1996	276,289	16,192	5.9	18,844	116.4	668	**1,413**
1997	299,448	9,216	3.1	7,384	80.1	421	1,012
1998	315,810	10,527	3.3	7,289	69.2	262	2,292
1999	193,780	6,751	3.5	5,097	75.5	70	2,668
2000	225,042	2,590	1.2	1,548	59.8	283	3,558
2001	273,206	1,540	0.6	1,744	113.2	153	4,720
2002	374,534	2,870	0.8	356	12.4	110	2,762
2003	286,814			268		76	1,957
2004	191,555	2,192	1.1	653	29.8	123	913
2005	116,511	1,581	1.4	167	10.6	8	1,237
2006	154,745	1,810	1.2	133	7.3	73	1,534
2007	158,807	2,248	1.4	65	2.9	156	4,497
2008	153,109	4,000	2.6	271	6.8	89	3,212
2009	160,649	3,813	2.4	16	0.4	35	1,395
2010	164,439	16,422	**10.0**	290	1.8	548	3,449
2011	244,177	16,798	**6.9**	46	0.3	267	5,029
2012	490,431	26,727	**5.4**	10,386	**38.9**	174	10,300
2013	392,967	35,293	**9.0**	18,220	**51.6**	84	4,900
2014	370,506	39,914	**10.8**	27,706	**69.4**	536	4,787
2015	412,656	58,079	**14.1**	39,771	**68.5**	316	3,383
2016	385,930	54,069	**14.0**	35,513	**65.7**	141	5,940
2017	537,249	48,727	**9.1**	28,682	**58.9**	615	6,000
2018	275,232	43,146	**15.7**	31,724	**73.5**	341	5,752
2019	314,353	22,575	**7.2**	12,862	**57.0**	276	4,064
2020	362,423	41,252	**11.4**	13,897	**33.7**	510	5,549
Mean	324,113	18,171		9,423		438	3,693
SD	130,732	18,436		12,356		447	2,154
Low	116,511	11		9		8	913
High	721,764	60,089		39,771		2,289	10,300

The Vernon Dam (Vernon, Vermont) fish ladder was opened on 4/23/20 and closed on 7/15/20, following CRASC's operation plan. Great River Hydro's efforts in Covid to start-up and operate

their fish passage facilities (includes downstream) is appreciated. The VTDFW set up and operated digital imaging equipment as in past seasons for fish ladder counts. Fish counts started on 5/20/20 and concluded on 6/30/20 with 13,897 American Shad counted passing upstream. It is possible a small number of shad may have passed prior to the count start on 5/20 based on Turners Gatehouse first shad passage and also later in July. Vernon Dam Ladder passed 33.7% of the American Shad counted passing from the Turners Falls Gatehouse Ladder in 2020. This proportion is the lowest value in the previous 8 years which is the period of reference given a within ladder fix, effective starting in 2012 (Table 4).

The noted decrease in the proportion of Gatehouse Fish Ladder shad subsequently passed at Vernon was examined. A field visit with GRH staff and agency staff helped GRH relate the very low tailwater elevations observed in June below Vernon Dam (Figure 6). Tailwater elevations were reported so low that the adjustable fish ladder entrance weir (automatically tracks tailwater level) set to provide a consistent ~ 1 foot differential, was design limited to maintain that level. The tracking/gate system was at its lowest possible level and the differential was reported as significantly greater than 1 foot during GRH visual observations. This situation would create hydraulic conditions that could impair shad entry and helps explain a potential causal factor for the passage rate. GRH was planning to provide some data that could be extracted from their monitoring systems to better quantitatively described the situation in June of 2020. These data are not readily produced and required staff resources to develop.

