CONNECTICUT RIVER BASIN ANADROMOUS FISH RESTORATION: Coordination and Technical Assistance F-100-R-31

Annual Progress Report
October 1, 2013 - September 30, 2014

U.S. Fish and Wildlife Service
Connecticut River Coordinator's Office
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Executive Summary

Federal Aid Project #F-100-R-31

States: Connecticut, Massachusetts, New Hampshire and Vermont

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

Period Covered: October 1, 2013 - September 30, 2014

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

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
- Identify fishery program priorities, design and implement field projects to address issues, plans, and opportunities
- Administer several different federal grant programs to address fish habitat, fish passage, and research projects

Accomplishments:

Program Coordination:

- Coordinated two Connecticut River Atlantic Salmon Commission (CRASC) and two CRASC Technical Committee meetings
- Organized a CRASC Shad Studies and River Herring subcommittee meeting
- Assisted in the completion of the U. S. Atlantic Salmon Assessment Committee Report, provided program update, narrative, updated databases, and presentation at annual meeting (http://www.nefsc.noaa.gov/USASAC/Reports/)
- Sampled American shad for fish health testing (USFWS Northeast Fish Health Lab) and coordinated adult transfers from Holyoke Fish Lift, MA
- Coordinated river herring population assessment and restoration activities in spring 2014
- Coordinated and served as lead writer for, Connecticut River American Shad Habitat Plan, for the Atlantic States Marine Fisheries Commission's (ASMFC) Shad and River Herring Technical Committee, plan approved February 2014

(http://www.asmfc.org/files/ShadHabitatPlans/AmShadHabitatPlan_CTriver.pdf)

- Coordinated meetings on future uses of Richard Cronin Salmon Station with potential identified partners (e.g., University of Massachusetts, Massachusetts Division of Fisheries and Wildlife)
- Coordinated the start-up meeting of Connecticut River American Shad Population Model with agency and research partners (July), assisted in submitting a Science Support Program (SSP) proposal tied directly to this effort under the lead of Drs. Steve McCormick and Ted Castro-Santos. The SSP was awarded in Dec 2014.
- Coordinated and drafted a CRASC American Shad Status report through the Technical Committee. Draft was reviewed at June CRASC and required further editing.

Technical Assistance:

- Assisted in salmon spawning activities at Richard Cronin National Salmon Station (RCNSS) in support of Connecticut Department of Energy and Environmental Protection's (CTDEEP) program (October 2013)
- Participated in ASMFC River Herring Aging Workshop held at CT Marine Fisheries (December 2013)
- Completed Annual Report for FY13
- Blueback (n=501) and alewife (n=103) otoliths from 2013 field population assessments were aged using digital imaging equipment
- Served as USFWS member to Northeast Regional Agency River Herring Team, provided updates on population assessment activities
- Downloaded remote water temperature loggers (river mouth to Wilder VT), performed QA/QC, redeployed, coordinated with hydropower operators
- Served on the Connecticut River Pilot for the Landscape Conservation Cooperative (full year) and its aquatic team, ongoing repeated meetings and tasks over the year
- Served as USFWS member to ASMFC Shad and River Herring Technical Committee participated in meetings during year
- Provided program information and requested data to cooperators, researchers, and the public
- Gave presentations on migratory fishes status, management, restoration to Westfield State University (WSU), Northfield Mount Hermon School, and Smith College/Tuck Business School for Global Women Leaders. Secured and supervised student intern (WSU), and a University of Massachusetts Amherst intern. Also organized and directed other volunteers and staff for various activities over course of the year
- Provided assistance in the continued analyses of the 2011 and 2012 whole river American shad telemetry study in cooperation with co-principal investigator U. S. Geological Survey Conte Laboratory (USGS), Dr. Castro-Santos
- Served on collaborative agency team for Federal Energy Regulatory Commission's (FERC) relicensing process requiring numerous meetings, site visits, planning, literature search/research, responses, and coordinated work efforts over the entire report period. A formal Study Dispute occurred with a positive outcome for the agency request study. Total Coordinator time expenditure was 6-8 weeks of time over the course of the report period.

- Coordinated a cooperative trial shad culture effort with North Attleboro National Fish Hatchery (NANFH), with TransCanada for future planned relicensing juvenile tagging studies
- Conducted spring fish population assessments targeting river herring in Connecticut and Massachusetts, sampling occurred on 21 dates (day and nights) from early April through June. Over 2,500 blueback herring, 200 alewife, and 50 striped bass were collected and examined with 844 pairs of otoliths removed paired with scale samples taken in the laboratory and prepared for reading. Provided UMass researcher with striped bass tissue samples for stock origin study.
- Captured by boat electrofishing 5,600 blueback herring that were transferred to the Oxbow and Manhan River, Easthampton, MA and to the Farmington River (CTDEEP transports) in May
- Conducted sea lamprey nest surveys in the lower Green River, lower Fall River, target reaches of the Manhan River and assisted CTDEEP in surveys in Salmon River watershed.
- Surveyed Oxbow (MA), Manhan River, lower Farmington River, and Wethersfield Cove for juvenile blueback, alewife, and American shad late summer
- Cleaned and mounted adult sea-run Atlantic salmon scales for age and growth analysis and completed aging and data analyses, removed otoliths from 45 juvenile American eels poached at Holyoke Dam (bin sub-sampled)
- Maintained adult Atlantic salmon return and stocking databases, and fish transfers database
- Maintained fish passage databases
- Entered data from all fish population assessment work and transfers into databases or spreadsheets and conducted summary analyses
- CRC Office grant agreements were completed by other FWS staff (Martha Naley and Phil Herzig) to towns, non-government organizations, state, and federal grantees for a variety of habitat restoration and fish passage projects. Closed out completed or outdated agreements.

Acknowledgements

I would like to thank the many people who have contributed to the accomplishments that are contained in this annual report, my Office Assistant, Darleen Cutting continued to make many important contributions over the year that increased office productivity and efficiency. Darren Desmarais (Fish Biologist) performed many critical functions this report period, examples include assisting and operating herring surveys, herring restoration, lab work of herring and shad, data entry and management, equipment preparation, and reading of otoliths. Phil Herzig, co-located at this office worked to ensure the various fieldwork, equipment, and many other aspects of described activities were successfully completed. Phil and Darren's efforts are greatly appreciated and greatly expanded the capabilities and accomplishments of the office. Ray Bressette completed his undergraduate internship with me through Westfield State University

and was a tremendous asset to my office activities. Kathryn Cooney, UMASS Amherst, also made important contributions completing an internship by reading 2013 alewife otolith samples.

Other USFWS staff assistance came from Martha Naley who continued to administer grants including the planned Fall River Dam removal. Melissa Grader continued with her work on the Manhan River fish ladder grant that became operational in 2014, ensuring in its first season issues were quickly address and initiated fish count reviews. John Warner and Melissa Grader, have provided important leadership in meetings, letters, and responses, dispute hearings, and other contentious study matters with the FERC five main stem relicensing process, over the report period. Brett Towler, provided fish passage engineering expertise on many ongoing matters and was responsible for running fishway inspections at main stem facilities. The North Attleboro National Fish Hatchery's Dan Wong and Kevin Cheung, spend much time and effort to successfully spawn, rear, and transport to Vernon Dam in fall of 2014 for pre FERC Study trials. Bill McDavitt of the National Marine Fisheries Service also provided appreciated input on passage and habitat matters and support for the Shad Population Modeling effort. The S. O. Conte Anadromous Fish Research Center continued to provide ongoing technical expertise on many fish passage issues, FERC study plans, Shad Population Model development, and shortnose sturgeon topics (Theodore Castro-Santos, Alex Haro, Micah Kieffer, Steve McCormick). Don Pugh (Trout Unlimited) provided important input and contributions on FERC relicensing matters and Population Model discussions. Katie Kennedy (Nature Conservancy) also provided important contributions on relicensing study designs and discussion.

The S.O. Conte National Fish and Wildlife Refuge continued to support the Coordinator's Office. The Refuge's Student Conservation Association Interns: David Rogers, Jake Greene, Marlisa Jemison, Brendan Western, and Jill Josimovich, all provided substantial time and effort to our spring field activities and other duties. USFWS's Artie McCollum managed SCA intern's time/duties to always meet CRC needs effectively.

The Sport Fish Restoration Grant money provided by the states of Connecticut, Massachusetts, Vermont, and New Hampshire, through F-100-R, are administered by the Wildlife Sport Fish and Restoration Program at USFWS with the appreciated assistance of the following Grant Coordinators; Tony Petrillo (CT), Kris McCarthy (MA), Randy Curtis (NH), Steve Gomez (VT), and Jen Stone (USFWS).

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

State fishery agencies -

- Connecticut: Steve Gephard, Dave Ellis, Tim Wildman, Jacque Benway, and staff
- Massachusetts: Caleb Slater, Ben Gahagan, and Scott Elzey and lab staff
- New Hampshire: Matt Carpenter, Gabe Gries, and Jason Carrier
- Vermont: Ken Cox, Lael Will and seasonals
- Rhode Island: Phil Edwards

The Connecticut River Watershed Council, under the direction of Andrew Fisk and his staff, continue to provide support in many ways to this office and our activities including relicensing studies involvement, field activities, and fish habitat restoration and passage measures.

The Anadromous Fish Program and The Connecticut River Atlantic Salmon Commission

The administration of the interjurisdictional cooperative effort to restore diadromous fish species, including American shad and river herring, to the Connecticut River basin is accomplished through the Connecticut River Atlantic Salmon Commission (the Commission). During the period from 1967-1984 (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 Marine Fisheries Service (NMFS).

The Commissioners 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). To effectively address numerous technical issues related to diverse restoration and management activities, the Technical Committee expanded and restructured its subcommittees, for a total of nine, with specific areas of responsibility (American Shad, River Herring, Atlantic Salmon, American Eel, Sturgeon, Sea Lamprey, Fish Passage, Habitat, and Fish Culture). Other experts and cooperators from the member agencies including the U.S. Geological Survey, Conte Laboratory (USGS), University of Massachusetts Cooperative Fish and Wildlife Research Unit, Trout Unlimited, The Nature Conservancy, Connecticut River Watershed Council, private industry, and others participate with the subcommittees and Technical Committee as needed. The Connecticut River Coordinator (Coordinator), an employee of the USFWS, acts as the Executive Assistant to the Commission and the Secretary for the Technical Committee. The Coordinator also serves as a member on all the Technical Committee's subcommittees and Chair for the Shad and River Herring subcommittees, the Atlantic States Marine Fisheries Commission's Shad and River Herring Technical Committee, the Northeast Regional River Herring Agency Team, and the U.S. Atlantic Salmon Assessment Committee.

The Coordinator, as titled, is responsible for coordination of state and federal activities, providing technical expertise, project development and implementation of fish population assessments, restoration and management programs at the population and habitat level, program evaluation, and advocacy and outreach of the multi-agency cooperative diadromous fish restoration program in the Connecticut River watershed (Figure 1). The Coordinator also

organizes meetings, develops new initiatives, develops plans and implements them, and maintains contact with interested parties.

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 upstream and downstream passage to historic habitats. Shortnose sturgeon, the only federally endangered species population (under recovery), continues to be monitored, studied, and protected through various mechanisms. Atlantic sturgeon is considered extirpated from the river, but the remaining East Coast populations were designated as federally endangered by NMFS in 2012, the most closely identified extant population to this river being the Hudson River. Field studies on sturgeon by CTDEEP have documented individuals from the Hudson River and other populations utilizing the lower Connecticut River. In 2014, the CTDEEP captured a juvenile Atlantic sturgeon believed to be age-1, an age not expected to migrate from a natal river.

