



**STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION**

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Commissioner

Bureau of Natural Resources
Marine Fisheries Division
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A STUDY OF MARINE RECREATIONAL FISHERIES IN CONNECTICUT



Federal Aid in Sport Fish Restoration
F-54-R-30 Annual Performance Report
March 1, 2010 – February 28, 2011

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Federal Aid in Sport Fish Restoration
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Annual Performance Report

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Job Title

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Cover photo taken at a Connecticut River American shad (*Alosa sapidissima*) juvenile seine survey site in East Haddam.

JOB 3: INSHORE SURVEY

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JOB 3: INSHORE SURVEY

STUDY PERIOD AND AREA

This report contains information on studies conducted in the Connecticut and Thames Rivers on American shad, blueback herring, menhaden and common nearshore marine species in 2010. Areas sampled on the Connecticut River range from Holyoke, MA to Essex, CT. The Thames River areas range from just south of Norwich Harbor to Uncasville, CT. Time series data collected under a separate funding source from 1978-2007 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: age structure, sex ratio and size.*
- 2) Annual indices of relative abundance for juvenile shad, blueback herring and common nearshore marine species.*

INTRODUCTION

Historically, American shad (*Alosa sapidissima*) have been an important resource to the State of Connecticut. Annual spawning migrations of shad in the Connecticut River have supported recreational and commercial fisheries within Connecticut, as well as recreational fisheries in upriver states. Information on the abundance of shad, age structure, sex ratio, and annual reproductive success are all important in the management of this species.

The Connecticut Department of Environmental Protection collects information on American shad to monitor annual changes in stock composition and manage the commercial and recreational fisheries in the Connecticut River. The department has collected information on adult shad since 1974 and has collected information on juvenile shad since 1978.

Sampling for American shad was expanded to the Thames River system after 1996 to monitor the effect of the operation of the Greenville Dam fishway. The fishway was constructed to aid in the enhancement of American shad in the system. CT DEP initiated a seine survey in the Thames River to estimate juvenile production of shad. Sites were chosen based on previous studies conducted in the Thames River. The seine survey has documented few shad and river herring, but has 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:

The adult American shad age structure and sex ratio were determined from samples collected at the Holyoke Dam fish lift in Massachusetts. Information on the number of fish lifted daily, number of days the lift was in operation and the daily sex ratio at Holyoke was provided to CTDEP by the Massachusetts Division of Fisheries and Wildlife. The annual sex ratio was calculated by weighting the daily reported sex ratio by the number of fish lifted.

Scales were removed from a subsample of shad for age determination. All shad sampled were measured to fork length (mm). Sex of the fish was determined by visual inspection of the gonads of sacrificed fish. Approximately 25 scales were removed from above the lateral line anterior to the dorsal fin of each fish.

Scale samples were separated by sex and stratified into 0.5 cm length groups. Scale samples were processed by cleaning with an ultrasonic cleaner and pressed onto acetate for aging. Age determination was made as the consensus, by two or more readers, of counting annuli and spawning scars on the magnified projected scale image, using criteria from 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 total number of fish lifted at Holyoke by direct proportion.

Connecticut River Seine Survey

One seine haul was conducted at seven fixed locations one day a week from July 15 through October 15. 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 a 15.2 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, menhaden) were identified, quantified or estimated and released. Invertebrate species are documented as present or absent in the catches.

Thames River Seine Survey

Eight fixed stations were sampled twice a month from July 10 through October 15. Method of seine deployment and gear used in the Thames River were identical to those used for the Connecticut River seine survey.

All, or a representative sub-sample of clupeids (*Alosa sapidissima*, *A. aestivalis*, *A. pseudoharengus*, and *Brevoortia tyrannus*) were returned to the laboratory for measurement and identification. All other fish were identified and counted (subsampling large catches 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).

Relative abundance indices were calculated using both the arithmetic and geometric mean catch per haul among all stations and dates combined. Arithmetic mean catch per haul is presented for American shad and blueback herring because it has been the preferred index when looking at year to year changes. Geometric mean is the preferred method when reporting to the Atlantic States Marine Fisheries Commission for annual compliance reports. See job 2 part 1 methods section for calculating geometric mean (Gottschall & Pacileo 2009).

