JOB 3: INSHORE SURVEY

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JOB 3: AMERICAN SHAD MONITORING AND INSHORE SEINE SURVEYS

STUDY PERIOD AND AREA

This report contains information on adult American shad monitoring and seine studies on juvenile American shad, blueback herring, menhaden and common nearshore marine species in 2012. Areas of the Connecticut River sampled range from Holyoke, MA to Essex, CT. The Thames River seine survey begins just south of Norwich Harbor and ends in Uncasville, CT. Time series data collected under a separate funding source are also included.

GOAL

To monitor relative abundance and distribution of American shad and other fish in Connecticut's nearshore waters.

OBJECTIVES

Provide:
1) Information on the adult American shad spawning population: commercial catch, age structure, sex ratio and size.
2) Annual indices of relative abundance for juvenile shad, blueback herring and common nearshore marine species.

INTRODUCTION

Annual spawning migrations of American shad (*Alosa sapidissima*) 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 is currently a commercial driftnet fishery that occurs in the lower CT River. Connecticut requires an annual commercial shad license for the Connecticut River. The fishery is managed through area, gear, and season restriction as well as rest days. The Connecticut River is the state's only occurrence of a commercial shad fishery. American shad were once 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. The recreational fishery occurs north of Hartford, Connecticut (RKM 83) and south of the Holyoke Dam in Massachusetts (RKM 139).

The Connecticut Department of Energy and Environmental Protection (CT DEEP) has conducted annual research studies on adult American shad in the Connecticut River since 1974, to monitor annual changes in stock composition. Data is collected from mandatory annual reporting of commercial landings. Landings information is compiled and used to estimate the maximum losses to the spawning stock from fishing. The Massachusetts Division of Fish and Wildlife monitors fish passage which includes adult American shad passage at the first main stem dam on the Connecticut River in Holyoke, Massachusetts. Data on the recreational fisheries are monitored periodically by a roving creel survey. Juvenile shad are monitored by CT DEEP

through an annual seine survey conducted since 1978. Sampling was expanded to the Thames River system after 1996 to monitor the effect of the operation of the Greenville Dam fish lift on anadromous fish restoration. The fish lift was constructed to aid in the enhancement of American shad and river herring in the system. CT DEEP initiated the seine survey in the Thames River to estimate juvenile production of shad and blueback herring. Sites were chosen based on previous work conducted by the department. The survey has documented few juvenile shad and river herring, but has been continued to monitor catches of forage fish and juvenile fish of recreationally important species such as menhaden, tautog, winter flounder and bluefish.

METHODS

American shad adults

Commercial fishermen are required by regulation to report daily landings and fishing effort for American shad. Landings information was compiled and used to estimate the maximum losses to the spawning stock from fishing. Once reports were received, the harvest was tallied by pounds and number of shad landed by sex. This information is collected from the commercial fishermen who submit their logbook catch data annually to CT DEEP.

The adult American shad age structure and sex ratio were calculated from samples collected at the Holyoke Dam Fish lift, located at river kilometer 140, in Holyoke, MA. Information on the number of fish lifted daily, the number of lift days (days the lift is in operation) and the daily sex ratio at Holyoke were obtained from the Massachusetts Division of Fisheries. The annual sex ratio was calculated by weighting the daily sex ratios by the number of fish lifted daily. A daily subset of fish lifted are sampled for scales

To estimate the age structure of the fishery, CT DEEP staff collected biological samples with drift gill nets with a mesh size similar to the commercial fishery and in a similar fashion to that used by commercial operators to assist in characterizing the fishery. Gill nets were fished during daylight hours to avoid interfering with commercial efforts; research nets were shorter in length and drift times were shorter than those employed by commercial netters. Fifty one scale samples were collected. Future drift net collection efforts will continue to be minimal since development of a sustainability plan as mandated by Amendment 3 to the Atlantic States Marine Fisheries Commission (ASMFC) American Shad Fishery Management Plan. Amendment 3 calls for system specific Sustainable Fishery Plans. The Sustainable Fishery Plan for the Connecticut River utilizes juvenile recruitment, Holyoke lift numbers (as a proxy for run size) and total commercial harvest to monitor stock health. Age composition from gillnet collections continues at a smaller scale to serve coast-wide stock assessment needs.

Age structure was derived from scale samples collected at the Holyoke Fish lift in Holyoke, MA to characterize the population independent of the commercial fishery. Adult shad were sexed, measured to fork length (mm) and 15-25 scales removed. All scale samples collected were separated by sex and stratified into 1 cm length groups. Scale samples were processed by cleaning with an ultrasonic cleaner and pressed onto acetate for aging. Age determinations were made as the consensus of two or more readers of projected images (43x) counting annuli and spawning scars according to the criteria of Cating (1953). Repeat spawners were noted by the

presence of spawning scar(s) at the periphery of the scale. The age and repeat spawning frequency were extrapolated to the annual lift count by direct proportion.

Juvenile Surveys:
Connecticut River Seine Survey

A single seine haul was conducted at seven fixed locations one day a week from July 11th through October 10th, 2012. 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 (Marcy 2004, Crecco et. al. 1981, Savoy and Shake 1993). 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 beached. All fish species other than family clupeidae, (American shad, blueback herring, alewife and menhaden) were identified, quantified or estimated and released. Invertebrate species are either counted or noted as presence/absence.

Thames River Seine Survey

Eight fixed stations were sampled twice a month from July 12th through September 6th. The method of seine deployment and gear used in the Thames River was identical to what is used for the Connecticut River seine survey.

For both surveys, clupeids (*Alosa sapidissima*, *A. aestivalis*, *A. pseudoharengus*, and *Brevoortia tyrannus*) were returned to the laboratory for measurement and identification. All other fish were identified, counted, subsampled as necessary, and returned to the water. 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 was calculated as a geometric mean catch per unit effort for both shad and blueback herring. Geometric mean is the preferred method when reporting to ASMFC for annual compliance reports. See job 2, part 1 methods section for calculating geometric mean (Gottschall 2009 Job 2.1).

RESULTS
Connecticut River Adult American shad

The Holyoke Fish lift was open for fish passage from April 4 through July 8, 2012 except for closings due to high water or operational factors. Total lift numbers of American shad at the Holyoke Dam were obtained from the Massachusetts Division of Fisheries and Wildlife.
The number of shad passed at Holyoke in 2012 (490,431), was the highest since 1992 (721,764) and was a little more than double the 2011 lift count (244,177) (Figure 3.3). The number of American shad lifted upstream annually at the Holyoke Dam has been highly variable through the time series but was well above the long term average of 297,183 with a range of 114,137 to

721,764 and a median of 281,542. The sex ratio of the 2012 shad run was derived from information collected at the Holyoke fish lift which is located at River kilometer 140, upstream of both the commercial and sport fisheries. The combined impact of these small fisheries is not thought to be significant enough to affect the composition of the run. The weighted sex ratio of shad sampled at Holyoke provided by Mass Wildlife was 62% for males and 38% females (Figure 3.5).

American shad scales were collected on 43 days over a 60 day span during lift operation. The shad age structure from scale samples was expanded based on the number of fish lifted at Holyoke Dam. Nine hundred eleven samples collected from shad at the Holyoke Dam fish lift were examined for age determination.

Length frequency of American shad collected at the Holyoke lift ranged from 33.0 to 47.5 cm for male shad and 36.0 to 50.0 cm FL among female shad. Length frequencies of both sexes were fairly normally distributed (Figure 3.5). Average size among males was 41.2 cm FL and among females was 45.1 cm FL.

The 2012 male population of spawning adult shad was produced from the 2005-2009 year classes. Forty two percent of male shad scales examined were from 4 year old fish. Forty three percent of male shad scales examined were from five year old fish. Six and seven year old fish were 12 and 0.2 percent of the population, respectively, while three year old males comprised on1y two percent of the age structure (Table 3.3).

The majority of female shad sampled in 2012 were from the 2007 year class. Fifty six percent of female scale samples examined were 5 year old fish. Four year old fish contributed twenty two percent to the annual run and twenty one percent were 6 year old fish. The incidence of overall repeat spawning remains low. The percentage of repeat spawners for males is 3.2% and 5.4% among females, with a combined repeat spawn rate of 4.1% (Table 3.3). The shad spawning population continues to rely on a few age classes and low rates of repeat spawners.