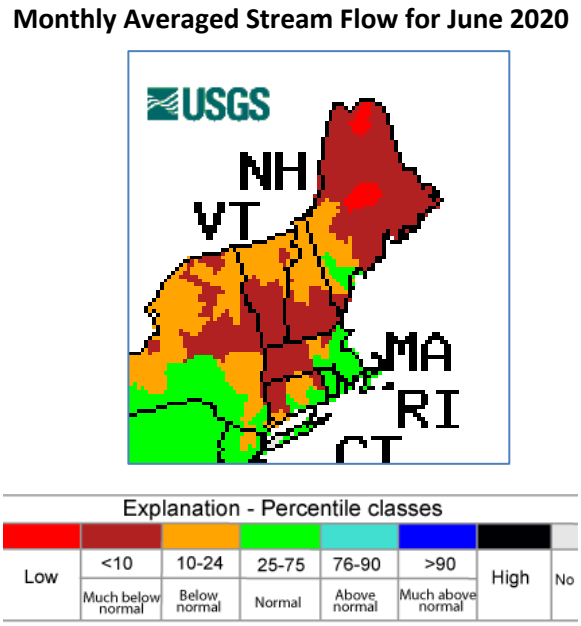


Figure 6. Monthly averaged stream flow for June from the USGS. There is no immediate stream USGS stream flow gage to the Vernon Tailwater.

Bellows Falls Fish Ladder was operated in 2020 and passed 460 shad upstream. This project's ladder was, by agreement, previously triggered on Atlantic Salmon upstream passage needs, so its period of operation was often limited/restricted in the past. Beginning in 2013, TransCanada now Great River Hydro, agreed to open this ladder based on a trigger of 100 Sea Lamprey passed

at Vernon Dam following a request from CRASC, to provide Sea Lamprey access to upstream habitats.

A total of 5,549 American Shad were passed upstream of the West Springfield Fish Ladder in 2020 on the Westfield River, which is an increase from the 4,064 shad counted in 2019 and greater than the long-term mean of 3,700. The record high American Shad passage count at that facility was 10,300 in 2012. A total of 510 American Shad were passed upstream of the Rainbow Dam Fishway on the Farmington River in Connecticut, a fishway with known upstream passage issues for this species.

Shortnose Sturgeon – A total of 18 Shortnose Sturgeon (SNS) were trapped at Holyoke Fish Lift from lift operations in 2020, with the first fish captured on 6/7/19 and last on 10/27/20 (Figure 7). The operational period to pass sturgeon extended until 11/13/20, when water temperatures had decreased to 4C. This is the fifth year of operations of the modified spillway lift entrance design to pass sturgeon, with annual counts tracking closely among the first 3 years and decreasing notably in 2019 and 2020 (Figure 7). There were no noted changes in the operation or facility in 2020 relevant to sturgeon passage. The timing of sturgeon movement in 2020 was within the expected range for timing (Figure 8).

