JOB 7: ALOSINE SURVEY

JOB 7: ALOSINE SURVEY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

JOB 7: ALOSINE SURVEY

GOAL

Goal: Monitor abundance and distribution of American shad and forage species in Connecticut's major rivers and nearshore waters.

OBJECTIVES

Provide:

1) Information characterizing adult American shad spawning populations: size composition, age structure, spawning history, and sex ratio.

2) Annual indices of relative abundance for juvenile shad and forage species.

STUDY PERIOD AND AREA

This report contains information on adult American shad monitoring and seine studies on juvenile American shad (*Alosa sapidissima*) and common nearshore species in 2020. Areas of the Connecticut River sampled, range from Holyoke, MA to Essex, CT. Time series data collected under previous funding sources are also included for comparative purposes.

INTRODUCTION

Annual spawning migrations of American shad in the Connecticut River have supported both recreational and commercial fisheries in the State of Connecticut, as well as recreational fisheries in upriver states, for generations. There are currently small commercial and recreational fisheries that occur in the Connecticut portion of the Connecticut River. The Connecticut River is the only river system in the state that allows shad harvest and requires annual licenses for both commercial and recreational fisheries. Sustainable fisheries for states have been managed since 2012 under the Atlantic States Marine Fisheries Commission (ASMFC) Amendment 3 to the coast wide Fishery Management Plan for American shad. Connecticut monitors 3 metrics on an annual basis to determine the overall sustainability of the shad stock. Sustainability metrics are: fish passage counts for adults, relative juvenile abundance, and adult escapement. The commercial fishery is managed through area, gear, seasonal restrictions, and rest days. The recreational fishery is managed through a daily bag limit of 10 fish (a combined aggregate of American and hickory shad).

Historically, American shad were one of Connecticut's top five most economically important commercial finfish species in terms of landings. The commercial fishery occurs in the main stem of the Connecticut River south of the Putnam Bridge in Glastonbury, CT. Commercial data are

collected from mandatory annual reporting of landings from commercial shad license holders. Landings information is compiled and used to estimate the maximum losses to the spawning stock from fishing. The recreational fishery predominantly occurs north of Hartford, CT at River Kilometer (RKM) 83 and south of the Holyoke Dam in Massachusetts (RKM 139). Information on the recreational fishery in CT was last collected by a roving creel survey conducted in 2010.

The Connecticut Department of Energy and Environmental Protection (CT DEEP) has conducted annual fisheries independent research studies on adult American shad in the CT River since 1974, to monitor annual changes in stock composition. Holyoke Gas and Electric (HGE) monitors fish passage, which includes adult American Shad passage, at the first main stem dam on the CT River in Holyoke, Massachusetts. The HGE staff compiles daily tallies of fish passed through the fish lift facility, samples periodically for size structure and sex ratio, and collects scale samples. CT DEEP processes and interprets scale samples collected by HGE staff to estimate age structure and spawning history (i.e. proportion of the run comprised of repeat spawners).

Juvenile shad are monitored by CT DEEP through an annual seine survey conducted since 1978. The seine survey provides an annual index of relative abundance for juvenile American shad, which is used to characterize year class strength and potential recruitment to the spawning run in future years.

METHODS

American shad adults

Fishery Dependent Data

Commercial fishermen are required by regulation to report daily landings and fishing effort for American shad annually to CT DEEP. Landings information was compiled and used to estimate the maximum losses to the spawning stock from fishing. Harvest was tallied by pounds of shad landed by sex.

Fishery Independent Data

Holyoke Lift

In a typical sampling year, scale samples from American shad are collected by Holyoke Gas & Electric (HGE) staff, at the Holyoke Dam Fish Lift, located at river kilometer 139, in Holyoke, MA. In 2020, all trapping and biological sampling of American shad was suspended to accommodate safety concerns and state and local restrictions related to the COVID-19 pandemic. Daily counts of American shad at the fish lift were still collected. Information on the number of fish lifted daily and the number of lift days (days the lift is in operation) at Holyoke were collected and obtained from the HGE staff. Because of the absence of biological sampling, the annual sex ratio could not be calculated for 2020.

In a typical year, adult shad collected at the Holyoke Lift are sexed, measured to fork length (mm), weighed (g), and 15-25 scales are removed. Scale samples collected are separated by sex and stratified into 1 cm length groups. All viable scale samples collected were cleaned with an ultrasonic cleaner, dried and mounted between 2 glass microscope slides.

Scales are magnified with a microscope using transmitted light, viewed through a Luminera camera, and displayed on a computer screen using Image Pro Premier Software. Digital photos are taken of each sample and cataloged. Image files of each scale sample are identified only by a sample number.