As reported in the past, the decision to conclude the cooperative program to restore Atlantic salmon in 2012 was precipitated by the loss of the White River National Fish Hatchery (fall of 2011) to severe flood damage and in conjunction with ongoing reviews of the program's status, trends and management projections. Given the life-history and final stock-out of fry that occurred on a large scale in 2013, management actions have been evolving. The State of Connecticut subsequently developed and operates the "Salmon Legacy Program" at a much reduced scale from the previous cooperative level of effort but for some clearly defined goals discussed in later sections. In 2014, all adult salmon entering fishways with trap facilities were examined and given a visible streamer tag and passed upstream. Assessments of returning adults will continue, providing data for CRASC and the broader U. S. Atlantic Salmon Assessment Committee work (e.g., determination of age structure). Atlantic salmon are expected to be a management topic requiring coordination through CRASC for likely the next three to four years. The CRASC continues to serve as an important forum, recognized official organization, and mechanism to address more than Atlantic salmon restoration.

The CRASC meets at least twice each year and the Technical Committee meets as frequently as needed. This report period, the Commission met on November 22, 2013 and on June 19, 2014. The Technical Committee met on November 14, 2013 and June 12, 2014. In 2014, Patrick Berry (Vermont Department of Fish and Wildlife) was replaced by Commissioner Louis Porter. The Commonwealth of Massachusetts appointed Dr. Andrew Fisk as its Public Member. Dr. Fisk is the Executive Director of the Connecticut River Watershed Council. Scheduled meetings are open to the public. Interested citizens are given the opportunity to provide input into the decision-making process and area news publishers are notified of scheduled Commission meetings. Minutes of both Commission and Technical Committee meetings are produced and distributed by the Coordinator's Office once approved. Approved Minutes were posted on the Connecticut River Coordinator's Office website. In addition to serving as an historic record, these minutes describe the progress and status of many coordinated activities. Program reporting occurs in other forms such as the U.S. Atlantic Salmon Assessment Committee which produces a summary document each year for all of New England available online at: http://www.nefsc.noaa.gov/USASAC/Reports/

Table 1. Connecticut River Atlantic Salmon Commission Membership (as of November 2014).

Connecticut River Atlantic Salmon Commission	
Federal	**U.S. Fish and Wildlife Service** *Wendi Weber* Regional Director, Region 5 *Sherry White, alternate*
	National Marine Fisheries Service *John Bullard* Northeast Administrator *Daniel Morris, alternate*
Connecticut	**Connecticut Dept. of Energy and Environmental Protection** *William Hyatt* Chief, Bureau of Natural Resources *Stephen Gephard, alternate*
	Public Sector Representative *Robert A. Jones*
Massachusetts	**Massachusetts Division of Fisheries and Wildlife** *Wayne F. MacCallum* Director *Mark Tisa, alternate*
	Public Sector Representative *Andrew Fisk*
New Hampshire	**New Hampshire Fish and Game Department** *Glenn Normandeau* Executive Director *Scott Decker, alternate*
	Public Sector Representative *Duncan McInnes*
Vermont	**Vermont Department of Fish and Wildlife** *Louis Porter* Commissioner *Eric Palmer, 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** *William Ardren*
	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*

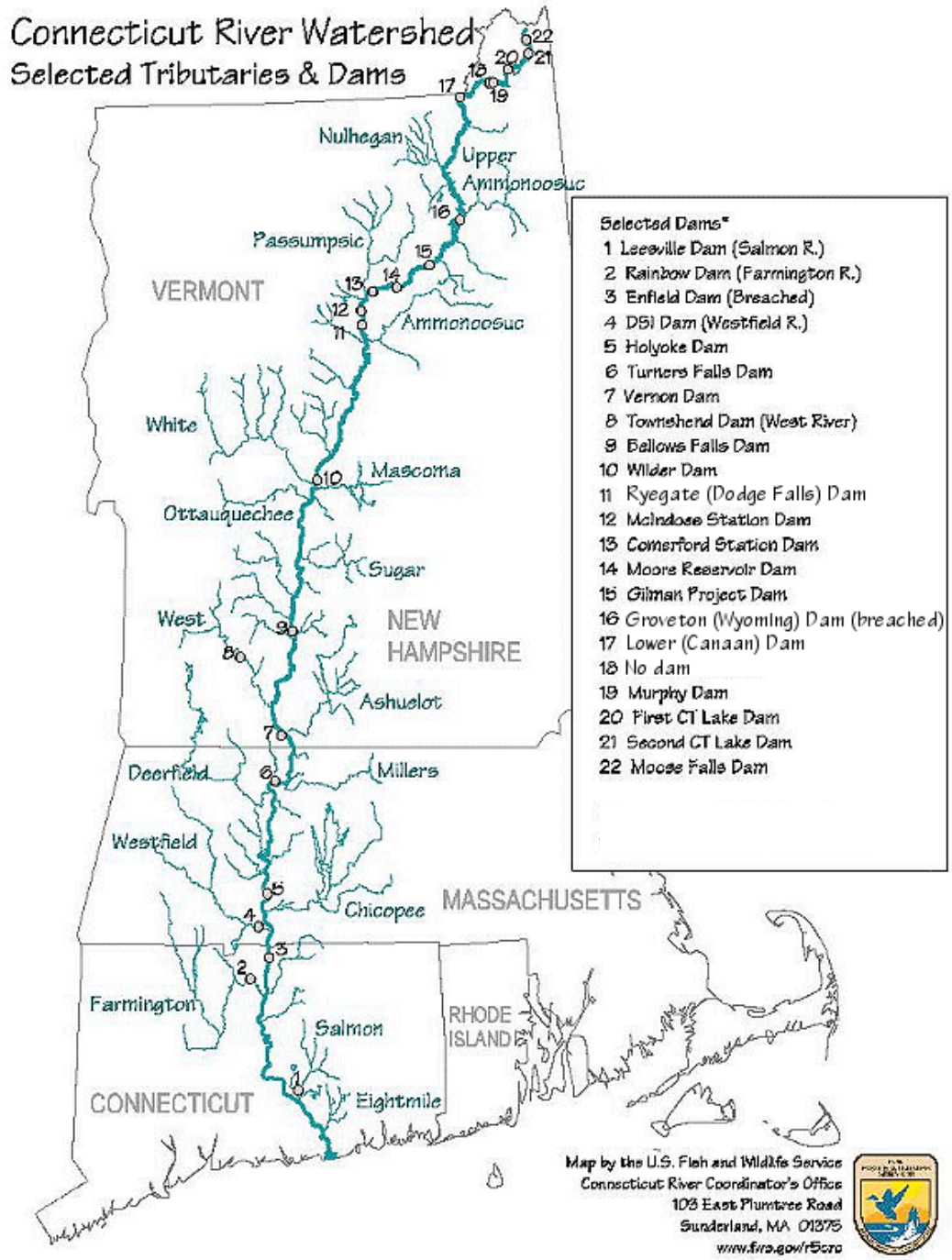


Figure 1. Connecticut River basin with major tributaries and main stem dams shown.

Coordination and Technical Assistance Funding

The Connecticut River Coordinator's Office, under the USFWS' Wildlife and Sport Fish Restoration Program's F-100-R-31, received $20,000 from the four state fishery agencies to coordinate activities and provide technical assistance through the state's annual Sport Fish Restoration Program apportionment (F-100-R). The grant project was assessed an USFWS administrative overhead fee leaving $16,393 available. The USFWS utilized the Sport Fish Restoration funds, including base funding and fish passage and habitat restoration funding (pass through grant agreements to partners, listed later) that totaled $314,272.90 to operate the Coordinator's Office and undertake the initiatives and complete tasks described in this report. Operating expenses and salaries for the Coordinator's Office were covered by these funds in fiscal year 2014.

Cost total: $314,272.90 **States (F-100-R):** $20,000.00 **Federal:** $294,272.90

Project Accomplishments

The Connecticut River Coordinator's Office enhanced the Commission's and States' ability to manage, evaluate, and implement restoration programs through a variety of activities and accomplishments some of which are described in greater detail here:

Coordination

- The Coordinator continued to provide administrative support to the Commission and Technical Committee as the Executive Assistant and Secretary, making meeting arrangements, assisting in setting agendas, developing reports, distributing information, monitoring financial receipts and disbursements, and recording and distributing minutes of Commission and Technical Committee meetings (four in the report period). The Coordinator participated on the CRASC Fish Passage, Shad and River Herring 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.

- The Coordinator's Office continued to administer the four-state (Connecticut, Massachusetts, New Hampshire, Vermont) Wildlife and Sport Fish Restoration Program Coordination and Technical Assistance Project to provide for program coordination and technical assistance.

- The Coordinator's Office compiled information for use by the U.S. Atlantic Salmon Assessment Committee in its annual report for 2013 year and attended the annual meeting at CTDEEP's Marine Fisheries Headquarters in Old Lyme, CT in February 2014. A presentation was developed and given on the Connecticut River Salmon Program with a report produced for the Committee. Data calls and planning meetings were held pre and post this meeting during the report period (http://www.nefsc.noaa.gov/USASAC/Reports/).

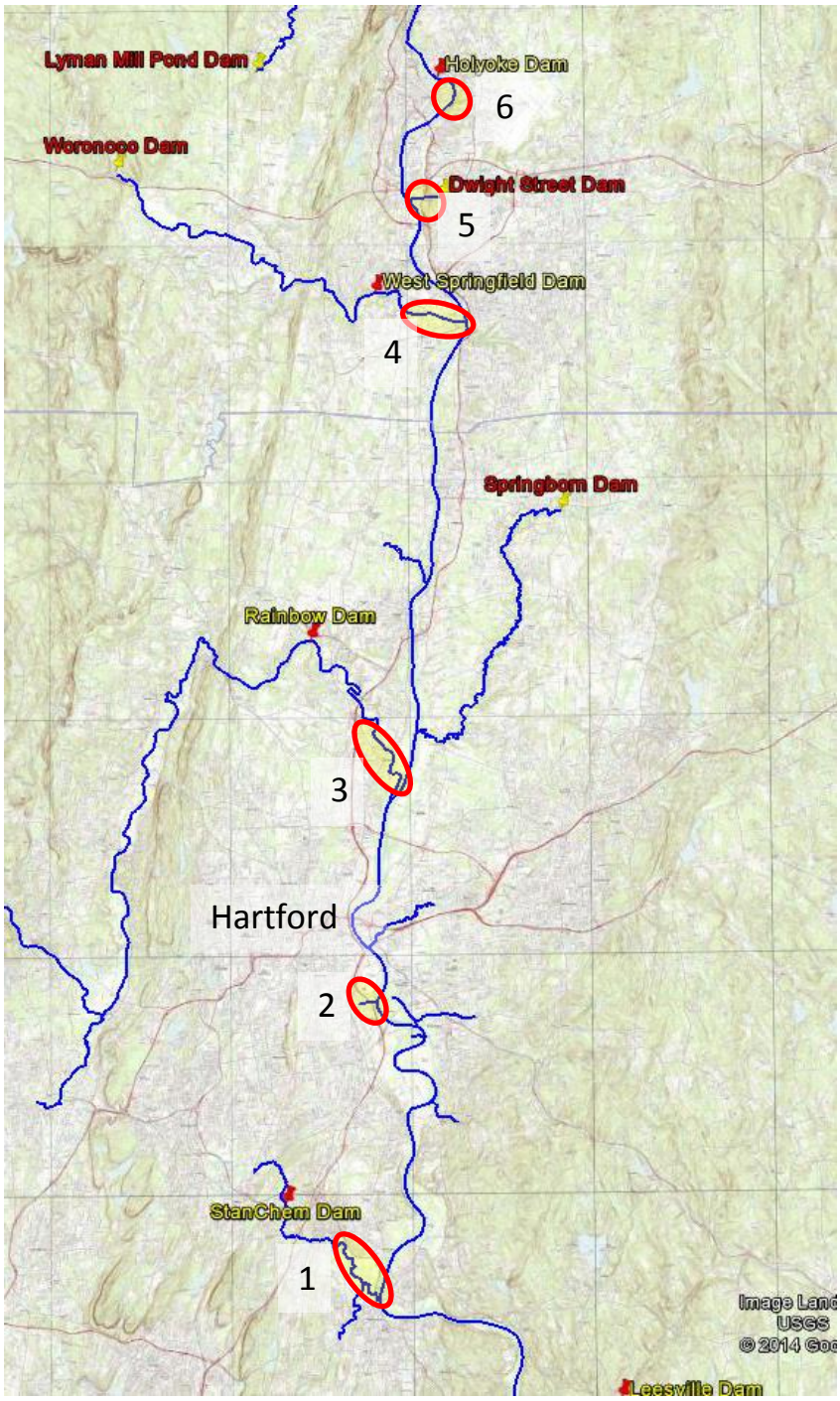
- The Coordinator worked with Connecticut Department of Energy and Environmental Protection (CTDEEP), New Hampshire Fish and Game (NHFG), Rhode Island Division of Fish and Wildlife (RIDFW), U.S. Geological Survey, Conte Lab (USGS), and Holyoke Gas and Electric fishway staff to develop a shad trap and transfer schedule for the Holyoke Fish Lift.