RESULTS

Connecticut River Adult American shad:

The Holyoke fishlift was open for fish passage from April 9 through July 13, 2010 except for periods of high water in the river on April 10, 11, 17 and 18. The lift operated for 92 days during the spring and summer of 2010. Total lift numbers of American shad at the Holyoke Dam were received from the Massachusetts Division of Fisheries and Wildlife. The number of shad passed at Holyoke in 2010, (164,439), was an increase from 2009 (Table 3.1, Figure 3.1). The number of American shad lifted upstream annually at the Holyoke Dam has been variable through the time series and remains below the long term average of 293,195 (range 114,137 to 721,764). The lift was opened in early April, with the first shad passage on April 9. The lift continued to operate through July 13 for 92 days except for closings due to high water or operational factors. The sex ratio of the 2010 shad run was derived from information collected at the Holyoke fishlift which is located at Rkm 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 69% males and 31% females.

American shad were sampled for scales on 24 days during lift operation from May 3rd through June 1st. The shad age structure from scale samples was expanded based on the number of fish lifted at Holyoke Dam. Four hundred thirty seven scale samples collected from shad at the Holyoke lift were examined for age determination, 0.3% of the total number of fish passed.

Length frequencies of males sampled for scales ranged from 31.0 to 48.0 cm with a mean size of 40.2 cm (Table 3.2, Figure 3.2). The 2010 male population of spawners was comprised of shad from the 2004-2007 year classes. Fifty one percent of male shad scales examined were from 4 year old fish. Twenty four percent of male shad scales examined were from five year old fish. Three year old males comprised 22 percent of the age structure and lastly 2 percent of males were 6 year old fish (Table 3.3).

Length frequencies of females sampled for scales ranged from 37.0 to 53.0 cm FL with a mean fork length of 44.9 cm (Table 3.2). The majority of the 2010 female spawners were made up of the 2005 year class. Forty eight percent of female scale samples examined were 5 year old fish. Four year old fish contributed 31 percent to the annual run and nineteen percent were 6 year old fish. The incidence of overall repeat spawning remains low. The percentage of repeat spawners for males is 5.4% and 11% among females (Table 3.3). Combining both sexes gives a total repeat rate of 7.2%. The shad spawning population continues to rely on a few age classes and low rates of repeat spawners.

Connecticut River Seine Survey

Juvenile collections in the Connecticut River were conducted from July 7 through October 13, 2010. One hundred three seine hauls were completed and 9,404 juvenile American shad were collected (Table 3.4). The arithmetic mean catch for 2010 is 4th highest in the 33 year time series (Table 3.6). Two stations (Holyoke and Wilson) accounted for 79% of the total 2010 catch. The maximum shad catch in a single haul was 3,004 fish collected in mid-August at the Wilson site. The high catch in 2010 resulted in an average (arithmetic mean) catch per unit effort of 317.7 (Table 3.6). 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 3.3). In 2010 overall shad catches were low at most stations, particularly the northern sites. The incidence of zero catch was lower than the previous year (27% vs. 41%) with the Essex and Glastonbury sites providing the lowest catches of the season. The Essex station produced the highest number of zero catches and lowest total catch by site of the season

Blueback herring catches for 2010 were surprisingly high and much larger than American shad, accounting for 78% percent collected of the two *Alosa* species (Figure 3.4). Historically the ratio of shad to bluebacks has varied with up to 90% bluebacks in early years. The 2010 *Alosa spp.* catches were both well above average and the blueback CPUE is the third highest in the time series with the last comparable high value occurring in 1997. The three southernmost stations (Salmon River, Deep River, Essex) accounted for 87% of the total juvenile blueback catches in 2010. A total of 32,722 blueback herring were collected in 2010. The last annual catch of this magnitude was in 1983 when over 36,000 blueback herring were collected.

In the 103 hauls completed in 2010, over 51,000 fish representing 35 species or taxonomic groups were collected (Table 3.7). Species other than American shad and blueback herring were also quantified. 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 2010, the most abundant species collected were blueback herring, spottail shiners, menhaden and American shad. American shad, spottail shiners, blueback herring and sunfish also had a high frequency of occurrence in the catches (Table 3.7).

Thames River Seine Survey

The 2010 Thames River survey was conducted from July 1st until October 7th and completed 56 seine hauls. Over 12,000 fish were collected representing 31 taxonomic groups or species (Table 3.8). Atlantic silversides were the most abundant species in the catch followed by anchovies. Menhaden are typically caught in higher abundance, however only 212 were collected in 2010. Other juvenile species collected included sixteen winter flounder, 19 blackfish and 311 bluefish.

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 (Table 3.9).