Age determinations were made with consensus of two or more readers on the displayed images by counting annuli and spawning scars according to the criteria of Cating (1953). When discrepancies between the two readers could not be resolved, the scales were examined by a third reader. Samples that were poor quality or did not have two or more viable scales were not aged. Shad were noted to be repeat spawners when the presence of spawning scar(s) at the periphery of the scale were identified. All annuli and spawning scars on scale images were digitally marked and stored as a line profile using Image Pro Premier Software.

Prior to 2015, Scale samples were processed by cleaning with an ultrasonic cleaner and pressed onto acetate using a roller press. The pressed scale images were read using a microfiche reader. When the new image analysis system was implemented, comparisons of scale ages were made using both the Microfiche and Image analysis equipment to ensure that the interpretation of scale ages remained consistent.

Juvenile Seine Survey

In a typical year, a single seine haul was conducted at seven fixed locations one day a week from mid-July through mid-October. Seine haul locations and techniques were identical to those used in past Connecticut River seine surveys. The sampling sites were previously chosen based on location, physical conditions, and accessibility (Crecco et al. 1981; Marcy 2004). The seven stations were sampled during daylight hours with an 18.3 m nylon bag seine (0.5 cm delta mesh) and 30.5 m lead ropes. The seine was fished with the aid of a boat to deploy it upstream and offshore to sweep down through the site. Using the lead ropes, the seine was towed in a downstream arc to the shore and hauled by hand in to shore. Clupeids (*Alosa sapidissima, A. aestivalis, A. pseudoharengus*, and *Brevoortia tyrannus*) were returned to the laboratory for measurement and identification. All fish species other than family clupeidae, were identified, quantified, or estimated and released. Invertebrate species are either counted or noted as present. In the laboratory, juvenile clupeids were identified to species by the criteria of Lippson and Moran (1974) and counted. For each sample, up to 40 randomly selected clupeids of each species were measured to total length (mm).

A relative abundance index for young of the year American shad was calculated as a geometric mean catch per unit effort. The geometric mean is the preferred method when reporting to ASMFC for annual compliance reports because it normalizes clustered data. See Job 5 (Gottschall et al. 2021) for methods used to calculate the geometric mean. Forage species are reported as percent occurrence.

RESULTS

Results collected during the funding timeframe of March 1, 2020 through February 28, 2021 are presented below. The field activities and sample collections in 2020 for the alosine project were

severely impacted by Covid-19. The CT DEEP's virus-mitigation policies required all project staff to work remotely throughout most of 2020. Limited field work with small crews in addition to restrictions on out of state travel occurred during much of the project segment.

Time series data presented includes past years when work was funded by other sources.

Commercial Fishery Landings

The Connecticut River American shad commercial fishery reported a total catch of 21,414 lbs in 2020 (Figure 7.1). Participation in the commercial American Shad fishery remains at low levels as 4 boats reported landings and 6 commercial shad licenses were sold in 2020. The number of shad boats fishing annually continues to remain low as few new participants enter the fishery. Commercial shad landings represent less than 2% of the total number of shad reported at the Holyoke fish lift in 2020.

Commercial shad catch reports were skewed towards females (84%), with males accounting for 16% of the reported landings (Table 7.1). Males are most likely underreported and less represented in the catch due to mesh size selectivity, or a combination of the two factors. Male shad are often discarded because they are less valuable to sell to markets.

Connecticut River Adult American Shad Age Structure

The shad sample collections at the Holyoke fish lift were suspended in 2020 because of Covid-19 restrictions. The Holyoke Fish Lift was operated in a limited capacity and installation of video recording software was used as a back-up and a supplement to manual counts. Starting on May 4th, early morning and late evening passage operations commenced once the shad run reached around 7,000 fish as a daily total.

The Holyoke Fish lift was open for fish passage from April 21 through June 30, 2020 except for closings during April 16 to April 20 due to high flows, April 25 to April 28 for repairs, and May 2-May 3 due to high flows and poor visibility.

The environmental conditions during the 2020 fish passage season were somewhat favorable for shad passage as temperatures surpassed 10°C in early May and remained above 10°C for the rest of the passage season. Consistent temperatures coupled with steady river flow (Figure 7.2), resulted in peak passage numbers during the week of May 18th. The single daily peak of shad passage was on May 21st when nearly 55,000 shad were lifted. Ninety-six percent of the American Shad totals occurred between May 4 and June 6. The highest numbers of passage occurred from May 18-May 24 and represented 58% of the total number of shad passed. The number of shad passed at Holyoke in 2020 (362,244) was the 16th highest value since 1975 (Figure 7.2). The number of American shad lifted upstream annually at the Holyoke Dam has been highly variable through the time series, however 2020 was above the long term mean of 311,764, with a reported confidence limit range of 273,506 to 350,023 (Normandeau 2021).