Landings/Commercial Fishery

Fourteen commercial shad licenses were sold in 2012 and eight boats reported landings. The number of licenses sold is comparable to recent years (Table 3.1, Figure 3.2). The number of shad boats fishing annually continues to remain low as few new participants enter the fishery.

The Connecticut River American shad commercial fishery took 61,623 fish in 2012, the highest landings since 2005 and double 2011 landings (32,183), consistent with the doubling in the Holyoke fish lift count this year (Figure 3.1). The fishery continues to have a small impact on the stock. The 2012 commercial harvest ranked fourteenth among 23 years since 1990. The catch is reported as pounds and was converted to numbers of fish by sex (Table 3.1).

CT DEEP scale samples representing the commercial fishery age structure ranged from 4 to 7 year olds among males and from age 4 to 7 year olds among females. Age frequencies were dominated by five year old fish for males with 62% of the males while five year old females

comprised 50% of female scales examined. Among males, 15% of the catch was 4 year olds and 23% were age six. Among females, 5% were four year olds and 37% were age five. The sex ratio of the samples collected was 75% females to 25% males indicative gillnets, which are of a size selective gear type more apt to collect larger shad, typically females (Figure 3.6).

Similar to CT DEEP fishing efforts, reported landings in mandatory Catch Reports were skewed towards females (84%), with males accounting for 16% of the landings (Table 3.1). Males are either underreported, less represented in the catch due to mesh size selectivity, or a combination of the two factors. Male shad are less valuable to sell to markets. Repeat spawning rates were not calculated due to low sample size.

Seine Survey

Juvenile collections in the Connecticut River were conducted from July 11th through October 10th, 2012. In the 88 hauls completed in 2012, nearly 29,000 fish representing 33 species or taxonomic groups were collected (Table 3.7). 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 were sometimes quantified with a visual estimate to minimize handling and processing time. Estimated catches are noted as such in the database. In 2012, the most abundant species collected were shiners (mixed species), blueback herring, *Fundulus spp.* and sunfish, followed by American shad ranking 5th highest in total catch. Spottail shiners, American shad, *Fundulus spp.* and sunfish also had a high frequency of occurrence in the catches (Table 3.7).

A total of 1,545 juvenile American shad were collected for the season (Table 3.4). The geometric mean catch of juvenile American shad from all stations and all dates was 3.03 (Figure 3.12). The geometric mean in 2012 was nearly the same as 2011 and ranks as the 5th lowest in the time series (Table 3.6). The annual index of juvenile abundance (geometric mean catch/haul) has varied without trend. The highest catch for 2012 was 220 shad collected at the Holyoke site in early September represented 46% of the total Holyoke catch for the season and 14% of the overall catch (Table 3.4). The station with the largest proportion of the seasons catch was in Deep River. Stations Holyoke and Deep River, combined, accounted for 68% of the total 2012 catch. Deep River having the highest proportion of the annual catch is somewhat of an unusual occurrence. Environmental conditions seemed to have had an effect on catches in the upper river in 2012. Daily discharge values as monitored by USGS, were well below median values for the sampling season (Figure 3.8). The water levels were very low at northern stations, while in the lower section of the river the tidal influence counteracts the effects of low discharge levels upstream.

Annual catches of American shad by station over time has been variable with Holyoke and Wilson typically being the sites with the largest annual catches of juvenile shad (Figure 3.11). The Enfield and Essex sites provided the lowest catches of the season. The Enfield station produced the highest number of zero catches and lowest catch of the season, 0 and 8, respectively.

A total of 6,249 blueback herring were collected in 2012 (Table 3.5). The geometric mean CPUE for blueback herring was lower than American shad. The ratio of blueback catches to shad has been widely variable through the time series. In more recent times, shad catches exceed blueback catches more often in the recent time series. Early in the time series, blueback catches far exceeded those of American shad. (Figure 3.9). The 2012 *Alosa spp.* CPUE indices were both well below average and the blueback CPUE is the 3rd lowest geometric mean in the time series. As with American shad, the Deep River station had the highest total catch for blueback herring, with 92% of the season's catch. A single catch early in the season at Deep River (2,620) was 42% of the season's total catch of 6,249 blueback herring (Figure 3.12)

Thames River Seine Survey

The 2012 Thames River survey was conducted bi-weekly from July 12th through September 6th with 40 seine hauls. Over 13,000 fish were collected representing 32 groups or species (Table 3.8). Atlantic silversides had the highest presence in the catch (100%), followed by *Fundulus spp*, bluefish and sticklebacks (Figure 3.8). Over the length of the time series, menhaden catches have had a wide variation ranging from less than 200 to over a million. The 2012 menhaden index ranked 7th lowest out of 15. The 2012 menhaden catch was 8,662, with a geometric mean cpue of 3.49. Juvenile menhaden catches have been variable with the lowest CPUE in 2010 (0.18) and a peak geometric mean cpue of 117.46 in 2002 (Table3.9). Other notable species caught were: Winter flounder (17), striped bass (14), Scup (53), snapper bluefish (498), and tautog (5).

Data Requests and Sample Collections

Data requests and sample requests are fulfilled for a number of different government and non-government organizations. Requests fulfilled in 2012 are listed in table 3.10.

Modifications

In 2013 the Thames River seine survey will be expanded both seasonally and spatially with sampling beginning in May, two sites being added further south in the river, and one site eliminated. The addition of more southern sites is to capture a more diverse assemblage of marine species.

Future adult American shad drift net collection efforts will be minimal due to development of a CT River specific Sustainability Fishery Plan, which uses the metrics of juvenile recruitment, Holyoke lift numbers (as a proxy for run size) and total commercial harvest to monitor stock health. This plan was developed as mandated by Amendment 3 to the ASMFC American Shad Fishery Management Plan. Age composition from gillnet collections continues at a smaller scale to serve coast-wide stock assessment needs.

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Table 3.1. Annual American shad commercial fishery harvest. Landings are reported by weight (lbs.) and counts, by sex, 1990-2012.

Year	Total lbs.	# Male	Male Wt (lbs.)	Mn Wt Male	# Female	Female Wt (lbs.)	Mn Wt Female	# of Boats	Total Trips
1990	259,425	8,568			21,142			20	402
1991	149,300	9,174			23,112			21	416
1992	144,300	7,171			26,768			16	410
1993	96,660	5,173			17,790			15	332
1994	104,000	1,812			19,400			16	312
1995	61,576	1,862	5,893	3.2	12,299	55,682	4.5	19	352
1996	66,757	2,298	6,941	3.0	13,660	59,816	4.4	13	264
1997	91,003	2,812	10,275	3.7	18,743	80,728	4.3	11	271
1998	89,342	2,983	9,440	3.2	18,529	79,902	4.3	12	280
1999	44,574	872	3,373	3.9	9,506	41,201	4.3	11	195
2000	107,416	2,342	7,491	3.2	21,228	99,925	4.7	11	210
2001	59,234	1,469	3,980	2.7	13,074	55,254	4.2	13	193
2002	108,099	7,153	22,555	3.2	20,653	85,544	4.1	11	248
2003	111,127	5,176	17,518	3.4	21,244	93,609	4.4	14	249
2004	66,328	2,456	8,000	3.3	13,436	58,328	4.3	14	226
2005	69,333	1,873	6,136	3.3	15,336	67,070	4.4	12	218
2006	38,547	1,864	5,445	2.9	7,372	33,102	4.5	12	185
2007	51,572	1,688	5,701	3.4	9,888	43,497	4.4	13	199
2008	28,419	858	2,637	3.1	6,486	25,782	4.0	10	203
2009	40,680	1156	4,045	3.5	6,437	32,187	5.0	13	182
2010	24,641	855	2,994	3.5	4,238	21,192	5.0	7	202
2011	32,183	953	3,334	3.5	5,772	28,849	5.0	8	218
2012	61,623	2,810	9,835	3.5	10,358	51,788	5.0	9	160

Table 3.2. American shad age distribution in the lower Connecticut River, 2012. Samples were collected by gill net to characterize the commercial fishery.