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Table 3.1. Number of adult shad lifted at the Holyoke Dam, 1975-2010.

Year	Shad Lift
1975	114,137
1976	346,702
1977	202,997
1978	144,698
1979	255,753
1980	376,276
1981	377,124
1982	294,834
1983	528,185
1984	496,879
1985	481,668
1986	352,122
1987	271,974
1988	294,157
1989	353,819
1990	363,825
1991	523,153
1992	721,764
1993	340,431
1994	180,807
1995	190,295
1996	276,289
1997	299,448
1998	315,810
1999	193,187
2000	224,483
2001	273,220
2002	374,543
2003	286,795
2004	191,295
2005	116,519
2006	154,745
2007	158,812
2008	153,149
2009	160,669
2010	164,439

Table 3.2. Length frequencies of adult American shad sampled for scales at the Holyoke fish lift 2010.

FL (cm)	Bucks	Roes	Total
30	1		1
31			0
32	2		2
33	2		2
34	6		6
35	18		18
36	19		19
37	23		23
38	19		19
39	22	1	23
40	29	5	34
41	37	2	39
42	39	4	43
43	35	8	43
44	25	16	41
45	14	24	38
46	6	18	24
47		21	21
48		21	21
49		10	10
50		4	4
51		2	2
Total	297	136	433

Table 3.3. Age distribution and repeat spawning rate of American shad in the Connecticut River based on adult shad scale samples from the Holyoke Fishlift, 2010.

Age	3	4	5	6
%Age Bucks	22.22	51.18	24.24	2.36
% Age Roes		31.62	48.53	19.85
%Age Combined	15.24	45.03	31.87	7.85

%Repeat Spawners	4	5	6	Total %
% Repeats Bucks	5.92	5.56	42.86	5.39
% Repeats Roe		7.58	18.52	11.04
% Rpt Combined	7.18	6.52	23.53	7.16

Table 3.4. Catch (C), effort (E) and catch per effort (C/E) of juvenile American shad from the 2010 CT River seine survey.

Date	HOL	ENF	WIL	GLA	SAL	DEP	ESX	C	E	C/E
7/7	0	299	10	2	6	96	0	413	7	59.00
7/14	0	38	37	2	7	1	0	85	7	12.14
7/21	7	36	310	7	0	4	0	364	7	52.00
7/28	1	33	70	4	5	87	0	200	7	28.57
8/5		0	114	5	3	33	0	155	6	25.83
8/11	171	0	447	10	5	2	0	635	7	90.71
8/18	11	1	3,004	8	98	0	0	3,122	7	446.00
8/25	92	0	22	16	15	11	0	156	7	22.29
9/1	1,374	0	507	33	15	2	0	1,931	7	275.86
9/8	169	0	91	6	51	61	10	388	7	55.43
9/15	370	0	93	5	71	40	0	579	7	82.71
9/22	273	0	23	0	41	12	0	349	7	49.86
9/29	33	0	35	3	103	1	0	175	7	25.00
10/5		83	165	66	373	73	9	769	6	128.17
10/13	0	0	2	0	40	9	32	83	7	11.86
Total	2,501	490	4,930	167	833	432	51	9,404	103	91.30

Table 3.5. Catch (C), effort (E) and catch per effort (C/E) of juvenile blueback herring from the 2010 CT River seine survey.

Date	HOL	ENF	WIL	GLA	SAL	DEP	ESX	C	E	C/E
7/7	0	0	0	1	416	2,740	2,586	5,743	7	820.43
7/14	0	0	0	56	49	77	3	185	7	26.43
7/21	0	0	0	71	3,524	430	24	4,049	7	578.43
7/28	0	0	0	3	30	531	0	564	7	80.57
8/5		0	164	1,370	4,248	85	1,178	7,045	6	1174.17
8/11	0	0	6	1,197	854	1,053	37	3,147	7	449.57
8/18	0	0	44	777	497	2	3,474	4,794	7	684.86
8/25	0	0	179	0	522	352	0	1,053	7	150.43
9/1	0	0	75	103	264	92	1	535	7	76.43
9/8	0	0	2	14	483	538	146	1,183	7	169.00
9/15	0	0	8	1	198	1,768	19	1,994	7	284.86
9/22	0	0	1	0	1,249	16	88	1,354	7	193.43
9/29	0	0	0	0	970	1	0	971	7	138.71
10/5		0	7	60	13	4	3	87	6	14.50
10/13	0	0	0	0	5	2	11	18	7	2.57
Total	0	0	486	3,653	13,322	7,691	7,570	32,722	103	317.69

Table 3.6. Total catch, geometric and arithmetic mean relative abundance indices (CPUE) of juvenile American shad (ASD) and blueback herring (BBH) in the CT River 1978-2010.