Because there were no samples collected in 2020, a summary of the 2019 biological samples is presented (Table 7.2). There were 1,1,02 American shad collected for scale samples, 0.5% of the annual fish passage count. Scale samples were collected over 47 dates from May 9 through June 20. Samples were collected during 98% of the days when shad passage occurred at the lift (Normandeau 2019). The 2019 shad run sex ratio was derived from information collected at the Holyoke fish lift which is located at River Kilometer 139, upstream of both the commercial and sport fisheries. The combined impact of these modest fisheries is likely not significant enough to affect the composition of the run. The 2019 weighted sex ratio of shad sampled at Holyoke was 36% male and 64% female. It is anticipated that scale sample collection will resume in 2021.

Length frequency of American shad collected at the Holyoke lift in 2019 ranged from 31.6 to 54.0 cm FL for male shad and 34.0 to 54.0 cm FL among female shad. The average size among males was 38.1 cm FL and among females was 44.8 cm FL.

The preliminary examination 2019 male population of spawning adult shad was produced from the 2012-2016 year classes. The largest percentage (45.5%) of male shad scales examined were from five-year-old fish, 38.9% were from four-year-old fish and 11.45% were 6 year old fish. Three and seven-year-old fish each represented 3.9 and 0.3 % of the population, respectively (Table 7.2).
The majority of female shad (57.9%) sampled in 2019 were five-year-old fish. Six-year-old fish contributed to 33.1% of the 2019 run and 8.7% were 4-year-old fish. Seven-year-old fish represented 0.29%. The examination of scale samples for incidence of overall repeat spawning has not yet been completed.

Juvenile Seine Survey
Due to Covid-19 travel and staffing restrictions, limited sampling occurred for juvenile alosines in the Connecticut River from August 12 through October 1, 2020. A total of 609 juvenile American shad were collected for the season (Table 7.3). The highest catch in 2020 was 533 shad collected at the Wilson site in late August, representing 88% of the total catch for the season (Table 7.3). In a typical year, the stations with the largest proportion of the season's catches are Holyoke and Wilson. Holyoke was not sampled because of an out-of-state travel ban out of state. Because of the limits on staff and vehicle travel, the Wilson site was sampled twice in August. Because of the lack of samples, the geometric mean CPUE for shad was not calculated for 2020. This is the first year in the 43 year time series that an index could not be calculated because of low sampling effort. Throughout the time series, the values of the annual index of juvenile abundance (geometric mean catch/haul) have varied without trend (Table 7.4).

In the 23 hauls completed in 2020, over 145,000 fish were collected representing 29 species or taxonomic groups (Table 7.5). To minimize mortality and to facilitate returning large catches of fish quickly to the water, some fish were identified only to the family or genus level (e.g. sunfish, catfish, killifish). Large catches of common species estimated with a visual count to minimize handling and processing time. In 2020, the five most abundant species or groups collected were menhaden, shiners, blueback herring, American Shad, and sunfish (Table 7.5).

Additional Activies:

Land Use Land Cover Change (LULCC) StoryMap of CT River Seine Survey Sites

The Marine GIS project in collaboration with staff from the Alosine Survey (Job 12), developed an ESRI Storymap that examined the physical changes of land surrounding the CT River seine survey sites within CT (1965-2016). The StoryMap was published on the CT DEEP website https://ctdeep.maps.arcgis.com/apps/MapJournal/index.html?appid=ecf0a13f2f804df881b7d150ec654747

Prior to the publication of the StoryMap, the observations of physical changes to the seine sites were observed, but not documented. Historical Aerial imagery available for CT sites was obtained and compared over the decades using a methodology created by the University of Connecticut Center for Land Use Education and Research. A description of the methodology is outlined in the StoryMap.

While it's difficult to draw definitive conclusions as to the impacts on the land cover change on juvenile shad habitat, there were noticeable trends in declines of deciduous forest, declines in land used for agricultural purposes, and increases in development which includes impervious land cover.

There have also been significant physical changes river itself, particularly with the increased growth of aquatic vegetation. Further investigation is needed to determine the impacts on shad habitat at the fixed locations of the seine sites.

Interstate fisheries management accomplishments

During this project segment the ASMFC benchmark coast wide stock assessment was completed and peer reviewed in May of 2020. The CT River portion of the American shad stock assessment included fishery dependent and independent time series data. The American shad stock assessment subcommittee accepted the use of commercial shad fishery landings, the CT River seine survey YOY index, the adult American Shad age structure data, and annual fish passage counts at the Holyoke Dam as part of the assessment analyses. The full details of the coast wide stock assessment are available on the ASMFC website www.asmfc.org/uploads/file/5f999ba1AmShadBenchmarkStockAssessment_PeerReviewReport_2020_web.pdf

As part of the ASMFC requirements for Amendment 3 of the American Shad Interstate Fishery Management Plan, a significant revision of the original 2013 shad habitat plan was submitted to the Management Board. Information provided included a habitat assessment, threats assessment, and description of the state's habitat restoration program. The final version of the 2021 American Shad Habitat Plan for CT is on the ASMFC website-CT_ShadHabitatPlan_2021.pdf (asmfc.org).