2012 Fishery Dependent Shad Age Structure					
	4	**5**	**6**	**7**	**Total**
Bucks	2	8	3		13
%	15.38	61.54	23.08		
Shad (n)	1,513	6,052	2,270		9,835
	4	**5**	**6**	**7**	**Total**
Roes	2	14	19	3	38
%	5.26	36.84	50.01	7.89	
Shad (n)	2,724	19,079	25,899	4,086	51,788
	4	**5**	**6**	**7**	
Combined	4	22	22	3	51
%	7.84	43.14	43.14	5.88	
Shad (n)	4,831	26,584	26,584	3,623	

Table 3.3. Fishery independent spawning history and age distribution of American shad in the upper Connecticut River, 2012

2012 American Shad Age Structure							
	3	**4**	**5**	**6**	**7**	**Total**	**% Repeat Spawn**
Bucks	13	234	241	67	1	556	3.24
%	2.34	42.09	43.35	12.05	0.18		
Shad (n)	7,137	128,460	132,303	36,781	549	305,229	
		4	**5**	**6**	**7**	**Total**	**% Repeat Spawn**
Roes		77	195	73	2	347	5.48
%		22.19	56.20	21.04	0.58		
Shad (n)		42,061	106,517	39,876	1,092	189,546	
	3	**4**	**5**	**6**	**7**		**% Repeat Spawn**
Combined	13	311	436	140	3		4.10
%	1.44	34.44	48.28	15.50	0.33		
Shad (n)	7,123	170,405	238,895	76,709	1,644	494,776	

Table 3.4. Catch (C), effort (E) and catch per effort (C/E) of juvenile American shad from the 2012 CT River seine survey.

Date	Holyoke	Enfield	Wilson	Glastonbury	Salmon River	Deep River	Essex	Catch	Effort
7/11/2012	0	0	0	2	9	0	2	13	7
7/18/2012	1	0	0	8	1	0	4	14	7
7/25/2012	19	0	0	3	5	13	0	40	7
8/1/2012	0	0	0	0	0	59	0	59	7
8/8/2012	0	0	0	0	7	108	0	115	7
8/15/2012			73	0	13	0	2	88	5
8/22/2012	72	0	12	0	5	81	0	170	7
8/29/2012	103	0	127	0	48	33	0	311	7
9/5/2012	220	0	10	0	10	22	0	262	7
9/12/2012	0		0	0	6	6	0	12	6
9/19/2012					0	90	0	90	3
9/26/2012	67		42	14	16	140	0	279	6
10/4/2012	0		7	0	21	6	0	34	6
10/10/2012	0		4	0	43	11	0	58	6
Total	482	0	275	27	184	569	8	1545	88

Table 3.5. Catch (C), effort (E) and catch per effort (C/E) of juvenile blueback herring from the 2012 CT River seine survey.

Date	Holyoke	Enfield	Wilson	Glastonbury	Salmon River	Deep River	Essex	Catch	Effort
7/11/2012	0	0	0	3	17	936	53	1009	7
7/18/2012	0	3	0	8	24	2620	8	2663	7
7/25/2012	0	0	0	9	115	404	0	528	7
8/1/2012	0	0	0	0	24	407	0	431	7
8/8/2012	0	0	0	0	4	409	0	413	7
8/15/2012			0	0	0	0	2	2	5
8/22/2012	0	0	0	0	0	108	0	108	7
8/29/2012	0	0	0	0	1	0	0	1	7
9/5/2012	0	0	6	0	0	12	0	18	7
9/12/2012	0		0	0	0	1	2	3	6
9/19/2012					0	418	0	418	3
9/26/2012	0		0	1	0	420	4	425	6
10/4/2012	0		0	0	0	0	5	5	6
10/10/2012	0		0	103	110	12	0	225	6
Total	0	3	6	124	295	5747	74	6249	88

Table 3.6. Geometric mean relative abundance index (CPUE) of juvenile American Shad and blueback herring,1978-2012.

Year	Juv Shad	Juv BBH
1978	5.89	
1979	7.84	24.8
1980	9.21	26.75
1981	6.05	11.49
1982	1.81	6.09
1983	4.99	16.47
1984	3.37	11.57
1985	7.14	18.23
1986	6.29	13.61
1987	9.89	21.58
1988	5.68	17.04
1989	4.85	7.52
1990	10.39	14.41
1991	3.92	11.36
1992	7.21	9.87
1993	9.49	14.43
1994	12.22	13.92
1995	1.34	5.03
1996	6.5	5.91
1997	6.75	9.66
1998	3.65	4.39
1999	5.47	5.57
2000	4.42	4.17
2001	2.73	3.83
2002	5.55	3.95
2003	6.88	5.88
2004	5.62	2.36
2005	10.08	4.1
2006	1.82	3.5
2007	8.15	6.61
2008	5.06	2.2
2009	3.4	1.77
2010	10.23	12.82
2011	3.08	2.93
2012	3.03	2.22

Table 3.7. List of fish species or group and percent frequency of occurrence of fish collected in Connecticut River seine survey, 2008-2012. **includes more than one species*

Species	2008	2009	2010	2011	2012
alewife	6.98	9.28	7.77	12.05	14.77
American eel	13.95	19.59	17.48	8.43	18.18
American shad	61.63	60.82	72.82	63.86	48.86
Atlantic Needlefish					3.41
Atlantic silverside	3.49	5.15	14.56	2.41	12.50
bay anchovy	2.33	2.06	0.97	4.82	10.23
black crappie	13.95	6.19	20.39	20.48	21.59
blue crab		7.22	17.48	6.02	12.50
blueback herring	46.51	36.08	60.19	45.78	36.36
bluefish	1.16	6.19	11.65	6.02	12.50
carp	4.65	5.15	19.42	12.05	15.91
catfish*	16.28	11.34	27.18	10.84	15.91
crevalle jack			3.88		
fallfish	4.65	3.09	3.88	2.41	3.41
gizzard shad			4.85		1.14
goby		1.03			
golden shiner	15.12	12.37	28.16	15.66	19.32
hickory shad	4.65	3.09			
hogchoker	2.33	8.25	15.53	18.07	18.18
killifish & mummichog*	43.02	27.84	37.86	55.42	42.05
largemouth bass	26.74	18.56	25.24	19.28	26.14
menhaden	3.49	11.34	13.59	4.82	18.18
northern kingfish			0.97		
northern pike	13.95	5.15	1.94	9.64	5.68
chain pickerel	1.16		0.97	4.82	3.41
pipefish			4.85	1.20	2.27
rock bass	19.77	5.15	25.24	13.25	10.23
smallmouth bass	39.53	14.43	20.39	30.12	22.73
spottail shiner*	73.26	59.79	64.08	65.06	55.68
stickleback*	4.65	5.15	13.59	1.20	1.14
striped bass			2.91	2.41	1.14
summer flounder	1.16				1.14
sunfish*	52.33	38.14	59.22	53.01	57.95
tessellated darter	33.72	26.8	31.07	30.12	39.77
white perch	22.09	7.22	18.45	16.87	10.23
white sucker	11.63	12.37	27.18	12.05	9.09
winter flounder			0.97		
yellow perch	47.67	29.9	44.66	50.60	35.23

Table 3.8. List of fish species or group and percent frequency of occurrence of fish collected in Thames River seine survey, 2005-2012. **includes more than one species.*