Year	American Shad			Blueback Herring		
	Count	arith_Mn	Gm_Cnt	Count	arith_Mn	Gm_Cnt
1978	1,320	18.59	5.89			
1979	820	12.81	7.84	7,482	116.9	24.8
1980	1,716	21.19	9.21	17,951	221.6	26.75
1981	1,169	12.57	6.05	11,888	127.8	11.49
1982	391	4.77	1.81	5,381	65.62	6.09
1983	1,574	16.57	4.99	36,150	380.5	16.47
1984	795	11.20	3.37	28,073	395.4	11.57
1985	1,223	15.88	7.14	17,697	229.8	18.23
1986	1,531	17.01	6.29	14,360	159.6	13.61
1987	4,205	44.73	9.89	24,952	265.4	21.58
1988	2,195	23.60	5.68	29,481	317.0	17.04
1989	5,898	61.44	4.85	13,148	137.0	7.52
1990	4,091	42.61	10.39	24,097	251.0	14.41
1991	5,534	51.24	3.92	16,954	157.0	11.36
1992	10,424	97.42	7.21	17,319	161.9	9.87
1993	7,876	79.56	9.49	12,784	129.1	14.43
1994	10,791	105.8	12.22	11,592	112.5	13.92
1995	3,060	29.42	1.34	8,357	80.36	5.03
1996	3,730	38.85	6.50	4,728	49.25	5.91
1997	6,626	59.16	6.75	29,648	264.7	9.66
1998	4,127	38.21	3.65	5,500	50.93	4.39
1999	5,899	61.45	5.47	9,152	95.33	5.57
2000	2,713	27.68	4.42	3,184	32.49	4.17
2001	4,815	53.50	2.73	5,240	58.22	3.83
2002	9,732	100.3	5.55	6,702	69.09	3.95
2003	3,207	36.86	6.88	4,568	52.51	5.88
2004	2,187	22.55	5.62	1,904	19.63	2.36
2005	4,719	50.74	10.08	5,869	63.11	4.1
2006	1,517	15.80	1.82	4,474	46.60	3.5
2007	5,332	54.97	8.15	9,355	96.44	6.61
2008	3,541	41.17	5.06	1,629	18.94	2.2
2009	1,790	18.45	3.40	1,137	11.72	1.77
2010	9,404	91.3	10.23	32,722	317.70	12.82

Table 3.7. List of fish species or group and frequency of occurrence of fish collected in Connecticut River seine survey, 2008-2010. **includes more than one species*

Species	2008	2009	2010
alewife	6.98	9.28	7.77
American eel	13.95	19.59	17.48
American shad	61.63	60.82	72.82
Atlantic silverside	3.49	5.15	14.56
bay anchovy	2.33	2.06	0.97
black crappie	13.95	6.19	20.39
blue crab	0.00	7.22	17.48
blueback herring	46.51	36.08	60.19
bluefish	1.16	6.19	11.65
carp	4.65	5.15	19.42
catfish*	16.28	11.34	27.18
crevalle jack	0.00	0.00	3.88
fallfish	4.65	3.09	3.88
gizzard shad	0.00	0.00	4.85
goby	0.00	1.03	0.00
golden shiner	15.12	12.37	28.16
hickory shad	4.65	3.09	0.00
hogchoker	2.33	8.25	15.53
killifish & mummichog*	43.02	27.84	37.86
largemouth bass	26.74	18.56	25.24
menhaden	3.49	11.34	13.59
northern kingfish	0.00	0.00	0.97
northern pike	13.95	5.15	1.94
chain pickeral	1.16	0.00	0.97
pipefish	0.00	0.00	4.85
rock bass	19.77	5.15	25.24
smallmouth bass	39.53	14.43	20.39
spottail shiner	73.26	59.79	64.08
stickleback	4.65	5.15	13.59
striped bass	0.00	0.00	2.91
summer flounder	1.16	0.00	0.00
sunfish*	52.33	38.14	59.22
tessellated darter	33.72	26.80	31.07
white perch	22.09	7.22	18.45
white sucker	11.63	12.37	27.18
winter flounder		0.00	0.97
yellow perch	47.67	29.90	44.66

Table 3.8. List of fish species or group and percent frequency of occurrence of fish collected in Thames River seine survey, 2005-2010. *includes more than one species.