MODIFICATIONS
None.

REFERENCES

Cating, J.P. 1953. Determining the age of Atlantic shad from their scales. Fish Bull. U.S. 85(54):187-199.

Crecco, V., Savoy, T., Gunn, L. 1981. Population dynamics studies of American shad in the Connecticut River, 1981-1983. Final Report AFC-13. Connecticut Dept. Environ. Protect. 76p.

Gottschall, K., Ellis, D., and D. Pacileo. 2019. Marine Finfish Survey, Job 2. In: A Study of Marine Recreational Fisheries in Connecticut. Annual Progress Report, CT DEP/Fisheries Division, Old Lyme, CT.

Lippson, A.J., and R.L. Moran. 1974. Manual for the identification of early developmental stages of fishes of the Potomac River estuary. Maryland Dept. of Nat. Res. PPSP-MP-13. 282 p.

Marcy, B.C., Jr. 2004. Early life history studies of American shad in the lower Connecticut river and the effects of the Connecticut yankee plant. Pages 155-180 *in* P.M. Jacobson, D.A. Dixon, W.C. Leggett, B.C. Marcy, Jr., and R.R. Massengill, editors. The Connecticut River Ecological Study (1965-1973) revisited: ecology of the lower Connecticut River 1973-2003. American Fisheries Society, Monograph 9, Bethesda, Maryland.

Pacileo, D. and J. Roberts. 2021. Marine Fisheries GIS, Job 4. In: A Study of Marine Recreational Fisheries in Connecticut. Annual Progress Report, CT DEEP Fisheries Division, Old Lyme, CT.

Normandeau Associates. 2021. Monitoring Report: Upstream Fish Passage at HG&E's Holyoke Dam, Spring 2020. Ferc Project No. 2004. 97pp.

Table 7.1. Annual American shad commercial fishery harvest. Landings are reported by weight (lbs.) and by sex, 2009-2020.

Year	Total (lbs)	Male Wt (lbs)	Female Wt (lbs)
2009	40,680	4,045	32,187
2010	24,641	2,994	21,192
2011	32,805	3,354	29,451
2012	61,975	10,187	51,788
2013	63,324	10,406	52,918
2014	62,707	7,789	54,918
2015	52,713	6,661	46,052
2016	33,998	3,081	30,917
2017	42,191	6,589	35,602
2018	19,939	1,606	18,334
2019	5,496	426	5,070
2020	21,414	3,411	18,004

Table 7.2. Fishery independent spawning history and age distribution of American shad in the Connecticut River at the Holyoke Lift, 2019.

2019 American Shad Age Structure at the Holyoke Lift						
Age	**3**	**4**	**5**	**6**	**7**	**Total**
%Bucks	3.92%	38.86%	45.48%	11.45%	0.30%	
Shad (n)	8,157	80,943	94,748	23,844	627	208,319
		4	**5**	**6**	**7**	
%Roes		8.65%	57.93%	33.14%	0.29%	
Shad (n)		9,168	61,424	35,144	306	106,042
	3	**4**	**5**	**6**	**7**	
% All	1.91%	23.42%	51.84%	22.53%	0.29%	
Shad (n)	6,019	73,613	162,968	70,835	926	314,361

Table 7.3 Catch and effort of juvenile American shad from the 2020 CT River seine survey.

Date	HOLYOKE	ENFIELD	WILSON	GLASTONBURY	SALMON RIVER	DEEP RIVER	ESSEX	Catch	Effort
7/15/2020									0
7/22/2020									0
7/29/2020									0
8/5/2020									0
8/12/2020					2	0	0	2	3
8/20/2020			46		14	0	0	60	4
8/27/2020			533		6	0	0	539	4
9/3/2020					2	0	0	2	3
9/10/2020					0	2	0	2	3
9/17/2020									0
9/24/2020					2	0	0	2	3
10/1/2020					2	0	0	2	3
10/8/2020									0
10/15/2020									0
Total			579		28	2	0	609	23

Table 7.4 Geometric mean relative abundance index (CPUE) of juvenile American shad(ASD), 1978-2019.