- Fish health testing is required to move adult shad to federal hatcheries and in 2014 shad were obtained through a commercial netter due to delays in the Holyoke Fish Lift activity from high spring flows (later figure shows passage vs. flow relationship). A 60 fish sample was processed by staff and samples were sent to USFWS Northeast Fish Health Center, where following required culture periods, it was determined that all samples were clean of screened pathogens.

Fisheries Management, Restoration, Assessment, and Technical Assistance, additional select detail:

- The Coordinator conducted for the second year a population assessment program for river herring that was initiated in early April, utilizing boat electrofishing as the primary sampling gear. Study objectives are to: 1) obtain a minimum whole fish sample of 50 blueback and alewife for age structures, per target sample location; 2) obtain baseline demographic data on all sampled herring (species, length, weight, sex); 3) derive relative abundance measures with measures of variance, using a standardized approach; 4) conduct surveys across a broad geographic range of spawning aggregations and over the duration of the runs (April-June), in an attempt to adequately represent spatial and temporal variations for both species; and 5) determine fish ages from otoliths and spawning history from scale examinations. This work was conducted to address identified priority data needs, specific to the Connecticut River and coast-wide, as described in the Atlantic States Marine Fisheries Commission's River Herring Benchmark Stock Assessment Report released in May 2012 (http://www.asmfc.org/uploads/file/riverHerringBenchmarkStockAssessmentVolumeIR_May2012.pdf). Data obtained from this study will increase in its management value over time (as an ongoing monitoring effort) with measures compared over time for status and trends and other fishery analytical methods (e.g., age structure based mortality estimators).

  Sample effort was standardized to two dip netters on the bow of the boat, using two 16 dropper array anodes off booms, with applied power time ("on-meter") of 500 seconds, ~500 volts and 5-6 amps direct current applied at intervals of 3-5 seconds, designated as a run. River herring, both alewife and blueback herring, were the primary target species, with striped bass also targeted for a supplemental genetics study at UMass Amherst in 2014. Sampling dates and locations typically included 4-5 runs in a target area. Surveys were conducted on a total of 21 dates, comprised both of daytime and night-time surveys. Six targeted sampling areas consisted of the lower Mattabesset River (Middletown CT), Wethersfield Cove (Wethersfield CT), lower Farmington River (Windsor, CT), lower Westfield River (Agawam MA), lower Chicopee River (Chicopee MA), and main stem river downstream of Holyoke Dam (Holyoke MA)[Figure 2].



The first 50 herring (by species) were targeted for later lab processing (otolith extraction and scales), sex and species confirmation. Herring sampled after the lab's target number was achieved, were identified, sexed, measured, weighed, and released, all data were compiled for analyses.

Otolith and scales were cleaned and stored, with all field data entered into a database. Individual fish samples/age structures and records are uniquely labeled. Some summary analyses for the data obtained in the spring of 2013 and 2014 is shown in Table 3 and described in the following narrative.

Figure 2. Adult river herring population assessment field sampling locations:
1) Mattabesset River; 2) Wethersfield Cove; 3) Farmington River;
4) Westfield River; 5) Chicopee River; 6) Downstream of Holyoke Dam
(Images from/using Google Earth)

Overall USFWS river herring population assessment effort was increased in 2014 from 2013, with disproportionate increases in bluebacks and alewives sampled (Table 3).

Table 3. Selected sampling statistics comparing USFWS river herring population assessments in 2014 and 2013.

	2014	**2013**
Number of sampling dates	21	18
Total sample runs	124	81
Total Efishing seconds	55,736	41,177
Total bluebacks captured	2,593	714
Total alewives captured	220	107
Blueback herring oto/scale - lab	655	501*
Alewife oto/scale - lab	188	103*

***single reader, all otoliths read and rated

A total of 124 timed sampling runs were completed over the 21 sample dates, covering 28 target sample areas. Sampling began on April 7 and ended on June 18 and included areas ranging from the main stem river immediately downstream of the Holyoke Dam to the lower Mattabesset River. The overall mean catch rate (N=124 runs) for blueback herring was 5.52 fish/min (SD ± 11.15). The overall mean catch rate for alewife was 0.23 fish/min (SD ± 0.54). Variability in catch rates for individual sample runs was quite high ranging from 0.0 to as high as 57.0 fish/min (blueback herring). Analyses of the catch data will be later examined using geometric means and possible other analytical constraints to account for inherent variability.

A plot of individual run catch rates for blueback herring is shown in Figure 3 to better illustrate the level of variability among runs and through time. The apparent lack of points reflects repeated runs of zero catch, primarily early sample dates. The figure also compares 2013 and 2014 catch rates, by date alone, noting that sites sampled varied between year along the x axis. The figure illustrates that catch rates were substantially greater in 2014 for blueback herring and those increases in catch rates were noted at nearly all sites sampled and over time. Multiple sample runs can be represented by a single point, primarily when zero catches occurred early or late in the year.

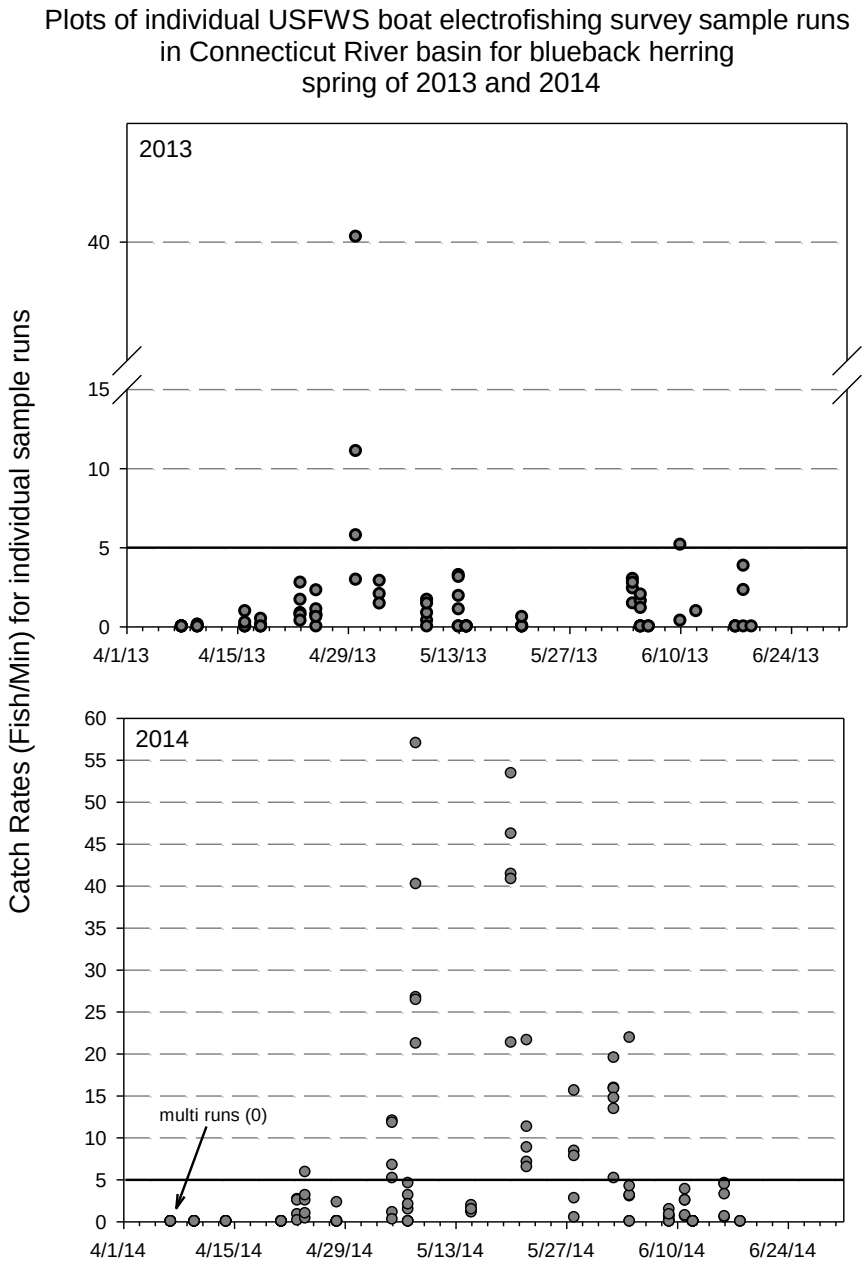


Figure 3. USFWS standardized boat electrofishing survey individual, timed run catch rates, reported as fish per minute captured, for all survey sites in spring of 2013 and spring of 2014 in the Connecticut River basin. Number of sites and timing of sampling at and among sites are variable.

- Reading of all alewife and blueback herring otolith samples obtained in 2013 was completed by a single reader in 2014. Ideally there would be a second blind read to compare age assignments, but having a single staff biologist makes this unlikely given the Coordinator's other duties. A tentative plan is to conduct a second blind read, on 20% of the samples, from a random draw. A draft length-at-age plot for 103 alewife sub-sampled for age structure, is shown in Figure 4. A draft age distribution for blueback herring in three sampled area in 2013, is shown in Figure 5.

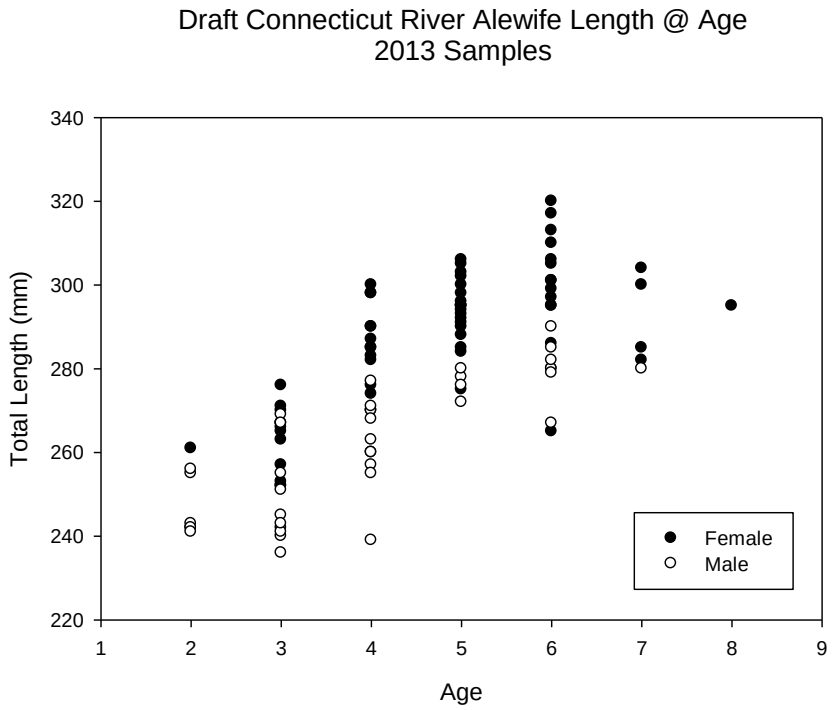


Figure 4. Alewife age structure by sex, as determined by otoliths (single reader), for fish sampled in 2013.