Species	2005	2006	2007	2008	2009	2010
alewife	6.67	1.56	17.86	1.59	8.06	1.77
American eel		6.25		1.59	4.84	0.71
American shad			5.36		6.45	
Atlantic herring					3.23	
Atlantic needlefish	6.67	1.56				
Atlantic silverside	80		82.14	74.6	80.65	21.63
bay anchovy		10.94	7.14	14.29	9.68	3.55
blueback herring			1.79	1.59	1.61	0.35
bluefish	60	45.31	44.64	31.75	46.77	15.25
butterfish	3.33			1.59	4.84	1.06
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	
darter				1.59		
horseshoe crab	3.33					
killifish & mummichog*	43.33	25	32.14	42.86	20.97	6.03
largemouth bass		1.56				
lizardfish		6.25	5.36			
menhaden	20	35.94	42.86	12.7	22.58	2.13
naked goby		3.13	8.93	9.52		1.77
northern kingfish	3.33					
northern pike	3.33					
oyster toadfish						0.35
pipefish	13.33	15.63	26.79	11.11	9.68	1.42
scup	6.67		14.29			
sheepshead minnow	3.33		3.57	3.17		
spot			1.79	1.59		
spottail shiner	6.67	9.38	3.57	6.35	3.23	1.06
stickleback*	16.67	12.5	5.36	36.51	32.26	2.13
striped bass	3.33	6.25	21.43	11.11	8.06	1.77
striped sea robin			3.57			
summer flounder		4.69	5.36	15.87	4.84	0.35
sunfish*		1.56				
tautog	20	6.25	21.43	12.7	1.61	1.77
tomcod			3.57	4.76	3.23	0.35
white mullet		4.69		3.17	1.61	3.90
white perch	13.33	3.13	8.93	1.59	1.61	0.35
windowpane flounder			7.14			
winter flounder	23.33	10.94	37.5	26.98	9.68	1.77

Table 3.9. Number collected, number of seine hauls and geometric mean catch per haul of Thames River juvenile menhaden, 1998-2010.