Year	Juv ASD	Year	Juv ASD
1978	5.89	2000	4.42
1979	7.84	2001	2.73
1980	9.21	2002	5.55
1981	6.05	2003	6.88
1982	1.81	2004	5.62
1983	4.99	2005	10.08
1984	3.37	2006	1.82
1985	7.14	2007	8.15
1986	6.29	2008	5.06
1987	9.89	2009	3.40
1988	5.68	2010	10.23
1989	4.85	2011	3.08
1990	10.39	2012	3.03
1991	4.26	2013	3.16
1992	7.55	2014	8.09
1993	9.49	2015	8.53
1994	12.22	2016	16.70
1995	1.34	2017	5.00
1996	6.50	2018	22.76
1997	7.15	2019	4.52
1998	3.65		
1999	5.47		

Table 7.5. List of fish species or group and percent frequency of occurrence of fish collected in Connecticut River seine survey, 2020.
**includes more than one species*

Species or Group	% abundance	Species or Group	% abundance
Alewife	0.01	Menhaden	88.82
American Eel	0.02	Northern Pike	<0.01
American Shad	0.42	Chain Pickerel	0.02
Atlantic Needlefish	<0.01	Pipefish	<0.01
Atlantic Silverside	0.21	Rock Bass	<0.01
Bay Anchovy	<0.01	Smallmouth Bass	<0.01
Black Crappie	0.02	Shiner*	5.46
Blue Crab	0.02	Stickleback*	<0.01
Blueback Herring	3.16	Sunfish*	0.39
Bluefish	0.15	Tessellated Darter	0.03
Carp	0.04	White Sucker	0.01
Catfish*	0.05	Yellow Perch	0.02
Crayfish	0.04		
Crevalle Jack	<0.01		
Golden Shiner	0.05		
Hogchoker	<0.01		
Killifish & Mummichog*	1.03		
Largemouth Bass	0.03		