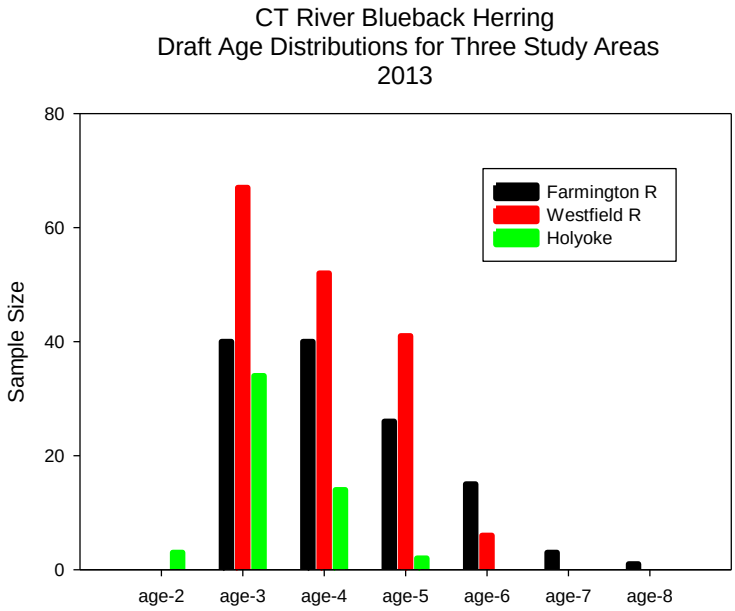


Figure 5. Ages of blueback herring sampled from three areas in 2013, single reader, males and females combined [Farmington R., N=125; Westfield R., N=166; Holyoke, N=53].

- Active river herring restoration measures were initiated as blueback herring catch rates in population assessment work increased. In the month of May the Coordinator's Office transitioned to capture efforts for pre-spawn herring from Wethersfield Cove, concurrent with population assessments. Similar to 2013, boat electrofishing was the primary capture gear for the 5,680 herring captured and transfer to accessible but unutilized

habitats upstream of Holyoke Dam and the Farmington River (Table 4). This was a substantial increase from the 2,931 captured and moved in 2013. Fish were transported in two USFWS tank trucks with salt, diffused oxygen, and recirculating water pumps. The CTDEEP also transported blueback herring on two dates when the agencies worked together. Transport mortality was extremely low (0 to < 5% per trip) with fish observed at release in better condition than when first placed in truck tanks, attributed to salt and relatively high dissolved oxygen levels.

Capturing and transferring of blueback herring with CTDEEP.

Table 4. Data for blueback herring captured primarily by boat electrofisher from Wethersfield Cove, CT and relocated for restoration in 2014.

Date	Agency	# Loaded	Receiving Location	# Mortalities	Total Released
5/12/14	USFWS	480	Oxbow, Easthampton, MA	5	475
5/14/14	USFWS	795	Oxbow, Easthampton, MA	6	789
5/15/14	USFWS	840	Oxbow, Easthampton, MA	0	840
5/15/14	CTDEEP	700	Farmington River, Farmington, CT	n.a.	700
5/19/14	USFWS	570	Manhan River, Southampton, MA	5	565
5/20/14	USFWS	890	Manhan River, Southampton, MA	4	866
5/21/14	USFWS	340	Oxbow, Easthampton, MA	0	340
5/21/14	CTDEEP	300	Farmington River, Farmington, CT	n.a.	300
5/27/14	USFWS	815	Oxbow, Easthampton, MA	10	805
					5, 680

- Sampling of juvenile alosine (American shad, blueback, and alewife) were conducted using seines and boat electrofishing. A visual survey for juvenile popping behavior was also conducted upstream of the Manhan River Dam via canoe concurrent with sampling the adjacent Oxbow. Sample data showed differences in size distributions of blueback herring between the Oxbow/Northampton, MA, which received 3,249 prespawn/transferred adult bluebacks, and the location were these fish were captured from, Wethersfield Cove, CT (Figure 6). Catch rates from boat electrofishing for

juvenile bluebacks were 3.9 fish/min in the Oxbow vs. 39.1 fish/min in Wethersfield Cove, translating to a 10 fold difference.

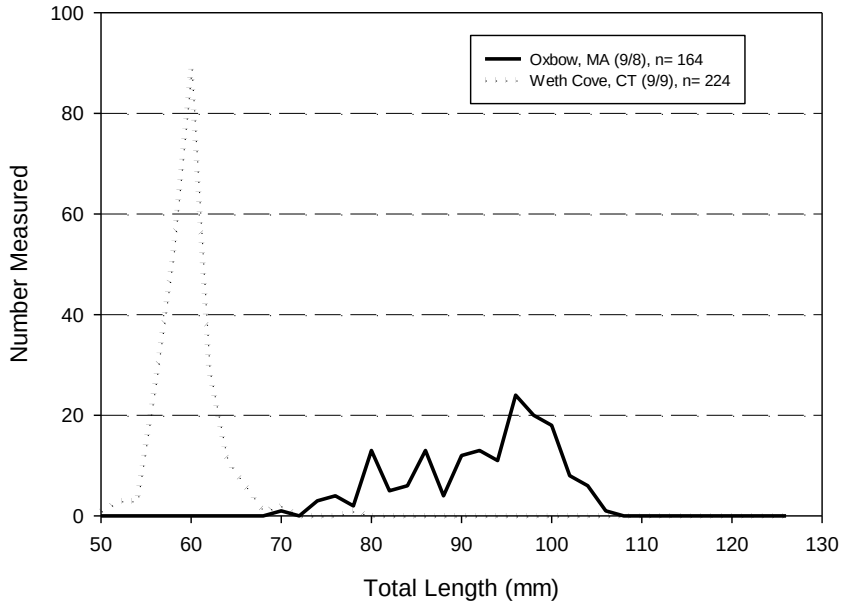


Figure 6. Blueback herring samples (subsamples from survey runs) obtained from fall survey of juveniles.

- A summary of American shad transfers from Holyoke Fish Lift to support restoration efforts in and out-of-basin with stocking locations are provided in Table 5. Fish taken to North Attleboro National Fish Hatchery (NANFH) supported Rhode Island restoration programs using larvae and the trial effort rearing of juveniles for FERC relicensing studies mentioned earlier.

Table 5. American shad trapped at Holyoke Fish Lift and transferred in 2014

	Transported By	Destination Waterbody	Number Transported	Number Released
5/21/2014	RIDFW	NANFH	75	75
5/22/2014	CTDEEP	FARMINGTON RIVER	80	80
5/22/2014	RIDFW	NANFH	75	75
5/23/2014	CTDEEP	FARMINGTON RIVER	80	80
5/27/2014	RIDFW	NANFH	75	74
5/28/2014	RIDFW	NANFH	77	77
5/28/2014	CTDEEP	NAUGATUCK RIVER	81	81
5/29/2014	CTDEEP	NAUGATUCK RIVER	82	82
6/2/2014	CTDEEP	MATTABESSET RIVER	85	84
6/3/2014	CTDEEP	MATTABESSET RIVER	82	78
6/4/2014	CTDEEP	QUINIPIAC RIVER	80	78
6/5/2014	CTDEEP	QUINIPIAC RIVER	83	81
6/9/2014	RIDFW	ASHUELOT RIVER	75	72
6/10/2014	RIDFW	ASHUELOT RIVER	75	70
6/11/2014	CTDEEP	FARMINGTON RIVER	64	63
			1169	1150

The Conte Laboratory also trucked a total of 543 shad to run fish passage experiments in their flume building on 8 dates in May and June.

- Sea lamprey nest counts by staff documented 29 nests downstream of Wiley-Russell Dam on the lower Green River (MA), compared with 84 (2011); 184 (2010); and 55 (2009). This reach is 0.9 km in distance. Downstream of the Manhan River Dam (MA) and the new fish ladder a total of 28 nests were counted compared with 35 (2011) and 20 (2010). Upstream of the new ladder, 3.3 km was surveyed in the main stem and moving up the North Branch with 72 nests counted. Lastly, a total of 30 nests were counted in the lower Falls River (MA) compared with 133 (2011) and 27 (2010) a distance of 1.5 km to the first barrier (planned for removal).

- Coordinator' Office organized meetings among potential partners to discuss future uses of RCNSS facility. Following the retirement of the hatchery manager, an extensive clean-up effort was completed by the Coordinator's staff of the facilities buildings and areas, spring through summer.

- The Coordinator used S.O. Conte Refuge Student Conservation Association (SCA) interns and students and volunteers over the report period to assist on tasks. One formal student internship program was completed with Westfield State University and the University of Massachusetts, who both provided assistance during the spring months. A total of approximately 400 volunteer hours, along with USFWS personnel from other offices/programs (~200 hours) were essential to achieving project/program objectives.

- The Coordinator spent approximately 6 full weeks of time on the FERC relicensing process for the Turners Falls Dam and Northfield Mountain Pumped Storage (NMPS) Project operated by FirstLight Power and TransCanada's Vernon Dam, Bellows Falls Dam, and Wilder Dam. The 5 year process (all licenses expire in 2018) was initiated in fall of 2012 and requires ongoing attention. The CRC web site (http://www.fws.gov/r5crc) provides links to both FirstLight and TransCanada's web sites where each company has posted many documents on this process.

  In this period, meetings to further define study plans by the companies continued. A formal study dispute was filed by USFWS following the issuance of the FERC Study Plan Determination (February) regarding a larval and juvenile shad entrainment study for NMPS. A substantial effort was applied to that hearing, at which time the company agreed to work with the agencies on a study plan. Other studies required time to review and plan for including a contested acoustic study required by FERC for TransCanada, which as of this report remains undecided pending a re-hearing. The Coordinator assisted in coordinating the effort to have North Attleboro National Fish Hatchery produce 5,000 juveniles for a trail effort (at hatchery, for transport and delivery, holding and tagging studies) with TransCanada consultants in evaluation for 2015 studies.

- The Coordinator's Office cleaned and slide mounted adult sea-run Atlantic salmon scale samples. The Coordinator worked with Steve Gephard (CTDEEP) in the aging of salmon scales and developing the 2014 adult run summary data (details in later section).

- The Coordinator maintained long-term temperature loggers (n=20) from Old Lyme, CT upriver to Wilder Dam, (VT/NH) in October-December 2013 and in 2014, first deployed in the fall of 2009. Loggers record year-round at 20 minute intervals. Loggers were also placed in lower portions of selected tributaries. Figures of these data will be shown later in the report.

Outreach

- The Coordinator's Office updated the station website on the Internet (http://www.fws.gov/r5crc) with current information and activities.

- The Coordinator's Office continued to maintain databases on migratory fish restoration activities. Daily fish counts at eight different dams were entered into a database by Office staff. These fish counts were updated daily (M-F during the spring run) on a telephone hotline (413/548-9628) and on the Internet.

- The Coordinator gave presentations on migratory fish restoration, status and trends, to Westfield State University, Ecology Class, Northfield Mount Hermon School, and Global Women Leader Program group for the Smith College Tuck School of Business Program.

Program Results

The Connecticut River Coordinator's Office collected and reported information relating to the activities and accomplishments occurring in the Connecticut River basin diadromous fisheries restoration program. [Some of the data presented here is preliminary. For the final, peer reviewed program data/information, refer to the annual U.S. Atlantic Salmon Assessment Committee Report.]

Migratory Fish Returns

American Shad - A total of 375,831 adult American shad were counted in 2014 at all passage facilities in the basin. A total of 370,506 shad were passed upstream of the fish lift in Holyoke, Massachusetts in 2014 (Figure 7). The long-term (1976-2014) mean shad passage count for Holyoke is 306,385 (SD± 131,987). The 25th percentile value for passage counts is 192,668 and the 75th percentile value for passage counts is 372,520.