Species	2005	2006	2007	2008	2009	2010	2011	2012
alewife	6.67	1.56	17.86	1.59	8.06	1.77	5.36	7.5
American eel		6.25		1.59	4.84	0.71	1.79	2.5
American shad			5.36		6.45		1.79	5.0
Atlantic herring					3.23			
Atlantic needlefish	6.67	1.56						
Atlantic silverside	80		82.14	74.6	80.65	21.63	98.21	100
bay anchovy		10.94	7.14	14.29	9.68	3.55	10.71	27.5
blueback herring			1.79	1.59	1.61	0.35		2.5
bluefish	60	45.31	44.64	31.75	46.77	15.25	41.07	85
brown trout							1.79	
butterfish	3.33			1.59	4.84	1.06	1.79	
carp		1.56	1.79			0.35		
catfish*				1.59				
crevalle jack	23.33	12.5	5.36	1.59	11.29	3.55		
cunner					1.61			5
darter				1.59			1.79	
gizzard shad								2.5
golden shiner							1.79	
hogchoker							17.86	7.5
horseshoe crab	3.33							
killifish & mummichog*	43.33	25	32.14	42.86	20.97	6.03	69.64	52.5
largemouth bass		1.56						
lizardfish		6.25	5.36					2.5
menhaden	20	35.94	42.86	12.7	22.58	2.13	17.86	50
naked goby		3.13	8.93	9.52		1.77	16.07	15.0
northern kingfish	3.33						7.14	10
northern pike	3.33						3.57	
oyster toadfish						0.35		
pipefish	13.33	15.63	26.79	11.11	9.68	1.42		20
scup	6.67		14.29					20
sheepshead minnow	3.33		3.57	3.17			1.79	
spot			1.79	1.59				10
spottail shiner	6.67	9.38	3.57	6.35	3.23	1.06	7.14	5
stickleback*	16.67	12.5	5.36	36.51	32.26	2.13	42.86	5
striped bass	3.33	6.25	21.43	11.11	8.06	1.77	7.14	17.5
striped sea robin			3.57					2.5
summer flounder		4.69	5.36	15.87	4.84	0.35	3.57	
sunfish*		1.56					7.14	
tautog	20	6.25	21.43	12.7	1.61	1.77	3.57	12.5
tomcod			3.57	4.76	3.23	0.35	1.79	2.5
white mullet		4.69		3.17	1.61	3.9	1.79	7.5
white perch	13.33	3.13	8.93	1.59	1.61	0.35	1.79	
windowpane flounder			7.14				1.79	
winter flounder	23.33	10.94	37.5	26.98	9.68	1.77	3.57	20

Table 3.9. Number collected, number of seine hauls and geometric mean catch per haul of Thames River juvenile menhaden, 1998-2012.

Year	Menhaden	Seine Hauls	G Mn
1998	429,209	151	12.63
1999	594,724	144	20.61
2000	1,020,000	112	50.25
2001	5,458	119	2.13
2002	840,458	55	117.46
2003	248,984	80	12.78
2004	30,274	56	3.91
2005	3,118	30	1.19
2006	129,719	64	6.08
2007	100,082	56	6.39
2008	195	63	0.37
2009	39,909	62	2.11
2010	212	64	0.18
2011	418	56	0.58
2012	8,662	40	3.49

Table 3.10. Data and sample requests for 2011.

Organization	**Type of Request**
Dominion Millstone Power Station	Data
KleinSchmidt	Data
LISTS	Sample
Massachussetts Division of Fisheries and Wildlife	Data
NMFS SEFSC	Data
Normandeau Environmental Consultants	Data
Old Dominion University	Sample
U.S. Fish and Wildlife Service	Data
Wilmerhale Law Firm	Data

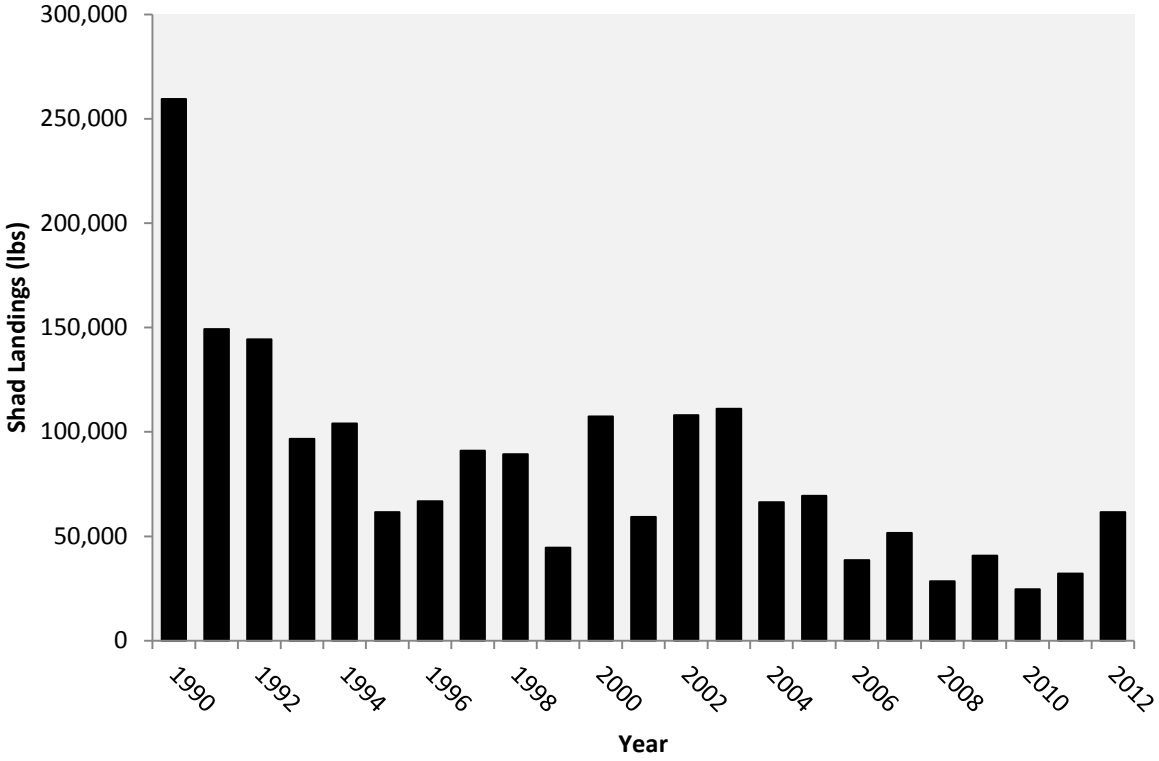

Figure 3.1 Commercial Landings (lbs) for Adult American shad, 1990-2012.

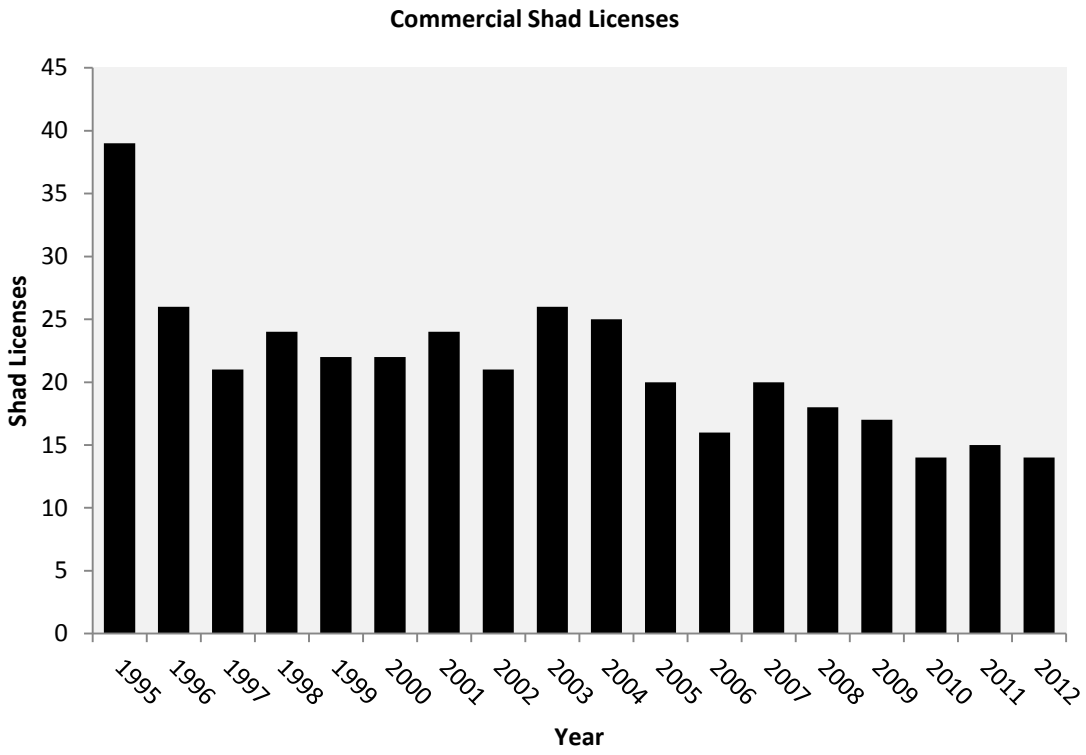

Figure 3.2. Number of Commercial shad license sales, 1995-2012.