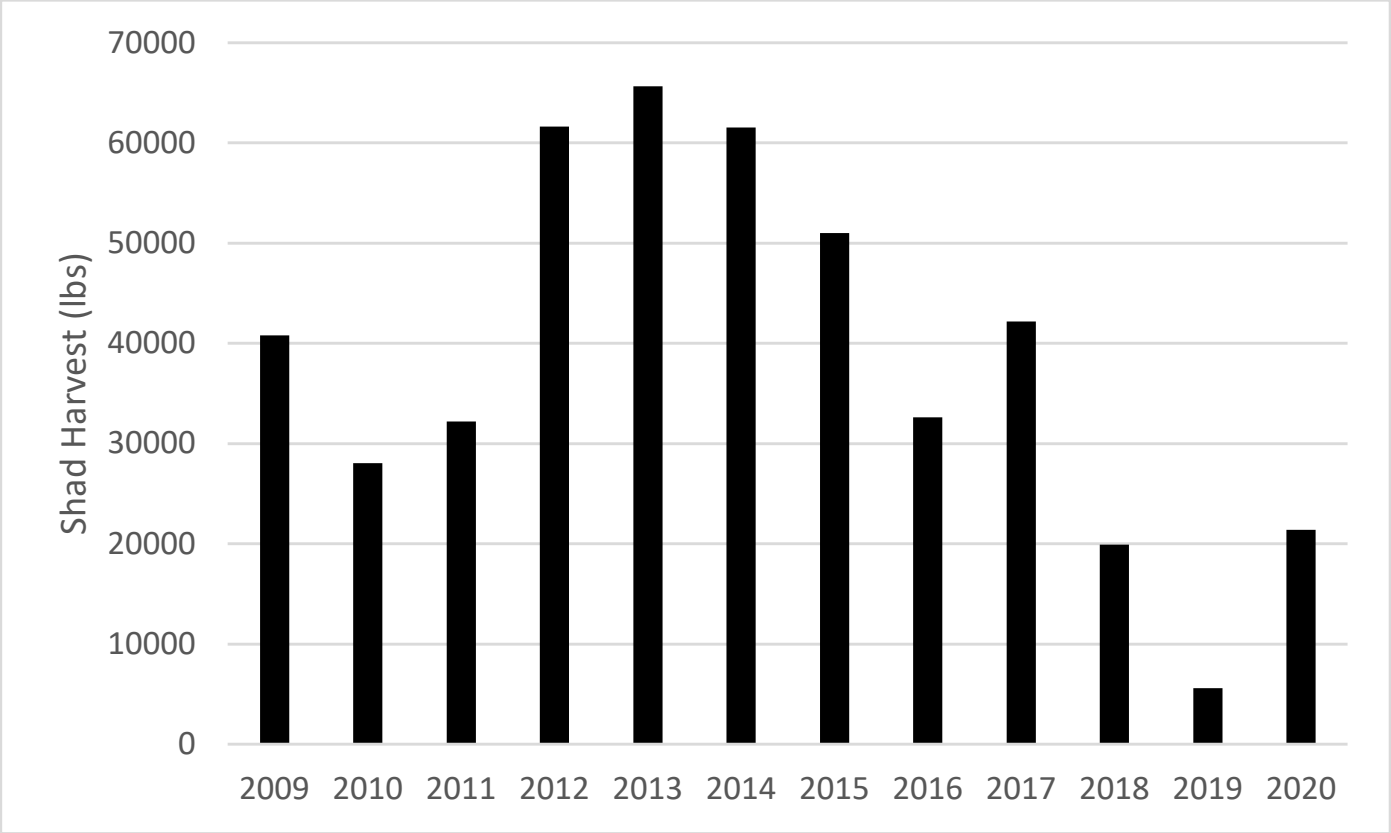

Figure 7.1. Commercial Landings (lbs) for CT River adult American shad, 2009-2020.

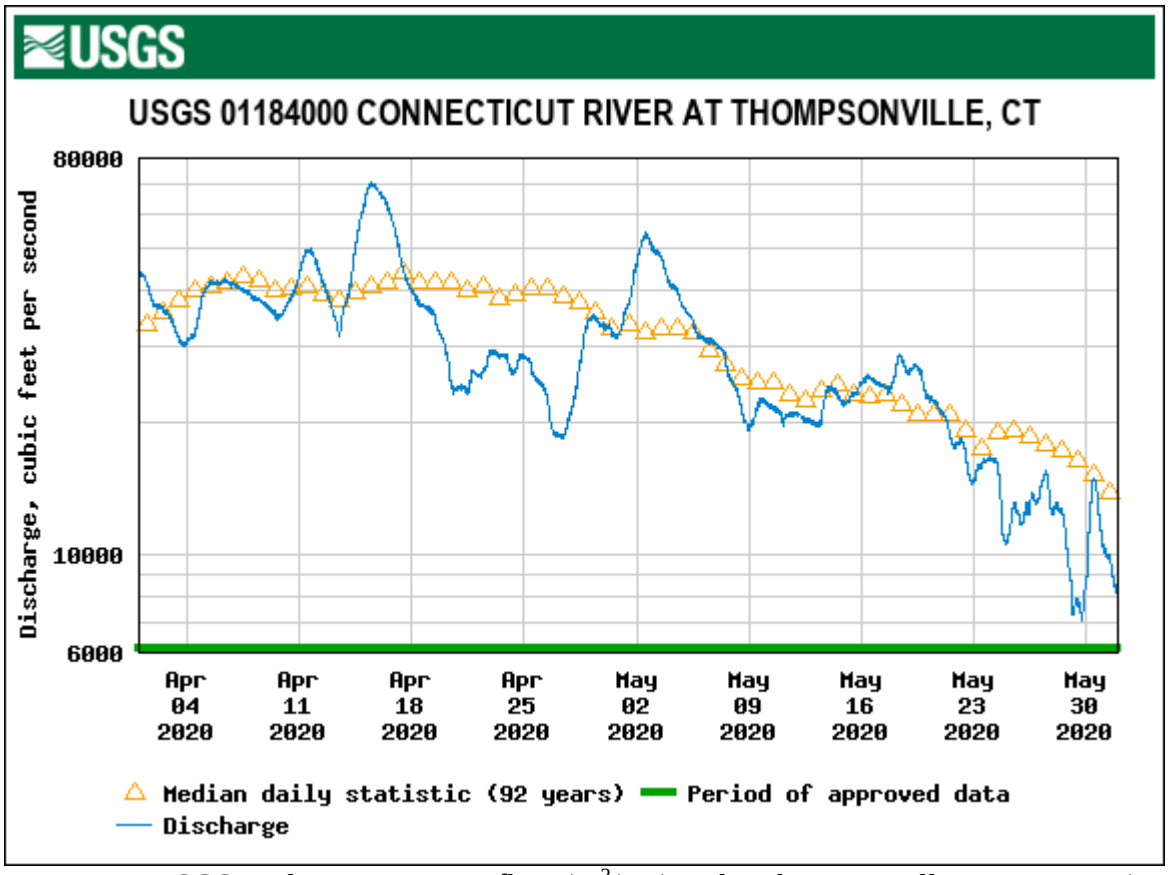

Figure 7.2 USGS Daily average river flow (Ft^3/sec) at the Thompsonville gage station (RKM 110) compared to median flows, during 2020 American Shad passage.