A total of 4,789 shad were passed upstream of the West Springfield Project in 2014, consistent with passage counts for 2013 (Figure 8). A total of 536 shad were passed upstream of the Rainbow Dam Fishway on the Farmington River in Connecticut, a fishway with known issues for passing both shad and river herring. Of the shad passed above the Holyoke Dam, 39,914 shad were counted and passed at the Gatehouse fishway at Turners Falls Dam in 2014 (Table 7). Overall, the 2014 passage number as a percentage of shad passed at Holyoke is approximately 11%, the high value in the time series, but well below the target. The CRASC, Shad Management Plan has an objective of 40-60% shad passage at each successive barrier on the main stem. Shad passage at Vernon Dam was relatively high for a third consecutive year, following repairs to the Vernon Dam fishway prior to 2012 season, with 27,706 shad passed in

2014. This translates to 69% passage rate (at Vernon) of the shad passed upstream of Turners Falls Dam, which does meet the noted management plan objective (Table 7).

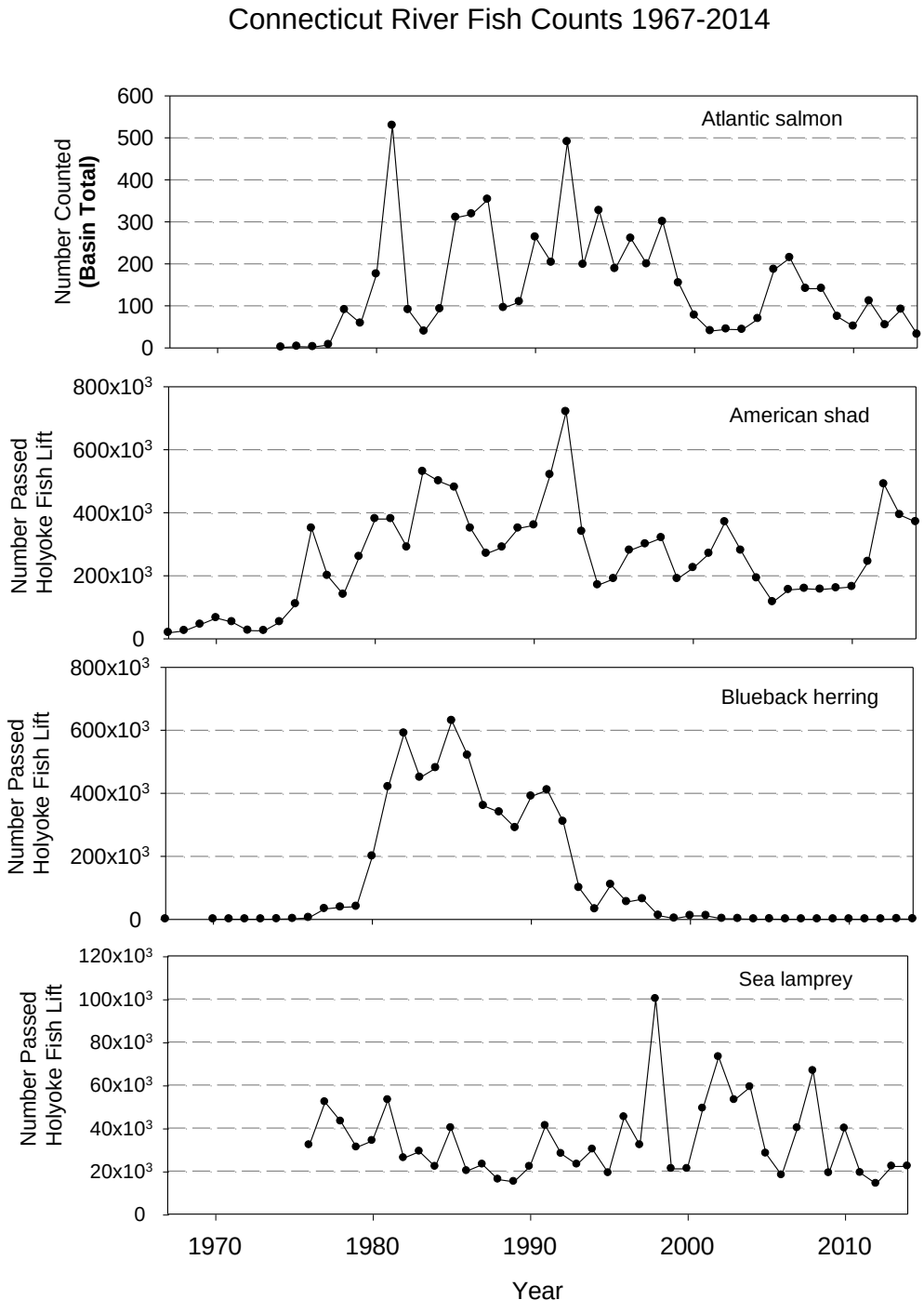


Figure 7. Summary of Atlantic salmon returns to Connecticut River basin (all facilities), and Holyoke Fish Lift passage counts for American shad, blueback herring and sea lamprey (1967-2014). Fish counts are affected by structural and operational changes (dams and fishways), and environmental conditions (temperature and flow/spill).

Table 7. American shad fishway passage counts 1980 – 2014, for Holyoke Dam, Turners Falls Dam, and Vernon Dam.

Year	HFL Passed	Gatehouse Passed	% Gate vs. HFL #	Vernon Passed	%Vern vs. Gate #
1980	380,000	298	0.1		
1981	380,000	200	0.1	97	48.5
1982	290,000	11	0.0	9	81.8
1983	530,000	12,705	2.4	2,597	20.4
1984	500,000	4,333	0.9	335	7.7
1985	480,000	3,855	0.8	833	21.6
1986	350,000	17,858	5.1	982	5.5
1987	270,000	18,959	7.0	3,459	18.2
1988	290,000	15,787	5.4	1,370	8.7
1989	350,000	9,511	2.7	2,953	31.0
1990	360,000	27,908	7.8	10,894	39.0
1991	520,000	54,656	10.5	37,197	68.1
1992	720,000	60,089	8.3	31,155	51.8
1993	340,000	10,221	3.0	3,652	35.7
1994	170,000	3,729	2.2	2,681	71.9
1995	190,000	18,369	9.7	15,771	85.9
1996	280,000	16,192	5.8	18,844	116.4
1997	300,000	9,216	3.1	7,384	80.1
1998	320,000	10,527	3.3	7,289	69.2
1999	190,000	6,751	3.6	5,097	75.5
2000	225,000	2,590	1.2	1,548	59.8
2001	270,000	1,540	0.6	1,744	113.2
2002	370,000	2,870	0.8	356	12.4
2003	280,000			268	
2004	192,000	2,192	1.1	653	29.8
2005	116,511	1,581	1.4	167	10.6
2006	155,000	1,810	1.2	133	7.3
2007	158,807	2,248	1.4	65	2.9
2008	156,492	4,000	2.6	271	6.8
2009	160,649	3,813	2.4	16	0.4
2010	164,439	16,422	10.0	290	1.8
2011	244,177	16,798	6.9	46	0.3
2012	490,431	26,727	5.4	10,386	38.9
2013	392,494	35,293	9.0	18,220	51.6
2014	370,506	39,914	10.8	27,706	69.4
Mean			**4.0**		**40.7**
SD			3.4		33.8

Spring 2014 river flows and water temperatures influenced shad passage rates at Holyoke Dam with the relatively high river discharge throughout the month of April and into May (Figure 9).

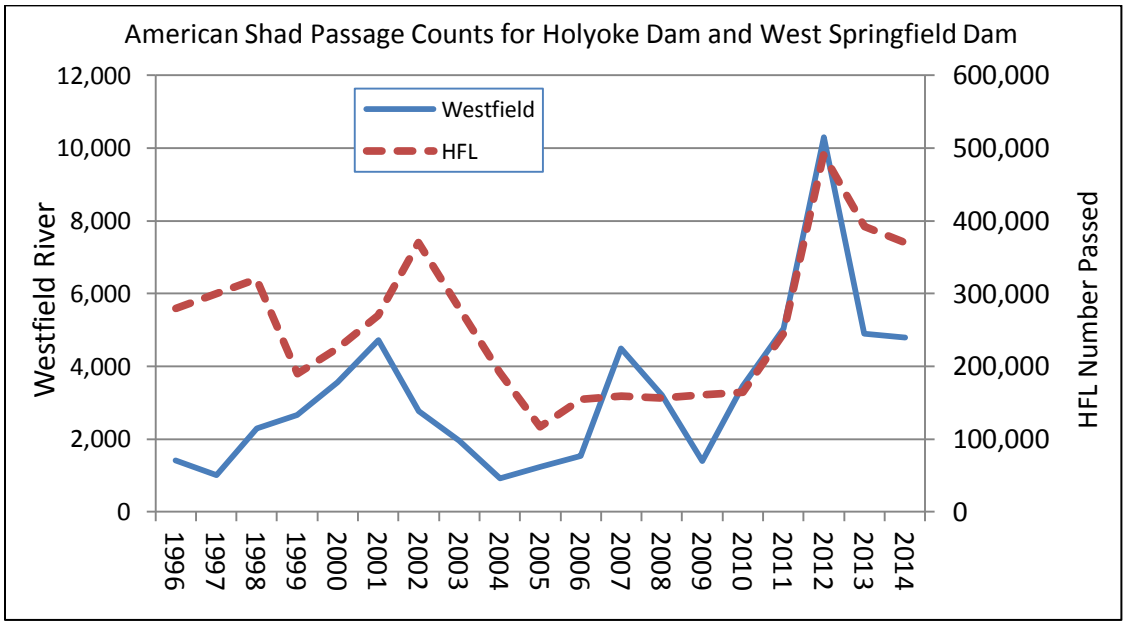


Figure 8. American shad passage counts for West Springfield Dam (Westfield River) for period of operation compared with Holyoke Dam Fish Lift counts

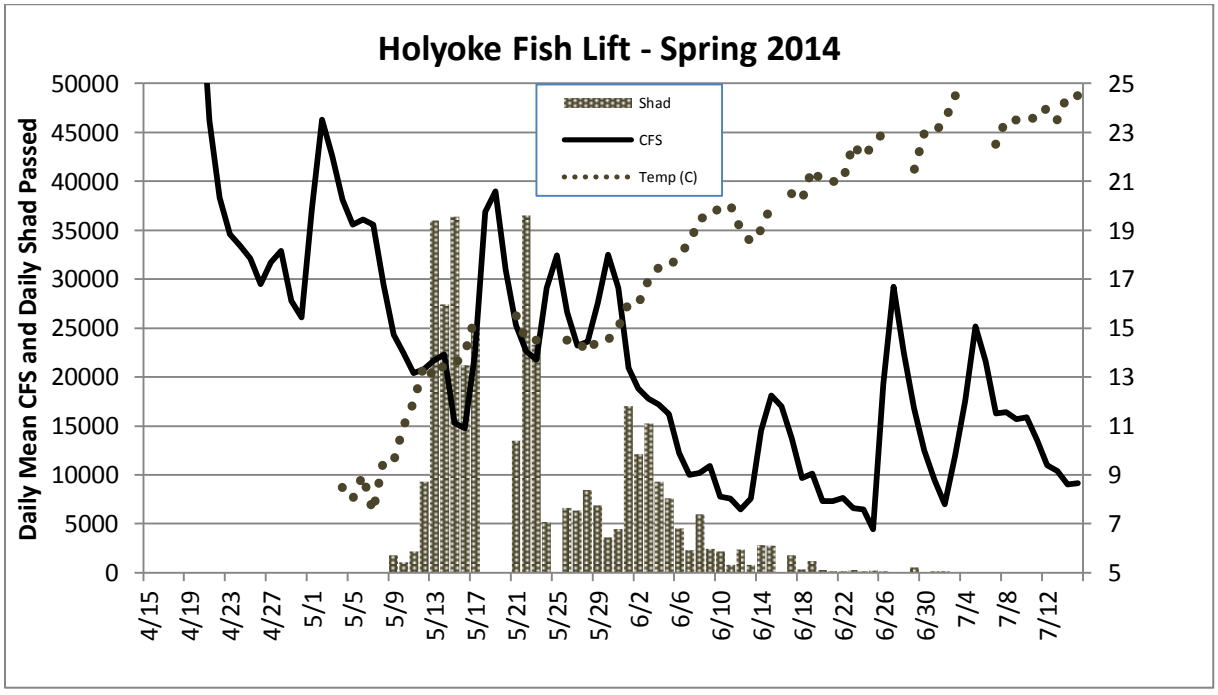


Figure 9. Holyoke Fish Lift American shad passage counts for the spring of 2013, with daily mean cubic feet per second (CFS) discharge value from USGS Holyoke Gage and the reported "daily" water temperature by HFL staff also shown.