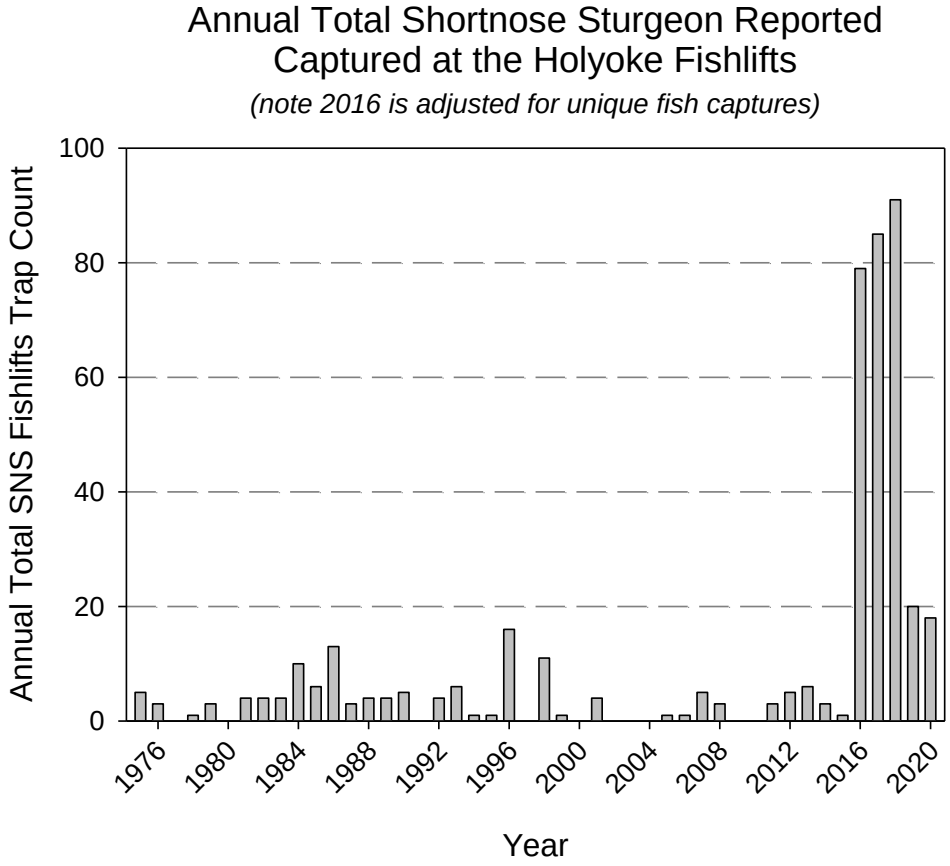


Figure 7. Annual total counts of Shortnose Sturgeon trapped at Holyoke Fish Lift 1975-2020. Sturgeon were not passed upstream until 2017, following an approved study plan to evaluate and monitor downstream passage.

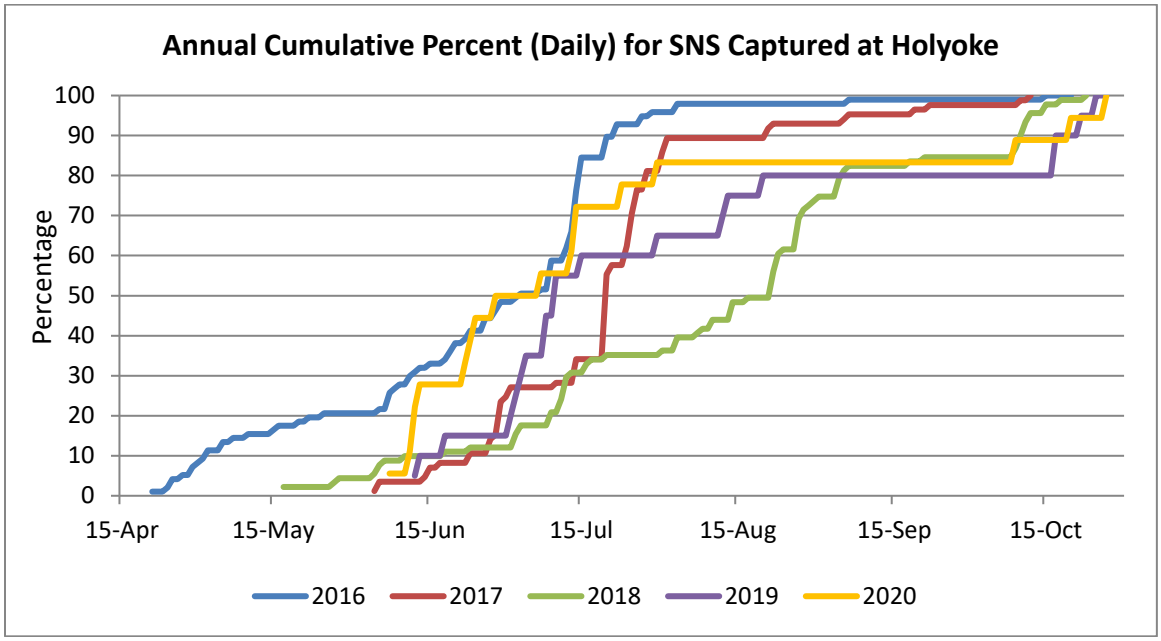


Figure 8. Annual cumulative frequency plots for captured Shortnose Sturgeon at Holyoke Fish Lift in relation to date (annual data from 2016-2020).