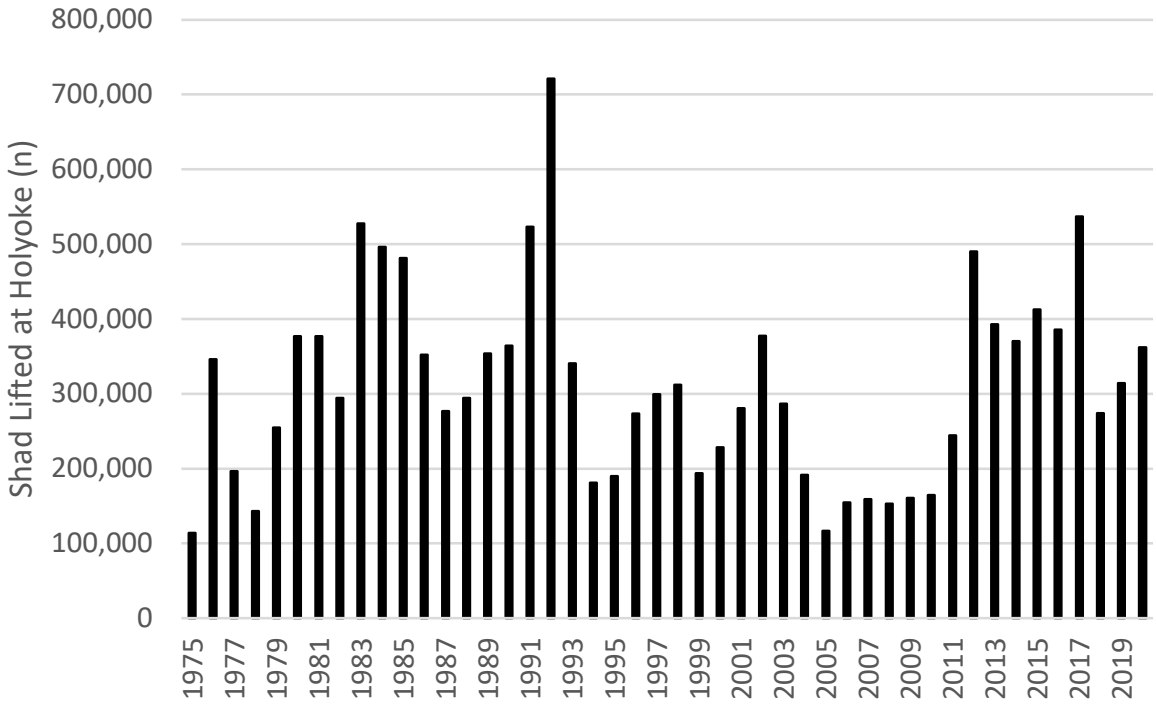

Figure 7.3 Number of adult American Shad lifted at the Connecticut River Holyoke Dam (RKM 139), 1975-2020

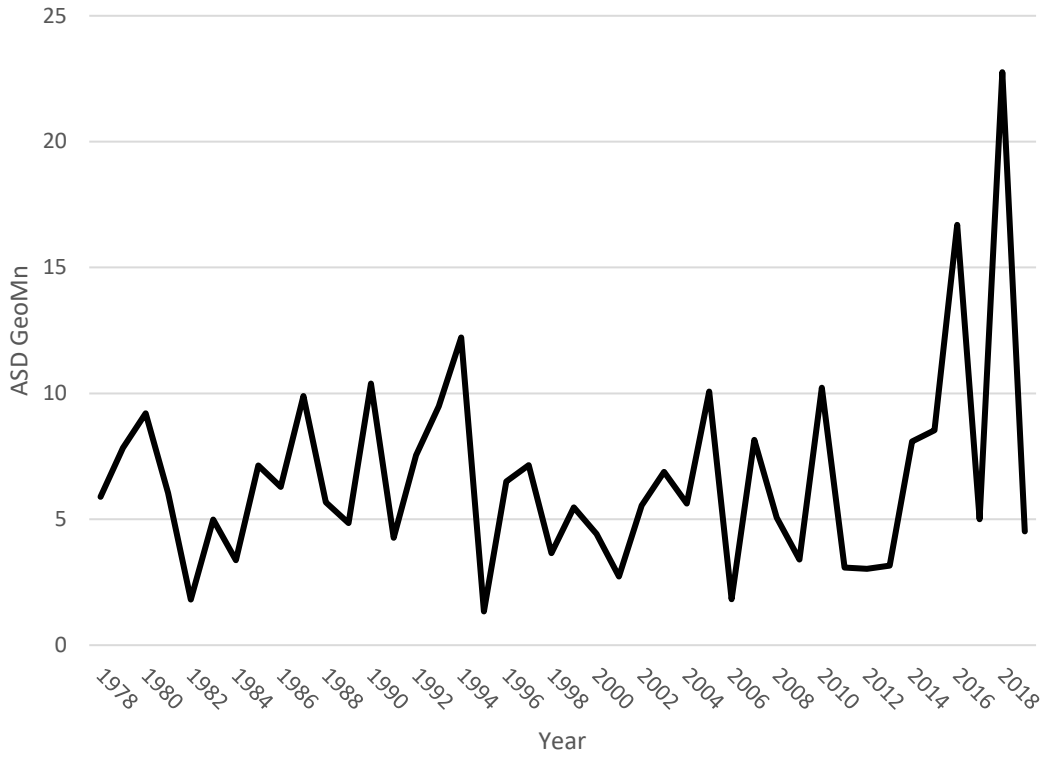

Figure 7.4 Annual geometric mean catch per unit effort of Connecticut River juvenile American shad by station,1978-2019. Index could not be calculated in 2020 due to low sample size.