Blueback Herring - A total of 647 blueback herring were counted at the Holyoke Fish Lift in 2014. River herring counts are not believed to reliably serve as a population metric for the lower river, and larger lower tributaries (downstream of fishways), where substantial spawning habitat occurs.

Sea Lamprey - A total of 28,050 sea lamprey were observed returning to the Connecticut River basin in 2014 based on fishway observations. A total of 4,276 sea lamprey were passed upstream of Rainbow Dam, 1,127 were passed upstream of the West Springfield Project, and 22,136 lampreys were passed upstream of the Holyoke Dam. A total 5,553 sea lamprey passed upstream of Turners Falls Dam (Gatehouse fishway count), 399 passed upstream of Vernon Dam, and 212 passed upstream of Bellows Falls Dam.

Striped Bass - A total of 69 striped bass were counted at the Holyoke Fish Lift in 2014.

Gizzard Shad - A total of 410 gizzard shad were counted at the Holyoke Fish Lift in 2014.

American eel – The American eel passage count using eel specific passes operated at Holyoke Dam, was 49,817 in 2014 (record year) compared to 13,584 in 2013 and 39,423 in 2012, 8,755 (2011), 4,138 (2010) and 5,639 (2009). The Rainbow Dam eel pass (Farmington River) passed 1,905 eels compared to 910 eels in 2013 and 197 eels (2012), 5,512 (2011) and 889 (2010). The USFWS was petitioned to consider listing American eel under the Endangered Species Act in 2011. The review process continues at the time of this report. Figure 9 shows the sub-adult eel passage count data from Holyoke Dam eel trap and collection equipment for 2014 in relation to mean daily river discharge.

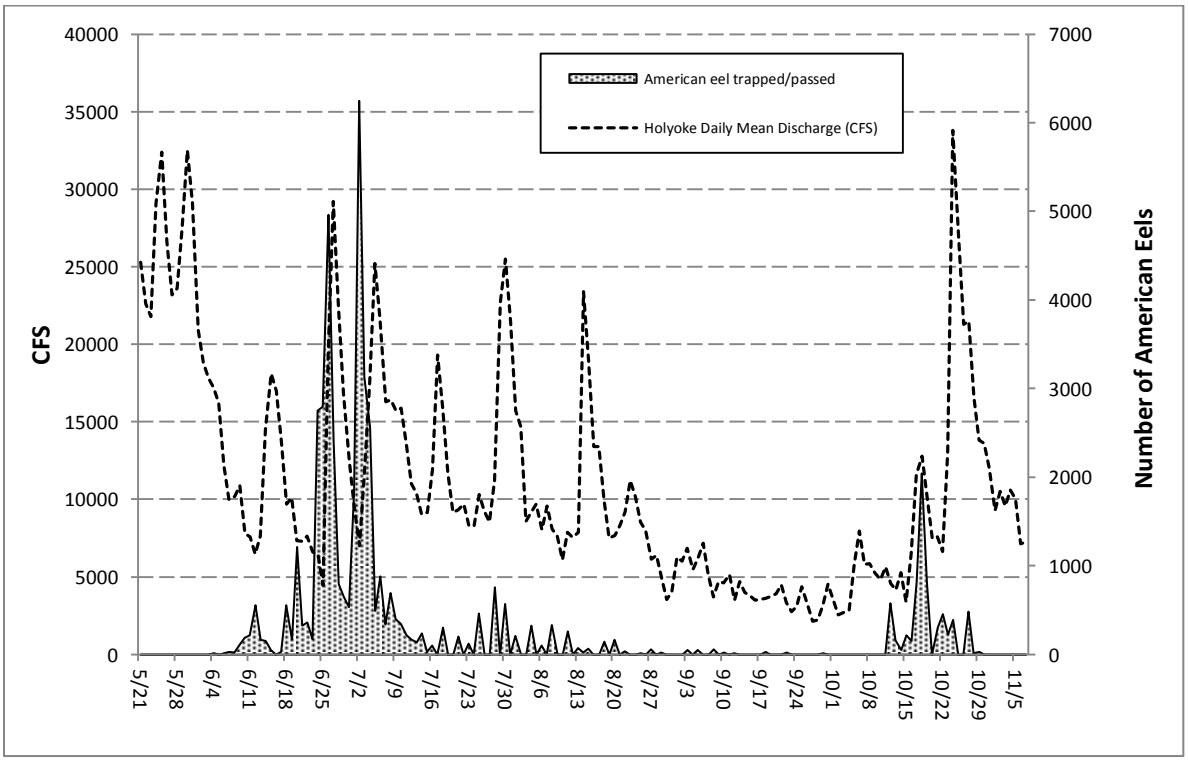


Figure 9. American eel counts from eel passes/traps and with daily mean river discharge.

Other tributary fishway counts in the basin are included in Table 8 below.

Tributary	Fishway	Shad	Alewife	Blueback	Gizzard shad	Sea lamprey
Mill Brook, *Old Lyme, CT*	Mary Steube		1543			
Eightmile River, *Lyme, CT*	Moulson Pond	3	13	18		342*
Mattabesset River, *Berlin, CT*	StanChem	5	254	80	100	17
Manhan River, *Easthampton, MA*	Manhan Dam	Video tape is under review, 54 lamprey passed in 3 days, one adult salmon noted too				

Atlantic Salmon - A total of 32 sea-run Atlantic salmon adults were documented as returned to the Connecticut River watershed during 2014. This is a decrease from the 92 known returning adults in 2013 (Figure 7). Starting in the lower basin, one adult was observed from the Salmon River (CT) – Leesville Dam, three at Farmington River (CT) – Rainbow Dam, two at Westfield River (MA) – West Springfield Dam, and 26 at the Holyoke Dam (MA). All adult salmon were released following a planned effort to trap, streamer tag, examine the fish, and obtain scale samples. However, some fish were not handled to avoid injury or stress at time of capture. Nearly all adults were counted in the spring with only one new fish counted at Holyoke in the fall.

Movement information of adult salmon upstream of Holyoke Dam is limited as no radio tagging occurred. However, one adult that was tagged and released at Holyoke Fish Lift subsequently dropped back downstream and was trapped at the West Springfield Dam on the Westfield River. The Westfield River trapped fish were transported and released upstream of dams with no upstream passage into suitable habitat, the only facility to undertake this action. From the 26 adults counted (that is minus the Westfield River drop-back), 11 were observed passing Turners Falls Dam, 11 passed at Vernon Dam, 2 passed at Bellows Falls Dam, and zero passed at Wilder Dam. Adult salmon were confirmed upstream of Holyoke in three tributaries; above the Manahan River Dam, Sawmill River, and Fall River all in Massachusetts.

All examined sea-run adults were wild (fry stock) origin. Scale reading was possible for 26 of the adults that were physically sampled. Two of the 26 examined fish were one-sea winter (grilse) with the remaining fish not trapped but observed and noted as "multi sea-winter fish". From the 26 aged fish, freshwater age could not be determined for three, seven were age-1 smolts, 15 were age-2 smolts, and one was an age-3 smolt.

Atlantic Salmon Egg Collection (Fall 2013)

A total of 556,000 green eggs were produced at one state hatchery in 2013. Only the CTDEEP Kensington State Fish Hatchery maintained domestic broodstock. Those eggs were used for fry stocking for the Connecticut Legacy program. Sea-run broodstock held at RCNSS through the end of 2013, produced 350,200 eggs. Those eggs were eyed at RCNSS and not transferred to KSFH until fish health screening was completed. Due to multiple issues at the RCNSS, most of the eggs had hatched prior to transfer and mandatory disinfection upon receipt at KSFH resulted in high losses. The net gain of sea-run eggs for the Legacy program amounted to about 20,000 fry. These will be the source of the next generation of domestic broodstock at KSFH.

Juvenile Atlantic Salmon Releases

A total of 198,957 fry were stocked, only in the State of Connecticut in 2014. This compares to

the final multi-state stock out of 1.95 million fry in 2013, which was also a substantial reduction from preceding years. Connecticut's 2014 stocking consisted of 119,737 fry into the Farmington River basin and 79,220 fry into the Salmon River basin.

Fish Passage

There has been a diversity of activities related to fish passage some of which are highlighted here. John Warner continues as our USFWS lead Hydropower Coordinator. In the winter of 2014, the CRASC decided to only require the operation of late fall adult salmon downstream measures in cases were 50 or more adults salmon were documented as passing upstream of a facility. In addition, TransCanada agreed to open the Bellows Fall fish ladder with either the passage of an adult salmon at Vernon Dam OR the passage of 100 sea lamprey. Sea lamprey is currently not a current trigger for that ladder's operation. Fishway inspections prior to the start or early in operations occurred under the direction of USFWS Engineers Brett Towler and Brian Waz (Vernon, Turners Falls, Holyoke, and on Westfield River -West Springfield Dam).

Holyoke Dam – the downstream fish passage settlement agreement group has approved company plans that were developed with the input of USFWS Engineer Brett Towler. Work to construct the downstream passage submerged intakes, bypasses and related project work will begin at the end of the 2015 fish passage season. Study Plans to evaluate downstream passage for shortnose sturgeon, American eel (adults) and American shad (adults) were to be developed and are expected to occur in 2016.

Turners Falls Dam and Northfield Mountain Pump Storage – Relicensing study plans continue to be reviewed, developed, and discussed by the company and the agencies. In September 2014, Interim Study Reports and meeting were held with the FERC.

Vernon, Bellows Falls, and Wilder Dam – all had continued meetings, planning, information reviews, and discussion with the agencies on relicensing studies. In September 2014, Interim Study Reports and meeting were held with the FERC.

Manhan River – the Manhan fishway was operational for its first season in 2014. Melissa Grader (USFWS) was lead in identifying and addressing needed modifications and setting up monitoring equipment. In only three days of fishway video count review a total of 54 sea lamprey were counted (passed). Plus one adult salmon was observed dropping back downstream in the review of that time period.

The current status of upstream fishways at barriers in relation to access for blueback herring are shown in figures 10, 11, and 12. As noted earlier, fish passage effectiveness and other factors are currently restricting blueback herring use of habitat upstream of the Holyoke Dam and also upstream of the Rainbow Dam.