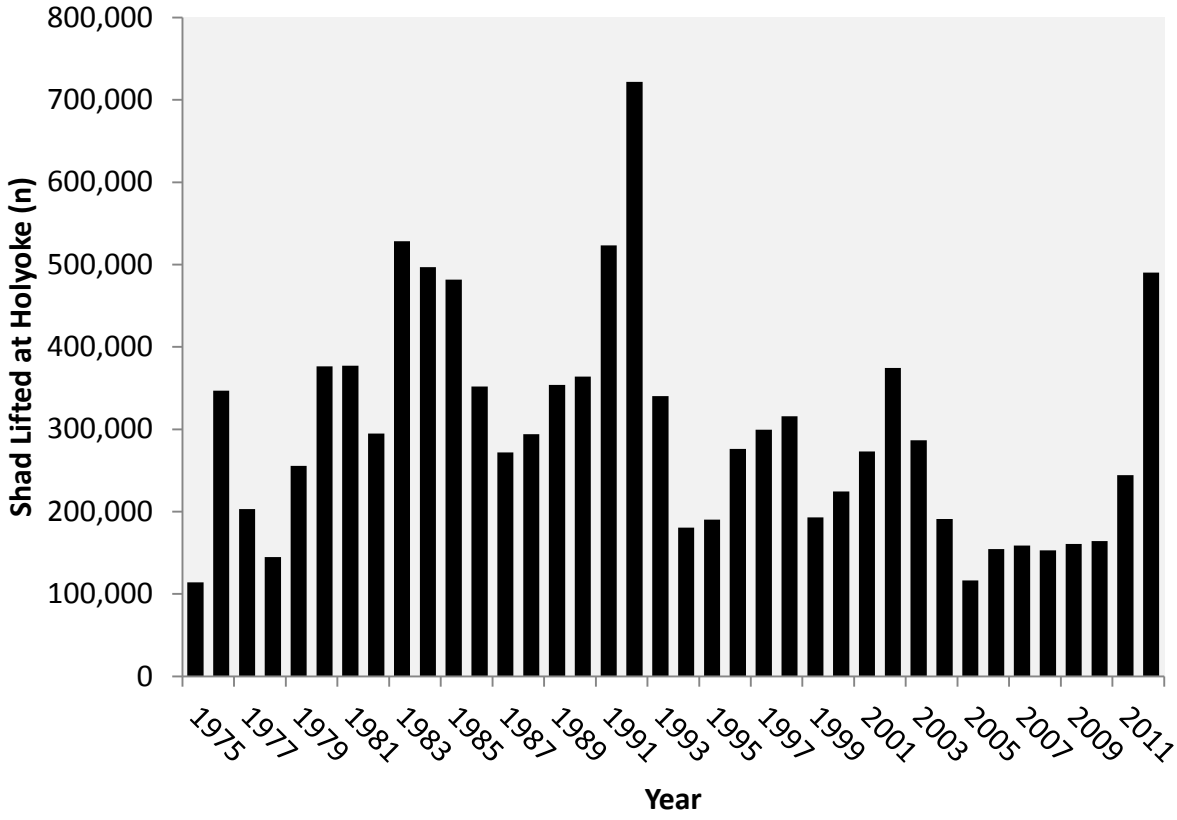

Figure 3.3. Number of adult shad lifted at the Connecticut River Holyoke Dam (Rkm 140), 1975-2012.

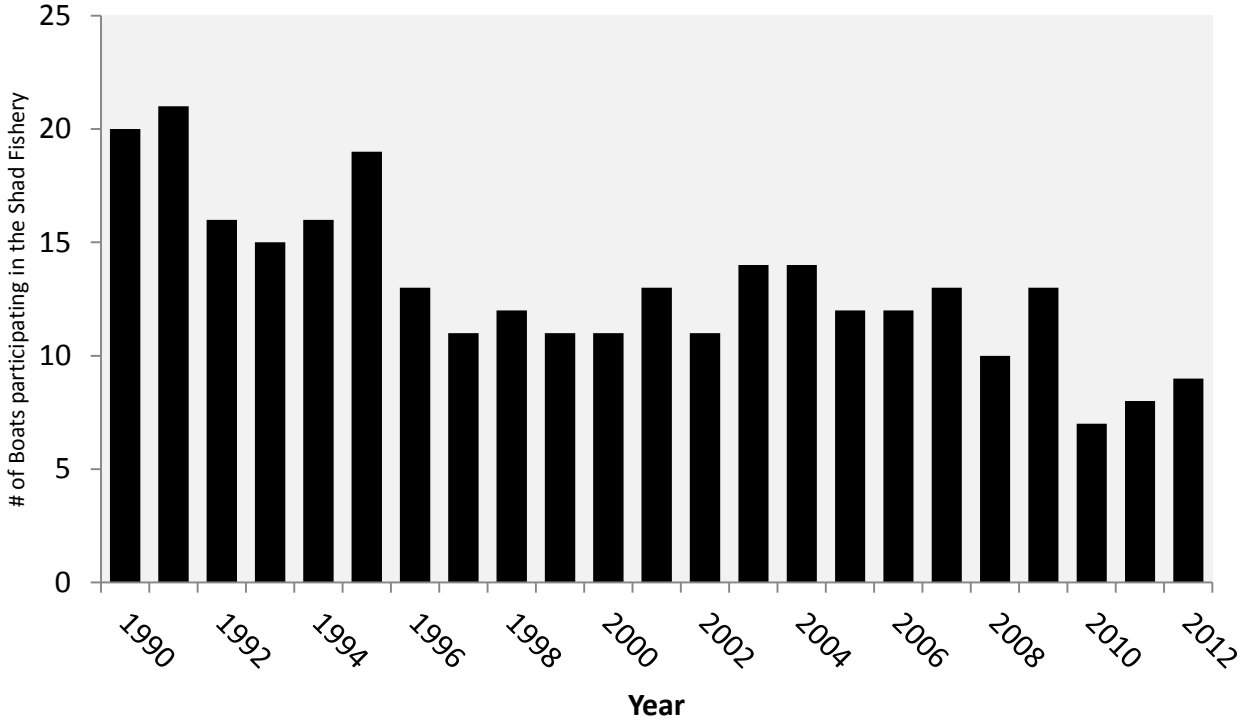

Figure 3.4. Number of boats participating in the commercial shad fishery, 1990-2012.

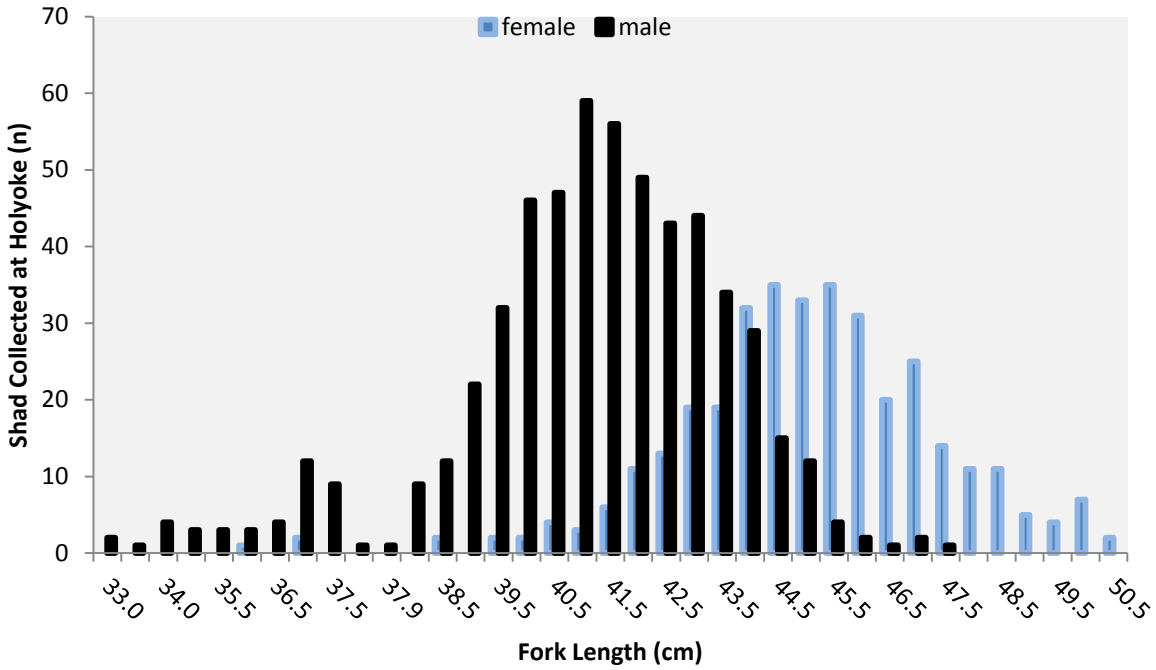

Figure 3.5 American shad length frequencies (FL, cm), by sex, based on collections at the Holyoke Lift, 2012.