Blueback Herring - A total of 763 Blueback Herring were counted at the Holyoke Fish Lift in 2020, a substantial decrease from the 5,052 counted in 2019 (Figure 4). This decrease was not unexpected given the record time low Juvenile Index value in 2016 for Blueback Herring from the CTDEEP survey discussed earlier in this report.

The CRASC River Herring Management Plan identifies an annual passage goal of 300,000-500,000 Blueback Herring at the Holyoke Fish Lift. That goal had been attained and exceeded up to the early 1990s, as population declines were being observed along much of the East Coast.

Sea Lamprey - A total of 37,399 Sea Lamprey were observed from first barrier fishway returning to the Connecticut River basin in 2020. This is an increase from the 2019 counts, driven primarily by the Holyoke Fish Lift, but observed among all counts. Holyoke passed 33,739 Sea Lamprey in 2020 compared to 18,347 in 2019 (Figure 4). The annual mean number of Sea Lamprey passed at Holyoke is 32,630 fish (1976-2019).

A total of 17,525 Sea Lamprey subsequently passed upstream of Turners Falls Dam (through Gatehouse Ladder), or 52% of the number passed at Holyoke (the proportion in 2019 was 20%). A total of 7,290 Sea Lamprey passed upstream of Vernon Dam (or 41% of the Gatehouse Ladder total) with 2,142 lamprey passed upstream of Bellows Falls Dam. In the lower river basin, 3,628 Sea Lamprey passed at Rainbow Dam versus 946 in 2019. No nest count surveys were conducted by CTDEEP in the Salmon River basin.

Striped Bass - A total of 452 Striped Bass were counted passing at the Holyoke Fish Lift in 2020 versus the 207 passed in 2019.

American Eel – The American Eel passage count at Holyoke Dam, which used three specially designed ramp/traps in different project locations (tailrace fish lift entrance, upper stilling basin,

and S. Hadley shore of bypass reach), totaled 17,689 in 2020. This is a substantial decrease from the 27,505 eels counted in 2019 (Figure 9). Eel ramps were deployed in May and June and operated through November 2020, with varied limited out-of-service periods. Eel ramp/traps are not checked on weekends after July 15, same as the upstream lift operations noted with SNS. The Holyoke Gas and Electric Report on American Eel passage will be available in the winter of 2021 and will compare catch rates among the trap locations and provide details on other statistics. American eels captured in these ramp/traps are relatively small primarily ranging between 10-20 cm in total length.