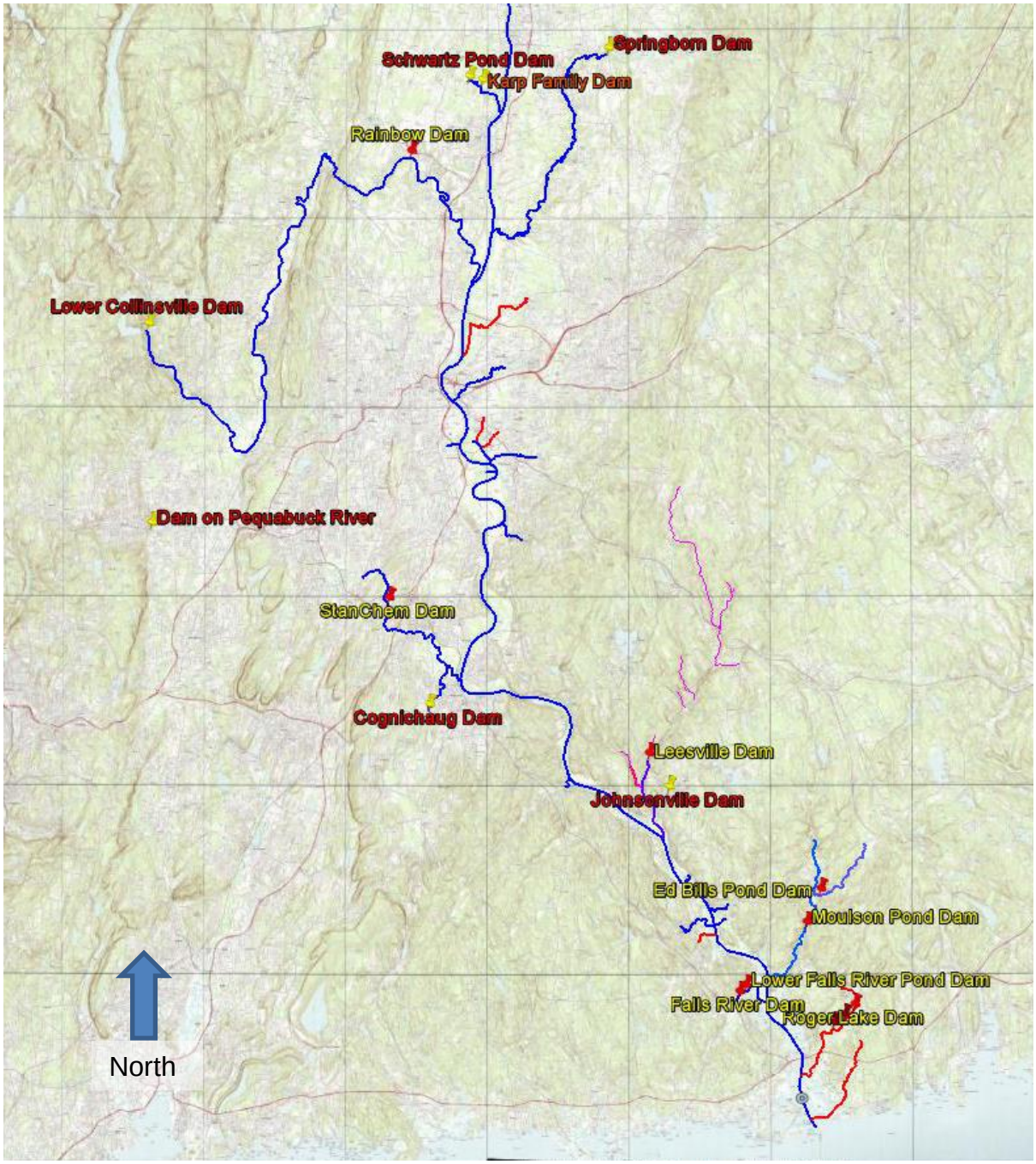


Figure 10. Dams with upstream fishways are listed in yellow while barriers that do not have fish passage are listed in red, upstream to the Massachusetts border. Blue lines show current distribution/accessible habitat for blueback herring and alewife. Red lines show the same for alewife only, based on CTDEEP data. Pink lines show some select examples of additional identified sea lamprey accessible/utilized habitat that is upstream of river herring habitats. (Images from/using Google Earth)

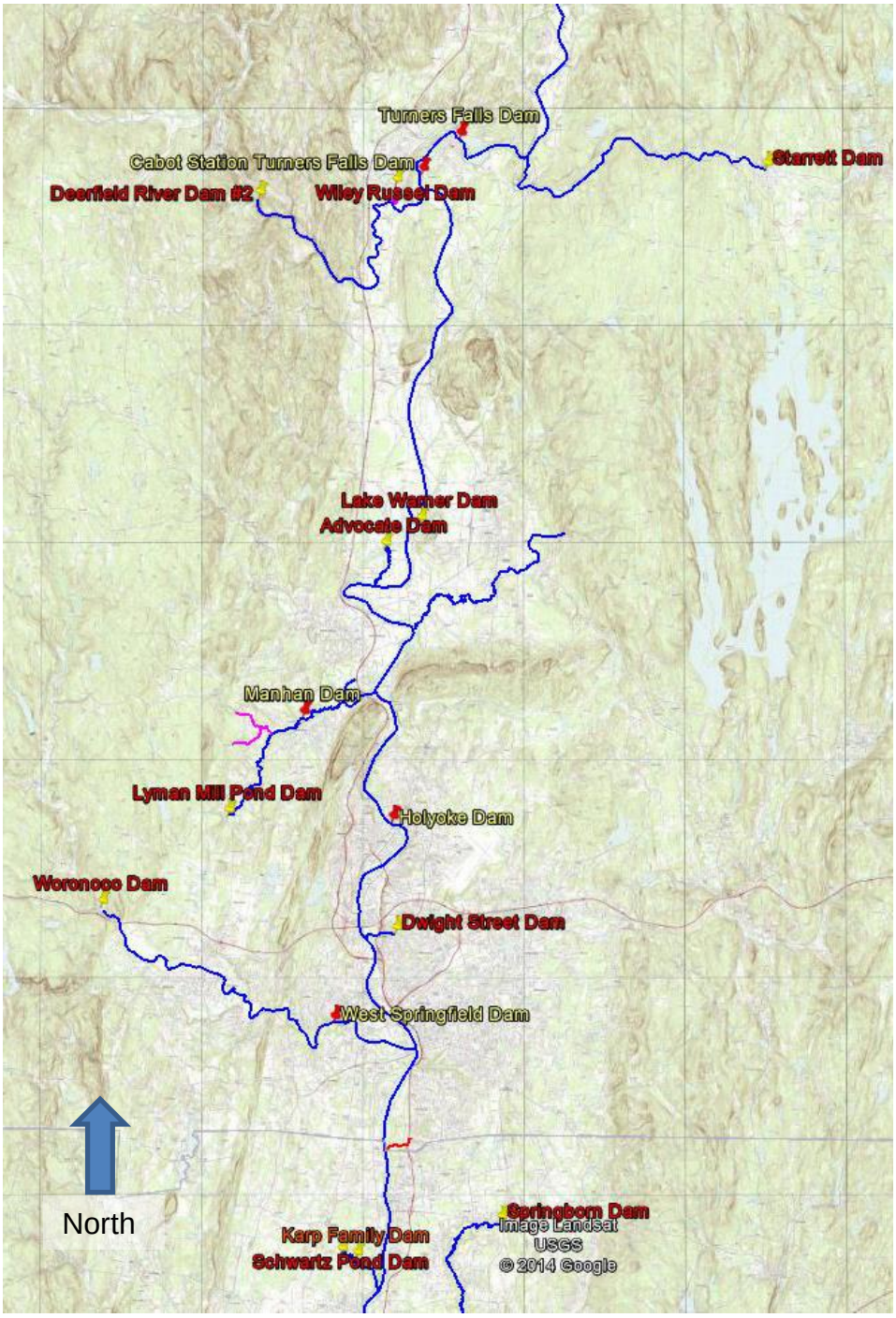


Figure 11. Dams with upstream fishways are listed in yellow while barriers that do not have fish passage are listed in red. Blue lines show current distribution/accessible habitat for blueback herring. Red lines show the same for alewife only. Pink lines are some additional (select for illustration) sea lamprey accessible habitat outside of blueback habitat. (Images from/using Google Earth)

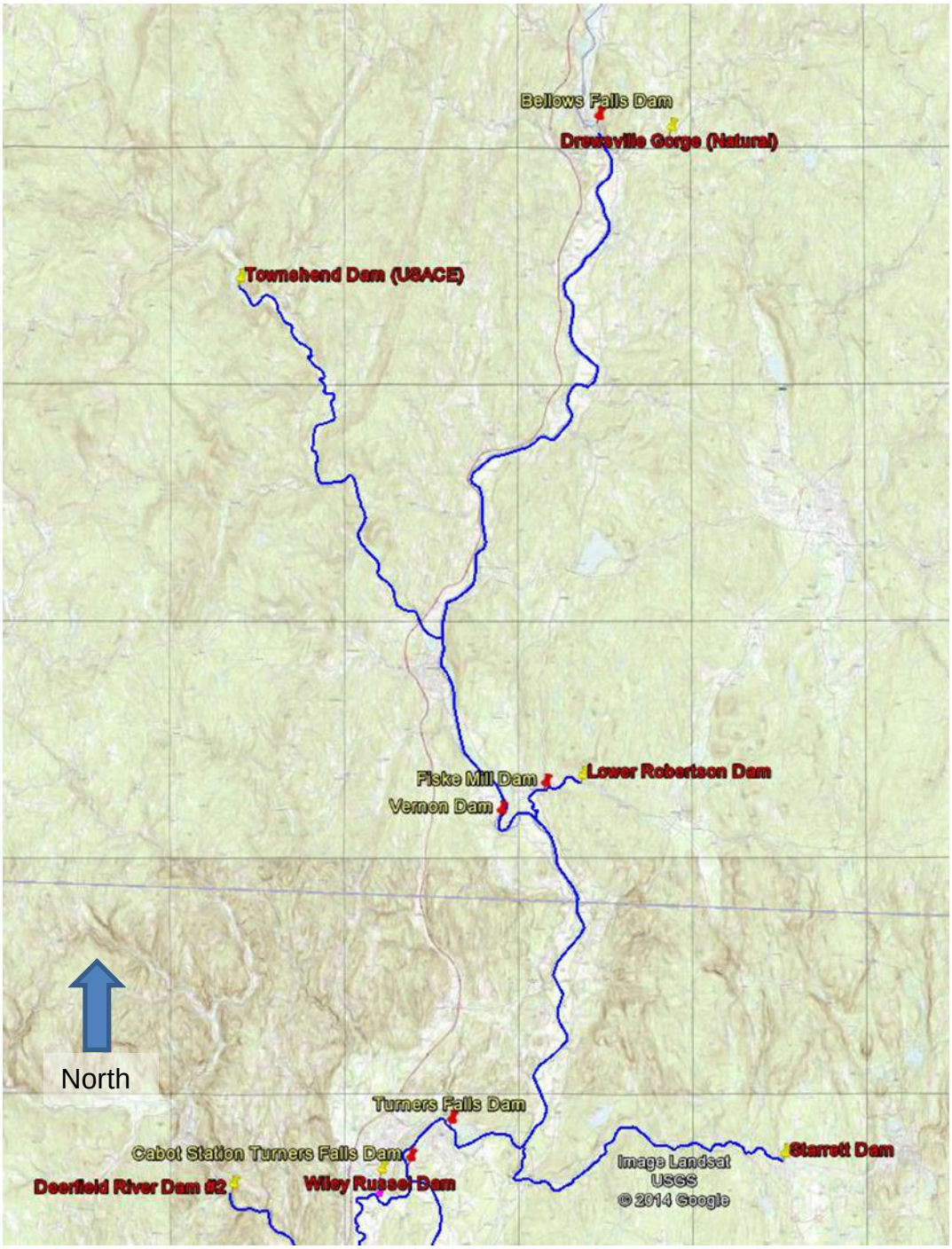


Figure 12. Dams with upstream fishways are listed in yellow while barriers that do not have fish passage are listed in red. Blue lines show current distribution/accessible habitat for blueback herring. (Images from/using Google Earth)

Appendix A. Description of the Connecticut River Basin

The Connecticut River is the longest river in New England. It begins in the Fourth Connecticut Lake (2,625 feet above sea level), and collects water from several major tributaries as it flows South between the states of New Hampshire and Vermont, and through Massachusetts and Connecticut. After collecting water from the 11,250 square mile drainage basin, the river flows into Long Island Sound at Old Saybrook, Connecticut, over 400 miles from its origin (Figure 1).

The river basin environment varies from highly developed and urbanized stretches in the lower river valley to more rural and forested reaches in the tributary and headwater areas. The natural streambed gradient profiles are interrupted by artificially ponded stretches created by the numerous dams located on the river and its tributaries. Over 2,500 dams in the basin impact and fragment habitat and natural steam processes, according to the most recent assessment of barriers in the basin (The Nature Conservancy). Hydropower dams and a main stem pump storage hydropower facility can regulate/alter flows, particularly in the main stem and lower reaches of larger tributaries. Aquatic organism entrainment and or impingement through turbines and for power station cooling systems are also a serious concern. In addition, discharge of heated effluent from power stations, are also cause for concern for organisms. Summer water temperatures average between 70^{o} and 80^{o}F with temperature peaks sometimes reaching 90^{o}F in July and August.