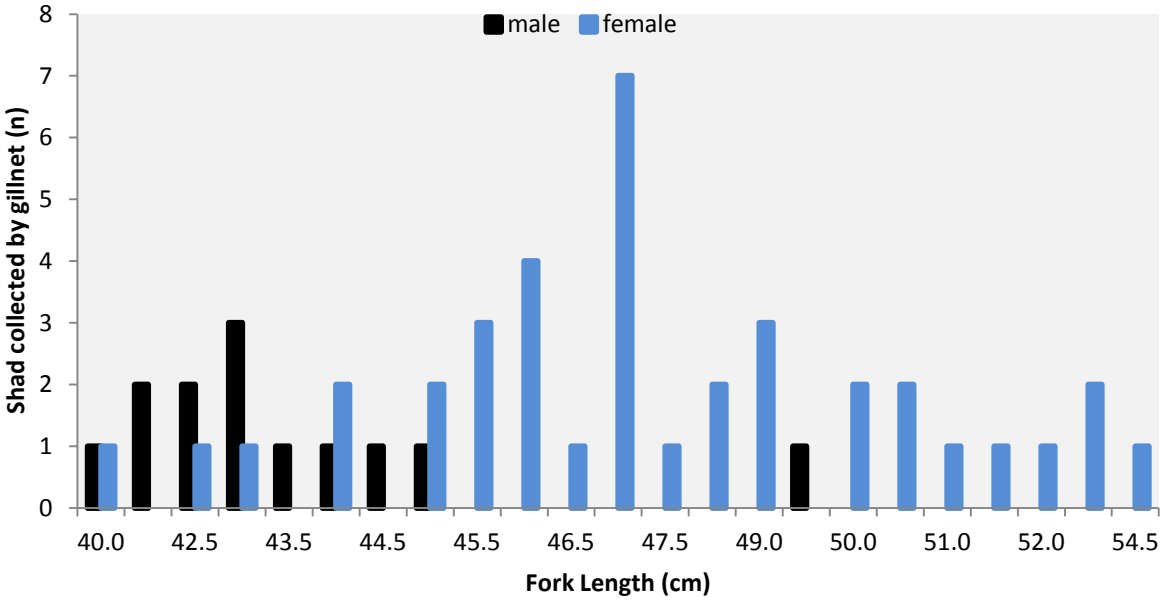

Figure 3.6. American shad length frequencies (FL, cm), by sex, collected by gillnet in the lower river, 2012.

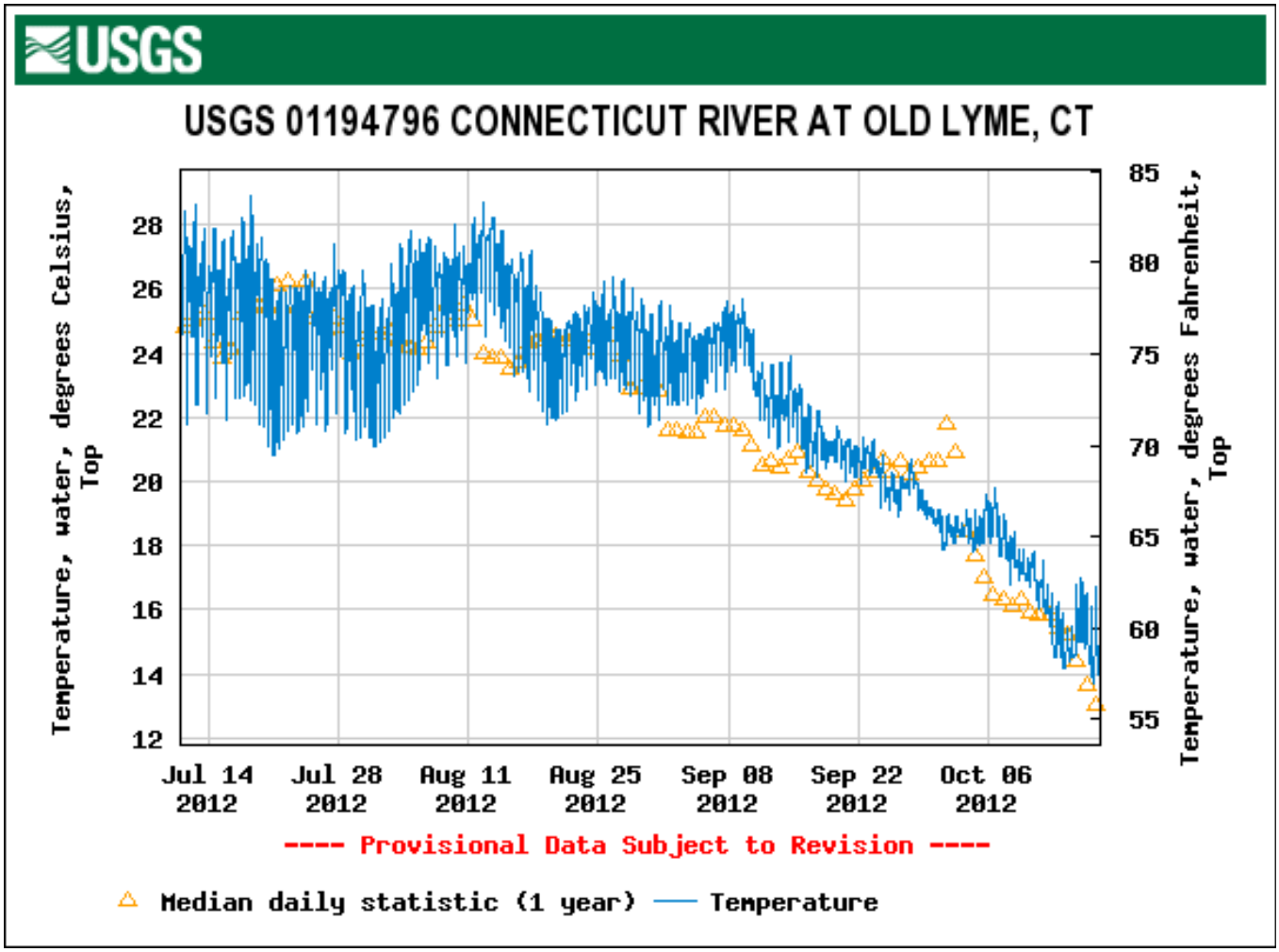

Figure 3.7. Connecticut River bottom temperatures measured at the USGS Old Lyme, CT gaging station July-October, 2012.