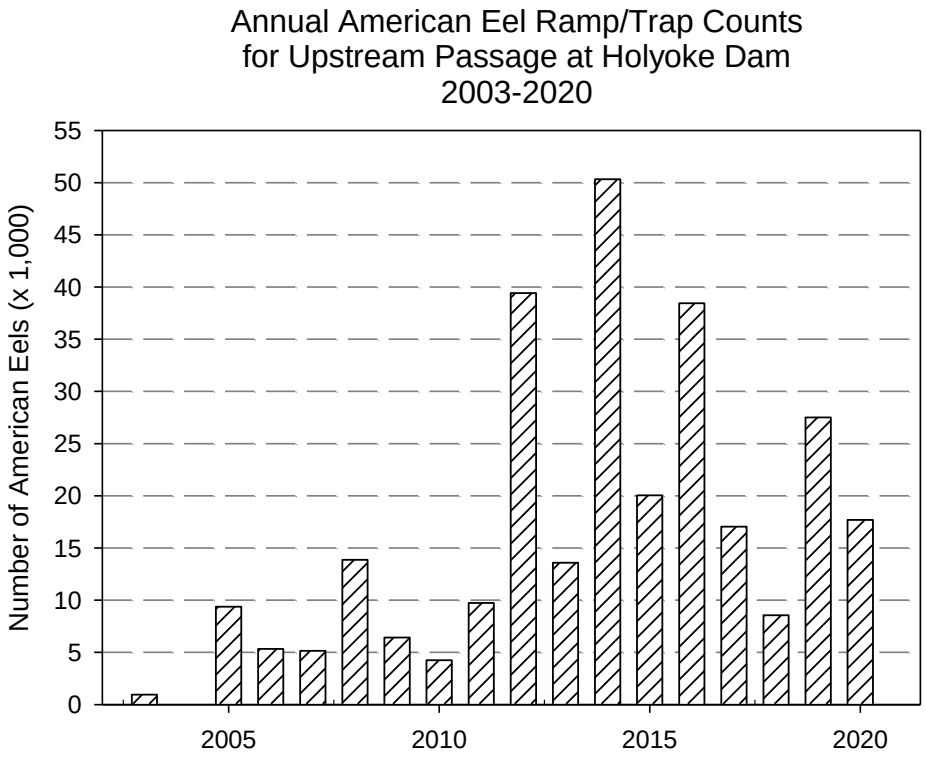


Figure 7. Annual American Eel ramp/trap counts reported by Holyoke Gas and Electric, at Holyoke Dam, for the period 2003-2020.

Atlantic Salmon – In 2020 there were no reported returns of sea-run adult Atlantic Salmon from on any fish passage counting facility in the basin. In 2019 three sea-run adult Atlantic Salmon were documented as returned to the Connecticut River basin. Historically adult returns are dominated by four year old fish (age-2 smolt and two sea winter assignments).

Gizzard Shad - A total of 66 Gizzard Shad were counted at the Holyoke Fish Lift in 2020, an increase from the 330 observed in 2019.

Appendix A. The Fishway Count Report produced by CTR FWCO for distribution and posted on the office web site. Often a second page includes field pictures or other data.

2020 Connecticut River Basin Fishway Passage Counts

Report Date: 12/30/2020

This report is compiled by the U.S. Fish and Wildlife Service, CT River Fish and Wildlife Conservation Office using fishway count data provided by several agencies as well as power companies and is dependent in most cases on the review of video counts, that have an associated time lag for updates. Please visit http://www.fws.gov/r5crc for more information.

Fishway, River - *State*	*Data as of:*	American Shad	Alewife	Blueback Herring	Atlantic Salmon	American Eel	Sea Lamprey	Striped Bass	Gizzard Shad	Shortnose Sturgeon	Other/ comment
Rogers Lake-*CT*	final	0	2,842	0	0	0	0	0	0	0	
Mary Steube, Mill-*CT*	final	0	37,886	0	0	0	0	0	0	0	
Moulson Pond, Eightmile-*CT*	final	2	107	150	0	0	22	0	0	0	
Leesville, Salmon-*CT*	final	1									no counting system
StanChem, Mattabesset-*CT*	final	0	63	18	0	4	10	0	28	0	
Rainbow, Farmington-*CT*	final	510	0	0	0	2	3,628	0	2	0	no fall eel pass operation
W. Springfield, Westfield-*MA*	final	5,549									only shad counted in 2020
Holyoke, Connecticut-*MA*	final	362,423	0	763	0	17,689	33,739	452	66	18	closed 11/13
Easthampton, Manhan-*MA*	not run										
**Turners Falls-Gatehouse, Connecticut-*MA*	final	41,252	0	3	0	0	17,525	0	0	0	closed 7/2
Vernon, Connecticut-*VT*	counts final thru 6/30/20	13,897					7,290				fish ladder ran thru 7/15/20
Bellows Falls, Connecticut-*VT*	counts final thru 6/30/20	460					2,142				fish ladder ran thru 7/15/20
Wilder, Connecticut-*VT*	not run										
Total to basin, only first barrier counts		368,482	38,056	931	0	17,695	37,399	452	96	18	
Last year totals		318,707	11,308	5,113	3	27,505[A]	20,479	207	366	20	