The Connecticut River and its tributaries support a diverse group of fishes and invertebrates. Both intentional and accidental introductions have altered native fish communities within the basin. Currently, at least 12 diadromous fishes utilize (e.g., spawning or feeding forays) or visit the Connecticut River, including American shad, Atlantic salmon, blueback herring, alewife, shortnose sturgeon, Atlantic sturgeon, sea lamprey, American eel, hickory shad, gizzard shad, striped bass and white perch. Surveys in the early 2000s were never able to confirm the presence of rainbow smelt which are believed to be extirpated, along with the Atlantic sturgeon. Occurrences of Atlantic sturgeon have been determined by CTDEEP as visitors from other coastal river populations such as the Hudson and Delaware rivers. In 2012, the Atlantic sturgeon was listed as a federally Endangered Species by NOAA Fisheries, with the Hudson River population identified as the closest Distinct Population Segment to the Connecticut River.

Appendix B. History of the Anadromous Fish Program

Native diadromous fishes (diadromy includes anadomous and catadromous fishes, with 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 or inherent range 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. No fishery management or scientific information exists that provides a technical description of the pre-colonial salmon population because extirpation predated the development of fishery science. However, historical accounts of the region are filled with references to large salmon runs and significant use of this species and other diadromous fish runs by the native people and early European settlers. As colonization by Europeans and the development of water power sites expanded throughout the basin, anadromous fish population notably declined. The major cause of the decline was the construction of dams that blocked salmon as well as

American shad, and blueback herring migrations to upstream spawning habitat (Figure 1). The first dam across the main stem Connecticut River was constructed in 1798 near the present site of Turners Falls, MA. It blocked the access of salmon to the remaining spawning habitat in the northern portion of the river and the species disappeared from the basin in the early 1800s, after years of unregulated harvest in the lower river and the loss of spawning runs in lower basin tributaries.

An interagency state/federal program to restore salmon to the Connecticut River based on the stocking of fry hatched from eggs taken from Penobscot River salmon was initiated in the 1860s. 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 American shad culture and stocking efforts to enhance reduced runs, operated by the fish culture pioneer Seth Green.

Although interest continued in restoring salmon in the basin, no action was taken for many decades due to the lack of funds and effective fish passage technology. The condition of the river environment continued to deteriorate in response to widespread pollution and dam construction. 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 all these events set the stage for anadromous species restoration. In 1967 the four basin states, USFWS, and NMFS 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 first adult salmon return from these smolt releases was documented in 1974.

Penobscot River salmon eggs became available later to the program and were used to stock the river starting in 1976. As a result of this release, 90 adult salmon returned to the river in 1978. Early in the program, the management emphasis was placed on stocking smolts. The USFS joined the effort in 1979 because of the impact of the agency's land-based holdings on salmon habitat in the northern watershed. Shortly thereafter, the USFWS built a large, modern salmon hatchery in Bethel, VT, and CTDEEP and MAFW converted trout hatcheries for salmon production. In 1983 smolt production shifted from a two-year to a one-year rearing regime in an effort to increase the quantity and quality of smolts. Early experimental stockings of salmon fry into nursery habitat showed the potential for natural, instream rearing of natural, high-quality smolts (referred to as "stream-reared" smolts) which are comparable to wild smolts. Evidence from CTDEEP studies on the Farmington River indicated that stream-reared smolts produced from fry stocking yielded substantially greater adult return rates than hatchery-reared smolts (10 times greater). Production of stream-reared smolts was combined with smolts produced in hatcheries to increase smolt emigration from the river. A major effort was begun in 1987 to stock as many fry as were available into appropriate habitat in the basin. Adults produced from fry stocking will attempt to return to spawn to the tributary in which they were stocked. Use of fry also maximizes the opportunity for natural selection to occur in the juvenile freshwater phase, to allow development of heritable traits and characteristics.

Beginning in 1994, the Program utilized only "Connecticut River" fish, with no introductions of genetic material (e.g., eggs or milt) 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 of inbreeding and outbreeding depression.

Adult salmon returns per 10,000 stocked fry has 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 is 0.11 (refer to U.S. Atlantic Salmon Assessment Committee Report 25 – 2012 Activities (http://www.nefsc.noaa.gov/USASAC/Reports/). This latter period is when the program shifted to fry stocking as the primary restoration strategy, directly coinciding with this unexpected dramatic decline in fry return rates (due to marine survival rates decreases). This translates to a sustained reduction on the order of 1/6 of what had been observed for this rate (< 1994) even with the following issues yet to be resolved; no or minimal downstream fish passage measure in place for fry origin smolts, high sea fisheries operating, and the use of mixed genetic origin broodstock. Frustratingly, many of these issues had been addressed, to varying degrees, by the mid and late1990s, which were expected to improve return numbers. Important questions that remain at this time include what are the mechanisms driving this sustained depression in marine survival rates? Will marine conditions improve to those resulting in the adult return rates of the 1970s and 1980s? The questions remain at this time and monitoring and research programs have not identified a primary causal factor(s), with the focus now on the recovery of Maine's Atlantic salmon populations. Some data and studies have shown shifts in salmon marine prey species abundance and distributions, shifts in predator assemblages, and shifts in marine habitat area use. As more studies are published on the challenges presented by climate change as one driver, directly and indirectly, it is clear those populations on the extreme extents of ranges (such as Connecticut River Atlantic salmon) are at potentially greater risk of adverse impact. This situation subsequently led to a similar cessation of restoration efforts for Atlantic salmon in the Merrimack River in 2013 by the USFWS and the other member agencies in that basin.

Action to provide upstream fish passage on the Connecticut river had begun prior to the Anadromous Fish Act, when in 1955, a rudimentary fishlift was constructed at Holyoke Dam to pass American shad and river herring that relied on humans pushing them in wheeled buckets. At that time, and for approximately three decades after, the Enfield Dam remained a barrier under many flow conditions for migrating fishes, eventually disintegrating. The Holyoke Dam facility was expanded in 1975 and 1976 when a trap was built for salmon and other substantial modifications occurred, although not studied, upstream passage efficiency appeared to improve greatly with corresponding increases in annual counts (Figure 7). Other fishways built between 1974 and 1987 at major dams on the main stem river and certain tributaries allowed returning salmon, shad, herring, and sea lamprey access into portions of the basin targeted for restoration. Although most salmon were retained at the lowermost (first) dams, fishways were still constructed at upstream dams in order to pass American shad and other species. Major issues with several different fishways have been apparent relative to ineffectiveness at passing shad and herring. These issues have been dealt with on a case by case basis, often with limited success. However, with the Federal Energy Regulatory Commission's five main stem project relicensing underway, opportunities for improvements for fish passage are anticipated along with plans to address other problem sites in the near future (e.g., Rainbow Fishway on the Farmington River).

Upstream passage at Turners Falls Dam fishways 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 at that time. USFWS relied on best information (no specific studies available) at the time that suggested West Coast fish ladders on the Columbia were effective at passing American shad. This led to the adoption of these designs, downsized considerably from the Columbia River basin, for use on the main stem dams. The USFWS worked with the power companies in the design and construction, using the best information available to develop operating parameters for flow, velocities, and turbulence measures. Unfortunately, in the case of Turners Falls, modifications at Cabot Station ladder were determined necessary after only two years, and while those changes resulted in improved passage, it is still considered an ineffective ladder for shad.

Fish passage at dams upstream of Vernon Dam (Bellows Falls and Wilder dams) have been built specifically for salmon. Four fishways (Holyoke, West Springfield, Rainbow, and Leesville) were the primary trapping locations for sea-run adult salmon. As the number of salmon fry stocked in the basin increased during the late 1980s, concern grew for the deleterious effect of hydroelectric turbines on outmigrating smolts as well as juvenile and spent adult American shad. Stream-reared smolts were early on forced to either pass through turbines or spill at gates, at numerous hydroelectric generating stations as they emigrated downstream to the ocean. Efforts to provide downstream fish passage on both main stem and tributary projects were initiated in the 1980s. In 1990, memoranda 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 passage construction. Efforts to provide adequate fish (all diadromous species) passage conditions at these projects and throughout the basin are ongoing.

Due to relatively low adult salmon return numbers (Figure 7) since the mid-1990s, the approach to ensure the best scenario for genetic adaptations to develop and be passed on (through natural selection) necessitated the use of adult returns as a single spawning group. To maximize the opportunity for natural selection to act on both freshwater and marine life stages, fry stocking became the primary restoration strategy. That strategy required a number of eggs not attainable from limited sea-run returns alone, so the progeny of sea-run mating were raised to maturity in a hatchery, referred to as F1 domestic broodstock, which had provided the Program with the majority of eggs to approach target fry numbers on an annual basis (i.e. all F2 stocked fry have grandparents that were sea-run origin). Studies on released adults were conducted in the Westfield River in the 1990s, with some success and more issues that limited its effective use. In the end, adult return numbers could not support such an effort without "hatchery brood releases" being utilized too. Hatchery fish performance in this capacity was determined unacceptable as a large scale strategy. Had early Program adult return rates based on number of fry stocked been sustained into the 1990s and later, different restoration strategies would have been possible to consider, including tributary specific approaches to restoration.

The severe damage to the White River National Fish Hatchery (WRNFH) in fall of 2011, from a flood event, severely impacted the 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. Vermont and New Hampshire relied almost exclusively on this production to stock their state waters and the hatchery also supported the States of Massachusetts and Connecticut stocking and hatchery programs. 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. This announcement was made in public at the July 2012 Connecticut River Atlantic Salmon Commission meeting by the USFWS Northeast Regional Director. 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 goals and objectives. The goal of the program is to maintain Atlantic salmon in select watersheds, maintain existing genetics of the Connecticut River salmon, provide fish for their broodstock fishery program, and support educational programs such as the school egg/fry rearing program. Program objectives provide target numbers of eggs, fry, and broodstock to achieve goals.

Importantly the state and federal agencies continue to work in cooperation with our many partners to address pressing fishery management, protection, enhancement, and restoration matters (population and habitat) for many important ecological, recreational, and commercial benefits. The diversity of topics for necessary work include continuing efforts on many fronts to increase abundance levels and distributions as well as stock structure characteristics to support population resilience (e.g., diverse age structures and repeat spawners) for all native diadromous species to help secure their persistence and health. The CRASC and its predecessor, the Connecticut River Policy Committee, has provided a critical fishery leadership role from policy setting to project implementation, and continues to address the issues and opportunities for these fishery resources.

Appendix C. Administrative Report

Total Federal Aid Expenditures – FY2014

Utilities (Electric & Telephone)	$ 1,642.98
Equipment	$14,732.00
Supplies, Operations & Maintenance	$ 18.46
Sub-Total:	$16,393.44
USFWS Overhead:	$ 3,606.56
Grand Total:	$20,000.00

NHFG (48370550580)

Equipment	$ 4,098.36
USFWS Overhead:	$ 901.64
Total:	$ 5,000.00

MADFW (48370550591)

Utilities (Electric, Telephone & Propane)	$ 1,642.98
Equipment	$ 2,436.92
Supplies, Operations & Maintenance	18.46
USFWS Overhead:	$ 901.64
Total:	$ 5,000.00

VTFW (48370550570)

Equipment	$ 4,098.36
USFWS Overhead:	$ 901.64
Total:	$ 5,000.00

CTDEEP (48370550600)

Equipment	$ 4,098.36
USFWS Overhead:	$ 901.64
Total:	$ 5,000.00

Equipment expenditures using the state grants were used help to purchase a new four-stroke 115 h.p. outboard engine to re-power a 22ft electrofishing boat for expanded river herring restoration and assessment work, and to purchase a mobile radio telemetry receiver for use in expanded monitoring of planned FERC relicensing study radio tagged fish in 2015.