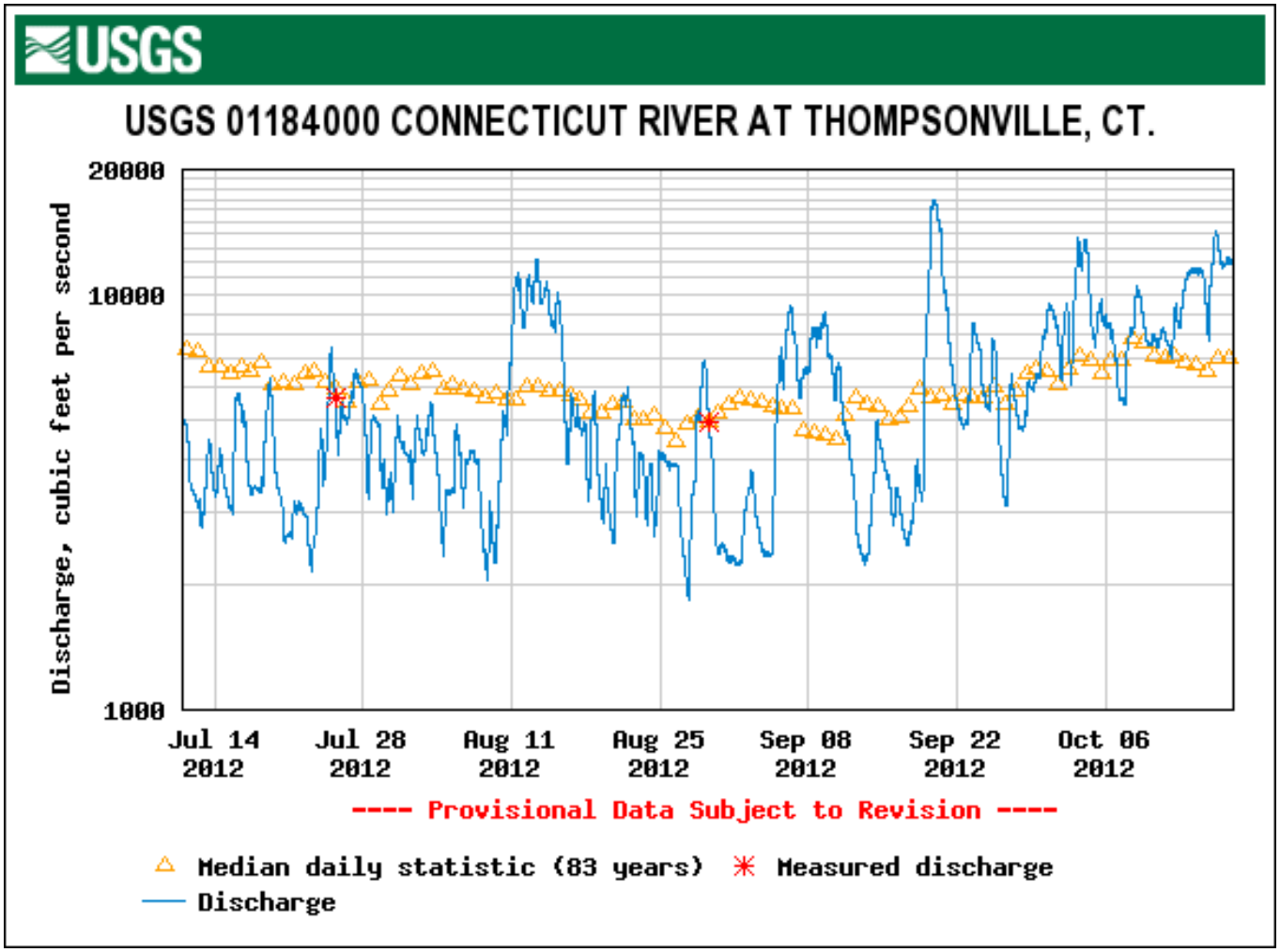

Figure 3.8. Provisional average daily Connecticut River Flow data provided by USGS at Thompsonville, CT station. Time frame shows discharge (cfs) during the 2012 juvenile seine sampling period

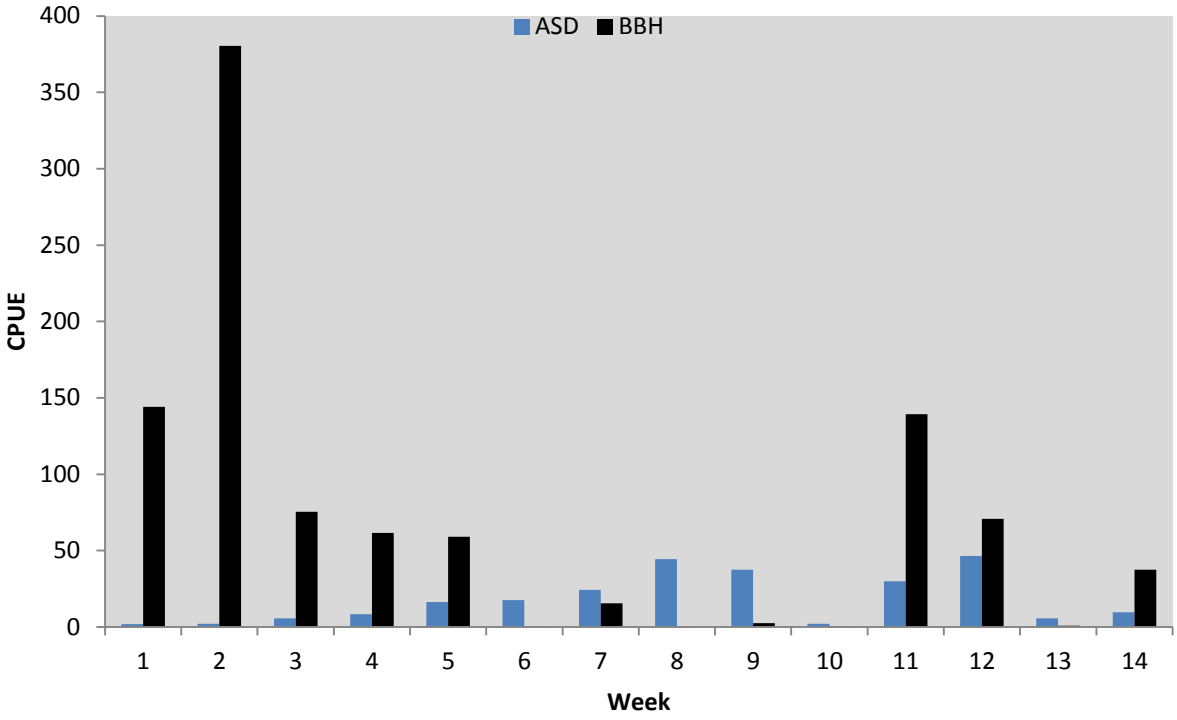

Figure 3.9. Weekly catch per unit effort of juvenile shad and blueback herring, 2012.

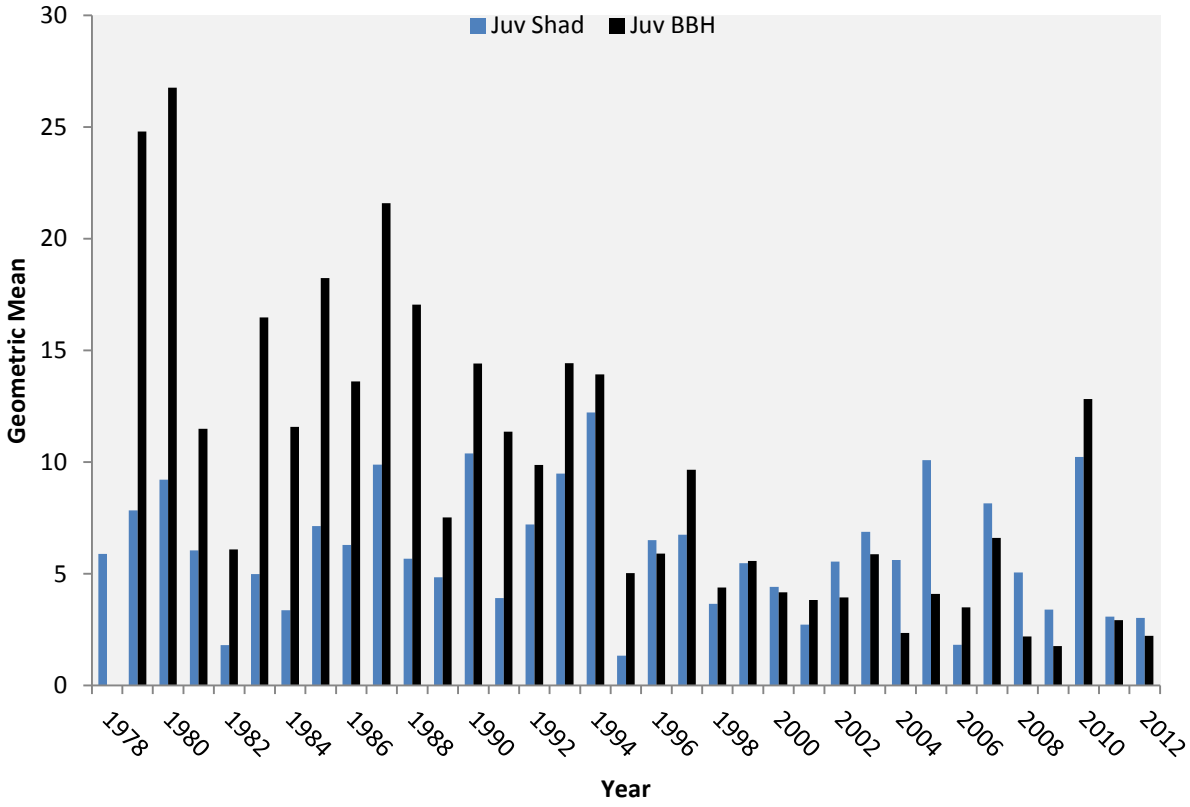

Figure 3.10 Annual cpue of juvenile shad and blueback herring, 1978-2012.