*** Spillway Fish Ladder - at the dam 23,022 shad, 13,689 sea lamprey; Cabot Station Ladder, base of canal, 34,868 shad, 12,991 sea lamprey, and 3 blueback herring. Note that at Turners Falls Project (Dam/Canal) fish must use one of these two fishways first before having the opportunity to pass the*

A - total collected from 3 eel ramp/traps at Holyoke in 2019

Appendix B. History of the Anadromous Fish Program

Native diadromous fishes (diadromy includes anadromous and catadromous fishes, with American Eel being the only catadromous species in this basin) were once abundant in the Connecticut River basin excluded from habitat only by natural barriers and their physiological limitations. Atlantic Salmon ascended the main stem Connecticut River to Beechers Falls, VT, nearly 400 miles upriver from its outlet at Long Island Sound. American Eel have been documented even farther upstream in the basin by early New Hampshire Fish Game Department studies in Pittsburgh, New Hampshire. No fishery management or scientific information exists that provides an accurate technical description of the pre-colonial diadromous fish populations. However, historical accounts of the region are filled with references to large American Shad, river herring and Atlantic Salmon runs that were known to have been an important food source in the spring for the native people and early European settlers. As colonization by Europeans and the development of waterpower sites expanded throughout the basin, anadromous fish populations notably declined. A major cause of the declines or loss of runs was from the construction of dams that blocked fish migrations from reaching their spawning habitat (Figure 1). Tributaries were more easily dammed and so elimination of these species progressed rapidly in these areas first, with settlement and use of early waterpower for mills. The first dam across the main stem Connecticut River was constructed as early as 1798, for barge/boat movement, near the present site of Turners Falls, Massachusetts. This dam blocked returning American Shad, river herring, Atlantic Salmon and Sea Lamprey from access to spawning and nursery habitat in the northern and central portion of the river basin. As a result, those species simply disappeared from areas of the basin in both New Hampshire and Vermont, not to be seen again for nearly 200 years.

An interagency state/federal program to restore Atlantic Salmon to the Connecticut River based on the stocking of fry hatched from eggs taken from Penobscot River Atlantic Salmon was initiated in the 1860s, decades after the construction of the Holyoke Dam, MA. Although the effort resulted in the return of hundreds of adult salmon for several years in the 1870s and 1880s, the program eventually failed due to both uncontrolled harvest of fish in Connecticut waters and the failure to construct effective fish passage at dams in Massachusetts. Concurrent with the salmon restoration effort were the state's American Shad culture and stocking efforts to enhance reduced runs of this valued species. Work to restore and enhance these two species was conducted through developing fish culture techniques that were gaining popularity as an approach to achieve fishery management goals.

Although interest continued in restoring Atlantic Salmon to the basin, no action was taken for many decades due to the lack of funds and the lack of effective fish passage technology (an early design fish ladder had been installed at Holyoke Dam). The condition of the river environment continued to deteriorate in response to widespread pollution and dam construction through the early to mid-1900s. By the 1960s, some tributary dams were breached and pollution abatement programs were initiated. Long-term cooperative restoration programs became feasible with the passage of the federal Anadromous Fish Conservation Act of 1965 (P.L. 89-304) which made funds available for interstate fish restoration programs. The combined effects of these events set the stage for coordinated anadromous species restoration. In 1967 the four basin states and USFWS, (National Marine Fisheries Service later created from the USFWS in 1970) signed a

statement of intent to restore anadromous fishes including American Shad, Atlantic Salmon, and river herring to the Connecticut River. Atlantic Salmon were a focus due to its appeal for recreational angling opportunities by the resource agencies. Early salmon stockings were initially comprised of two-year old smolts of Canadian origin reared in federal trout hatcheries that had recently been converted to salmon production. The term smolt defines a salmon life-stage when the transitional migration from freshwater to the marine environment occurs, typically in the months of April and May. The first adult salmon return from these hatchery smolt releases was documented in 1974.