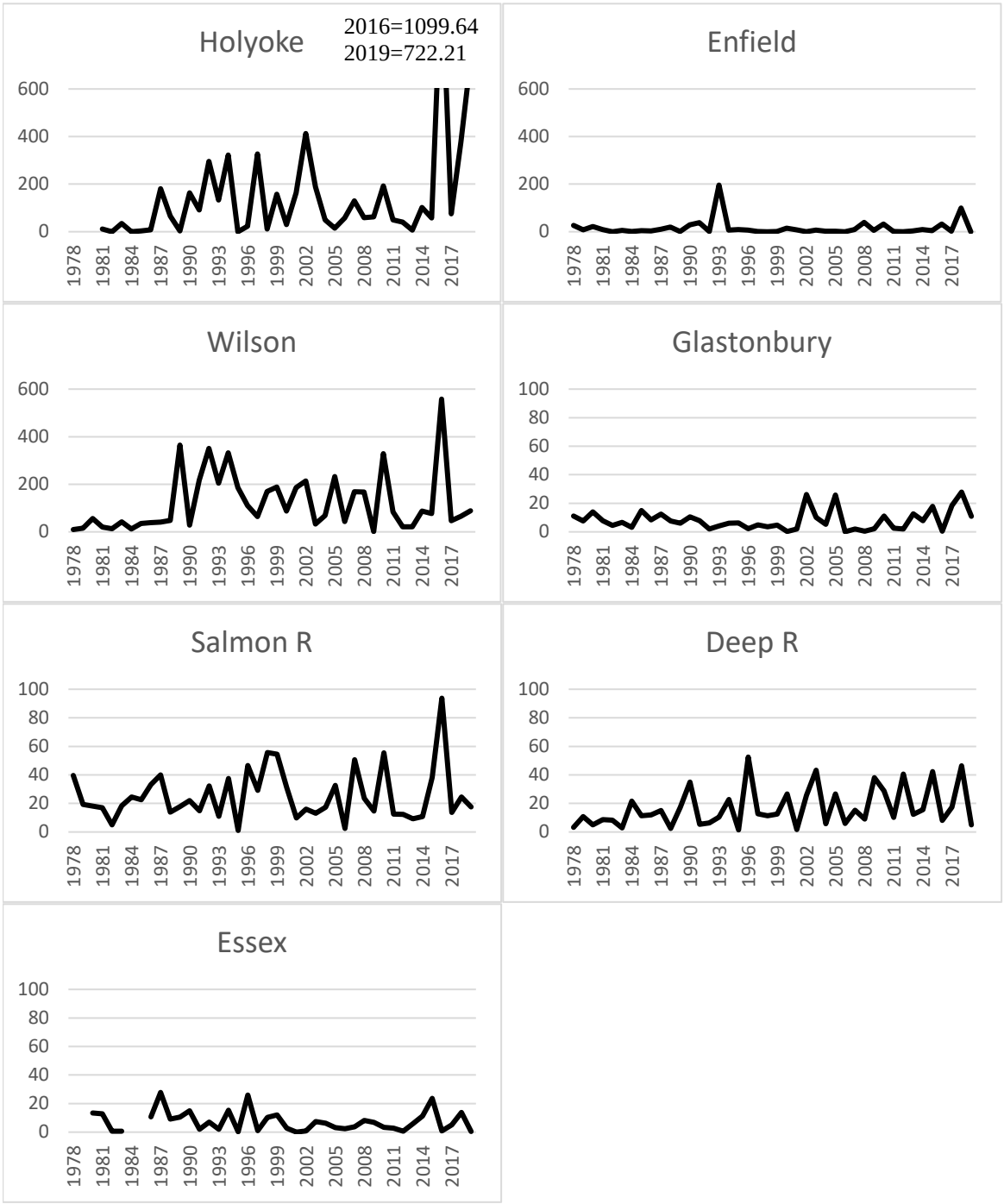

Figure 7.5. Annual CPUE of Connecticut River juvenile American shad by station, 1978-2019. Upper river sites (Holyoke, Enfield Wilson) have a Y axis max of 600 and lower river sites (Glastonbury, Salmon R, Deep R, Essex) have a Y axis max value of 100. Values were not calculated in 2020 due to low sample sizes.