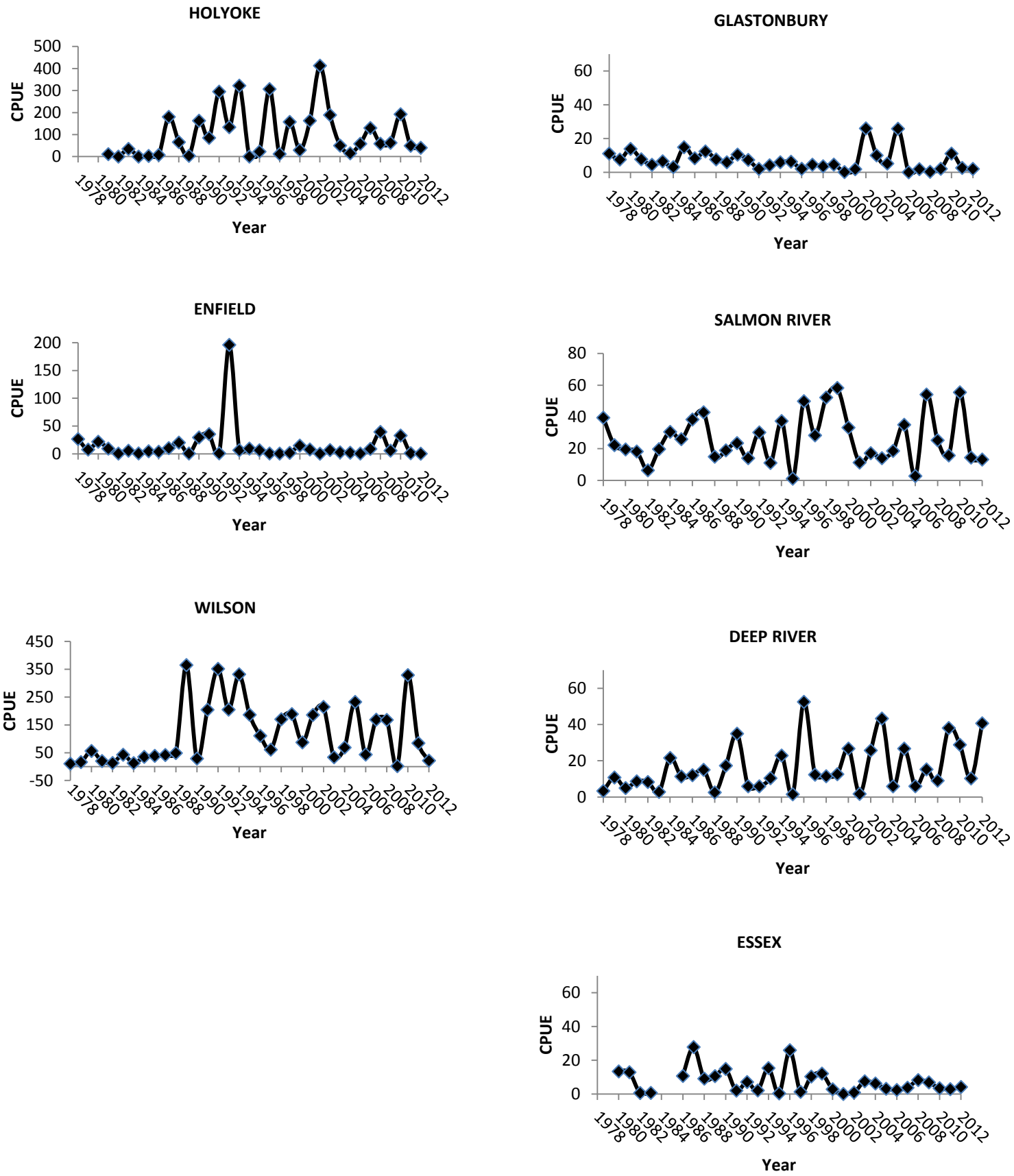

Figure 3.11. Annual CPUE of Connecticut River juvenile American shad by station, 1978-2012.

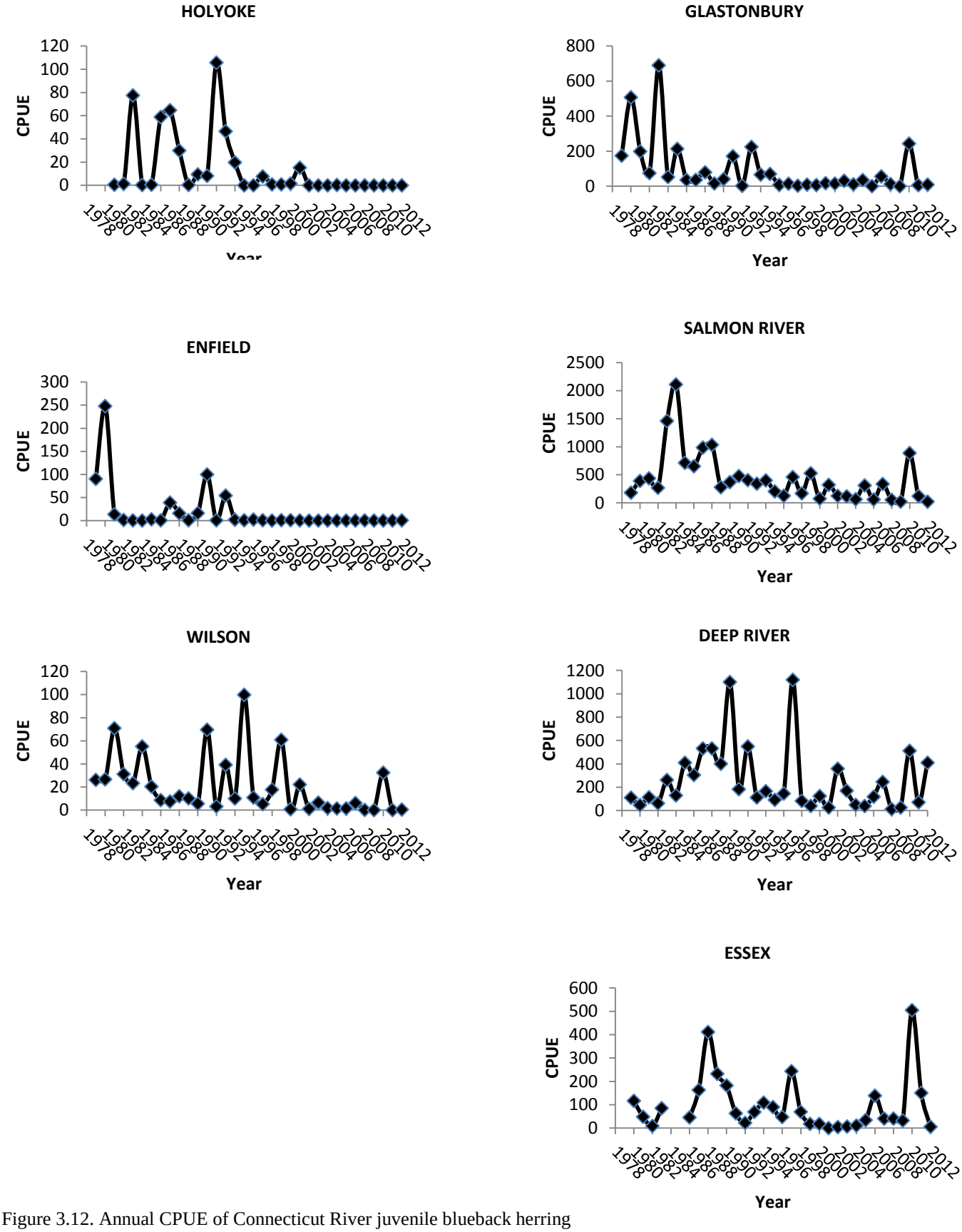

Figure 3.12. Annual CPUE of Connecticut River juvenile blueback herring by station, 1978-2012.