Early in the Atlantic Salmon Program, the management emphasis was placed on stocking smolts with the USFWS building a salmon hatchery in Bethel, Vermont, and CTDEEP and MADFW converting trout hatcheries for salmon production. Production of stream-reared smolts, from juvenile stockings was combined with smolts produced in hatcheries to increase smolt emigration from the river. A major effort was begun in 1987 to stock fry into appropriate habitat in the basin, based upon in-river research results.

Beginning in 1994, the Program utilized only "Connecticut River" fish, with no introductions of genetic material from outside the basin. Genetic monitoring had demonstrated the development of some unique genetic characteristics (alleles) that distinguish the Connecticut River population from other populations at that scale. The use of conservation genetics enabled the Program to maintain a genetically healthy population to maximize genetic diversity and reduce risks from genetic issues.

Adult Salmon returns per 10,000 stocked fry declined dramatically from what had been documented from 1979 through 1994, when this rate averaged 0.71 (high of 1.6). For the period 1995 through 2008, the mean adult/10,000 fry stocked was 0.11 (refer to U.S. Atlantic Salmon Assessment Committee Report 27 – 2014 Activities (http://www.nefsc.noaa.gov/USASAC/Reports/). This later period is when the program shifted to fry stocking as the primary restoration strategy, coinciding with this unexpected decline in fry return rates (due to marine survival rate decreases). This situation translated to a sustained reduction approximately 1/6 of what had been observed for this rate (< 1994) even as issues of safe downstream passage of smolts at hydropower facilities and ocean fishery closures were completed. Studies over time have shown shifts in salmon marine prey species abundance and distributions, shifts in predator assemblages, and shifts in marine habitat area use are likely contributing factors that can be related to climate change.

The severe damage to the White River National Fish Hatchery (WRNFH) in fall of 2011, from a flood event, severely impacted the Salmon Program as it maintained a high proportion of the domestic broodstock and subsequently annual egg and fry production for all the states. WRNFH had been producing approximately 65% of the fry for the Program in the preceding 10 years. The loss of this facility, in conjunction with ongoing reviews of the best science and information related to restoration efforts, and emerging USFWS Northeast Region fisheries issues and priorities, led the USFWS to announce its decision to conclude fish culture activities for the Connecticut River Atlantic Salmon Program. That announcement was made in public at the July 2012 Connecticut River Atlantic Salmon Commission meeting. Subsequently, in the fall of 2012, the Commonwealth of Massachusetts decided it would no longer culture salmon at its Roger Reed State Hatchery. The last spawning of domestic salmon broodstock occurred at that

facility in 2012, with all fry and remaining Connecticut River salmon of various ages stocked out in 2013. The State of New Hampshire had concluded the restoration effort with a last stocking in 2012 while the final stocking in Vermont was in 2013.

The State of Connecticut currently operates a "Salmon Legacy Program," which is not a restoration program but serves other defined purposes. The goal of Connecticut's program is to maintain Atlantic Salmon in select watersheds, maintain existing genetics of the Connecticut River salmon, provide fish for their state broodstock fishery program (outside of the Connecticut River basin), and support educational programs such as the school egg/fry rearing program.

Action to provide upstream fish passage on the Connecticut River main stem in the mid-1900s occurred in 1955, when a rudimentary fish lift was constructed at Holyoke Dam to pass American Shad and river herring, that relied on humans pushing them in wheeled buckets for release upstream of the dam. At that time, and for approximately three decades after, the Enfield Dam remained a partial barrier, even though laddered; it eventually disintegrated completely in the late 1980s. The Holyoke Dam facility was expanded in 1976 when substantial upstream passage modifications occurred, with a new second lift installed in the spillway (or at the base of the dam, as opposed to the existing "tailrace" lift entrance where the turbines release). Although not studied, upstream passage efficiency appeared to improve greatly with corresponding increases in annual fish counts for species like American Shad and Blueback Herring (Figure 4). Other fishways built at dams on the main stem river and tributaries allowed returning Atlantic Salmon, American Shad, river herring, American Eel, and Sea Lamprey access into select portions of the basin (with varying degrees of fishway effectiveness) targeted for restoration. Major issues with several different fishways have been apparent relative to ineffectiveness at passing American Shad, river herring, American Eel (downstream) and Shortnose Sturgeon. These issues have been dealt with on a case-by-case basis, with varied degrees, of success. However, with the Federal Energy Regulatory Commission's five main stem project relicensing currently underway, opportunities for improvements for fish passage are anticipated along with plans to address other problem passage sites in the near future (e.g., Rainbow Fishway on the Farmington River).

Upstream passage at Turners Falls Dam (Massachusetts) fishways (first operational in 1980) have been studied and modified for decades and is one of the projects in the FERC relicensing process at this time. Passage issues relative to American Shad are best explained by the fact that no ladders of the size required on the main stem had been designed for that species as the cooperative restoration effort took this management need on in the 1970s. The USFWS relied on the best information (no specific studies available) at the time that suggested West Coast fish ladders on the Columbia River were effective at passing introduced American Shad. This led to the adoption of these designs, downsized considerably from the Columbia River, for use on the main stem Connecticut River dams. The USFWS worked with the power companies in the design and construction, to develop operating parameters for flow, velocities, and turbulence measures. However, the downscaling created some unforeseen challenges in hydraulics for these species that the agencies, researchers (USGS CAFRC), and power company consultants have worked on understanding these issues and attempting to resolve some of these over the years with our increasing knowledge.

Following on the Turners Falls ladders completions, the Vernon Dam (Vermont) fish ladder became operational in 1981 with Bellows Falls and Wilder dam fish ladders in the subsequent years. As the number of salmon fry stocked in the basin increased during the late 1980s, concern

grew for the potential negative effects of hydroelectric turbines or other passage routes on outmigrating smolts, as well as juvenile and post spawn adult American Shad. Efforts to provide safe and effective downstream fish passage on both main stem and tributary projects were initiated in the 1980s. In 1990, a Memorandum Of Agreement (MOA) were signed with two major utility companies that operated hydroelectric facilities at six main stem projects that established time frames for downstream fish passage construction. The Holyoke Dam and Hadley Falls Power Station is a good example of a very recent large-scale fish passage improvement project, designed specifically to address; downstream passage and protection of adult American Eel and Shortnose Sturgeon as well as upstream passage of Shortnose Sturgeon and other anadromous species that became operational in 2016, using new engineering approaches.

The state and federal agencies continue to work in close cooperation with many partners to address fish management, protection, enhancement, and restoration topics for both populations and habitats. This work is important for the ecological, recreational, and commercial benefits, derived from healthy native fish populations and the aquatic habitats they require. Currently, ongoing fisheries work includes continuing efforts to increase both diadromous species abundance levels and distributions (particularly upper basin and in tributaries) as well as stock structure characteristics (e.g., multiple age classes) to support population resilience and health (as characterized by status). The current FERC relicensing process for the five main stem facilities is important in this regard relative to the 50-year length of these federal licenses and the opportunity to seek conditions and measures that protect the public's fishery resources now and for future generations. The CRASC and its predecessor, the Connecticut River Policy Committee, have provided and continue to provide, a critical coordinated fishery leadership role from policy setting to project implementation, resulting in many positive outcomes not commonly observed in other large East Coast river basins.