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

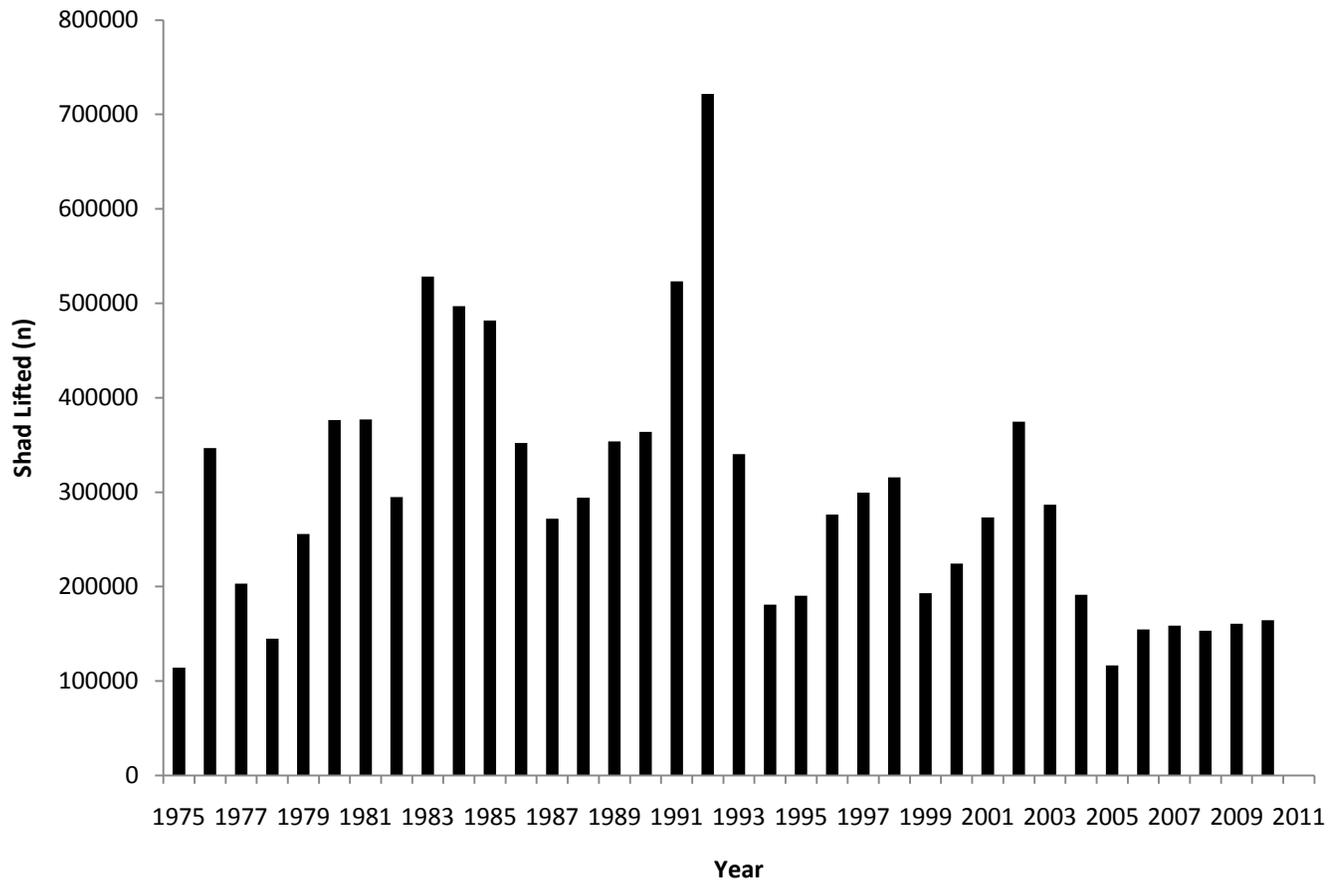


Figure 3.1. Number of adult shad lifted at the Holyoke Dam, 1975-2010.

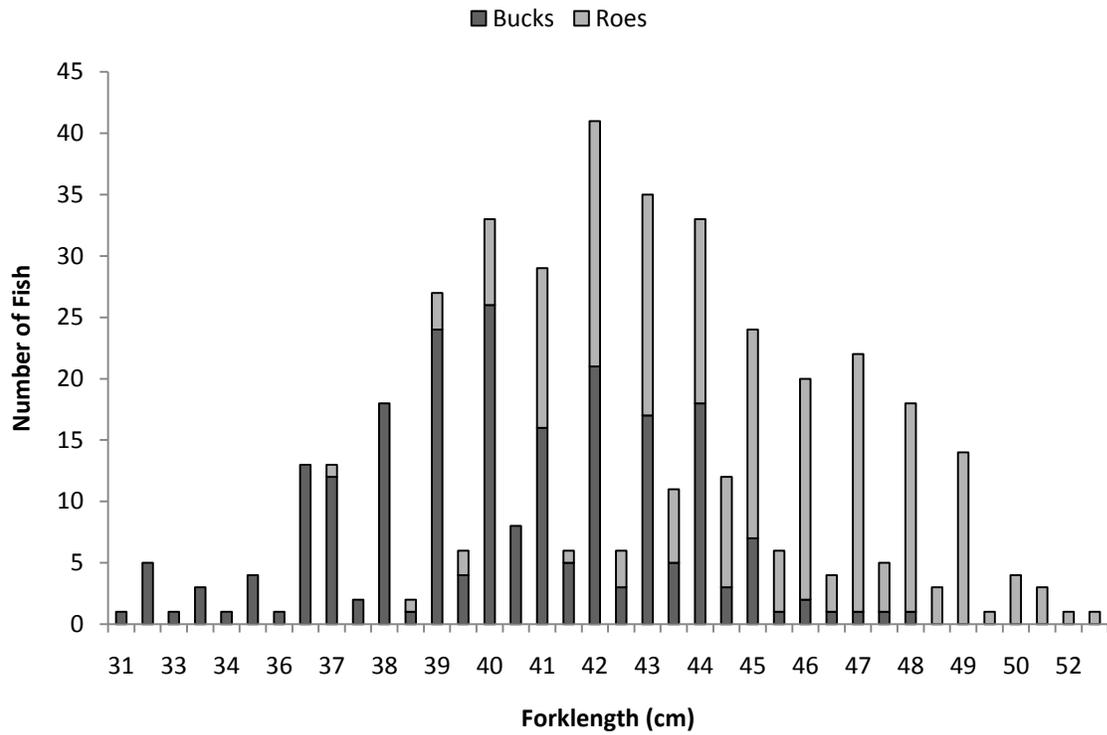
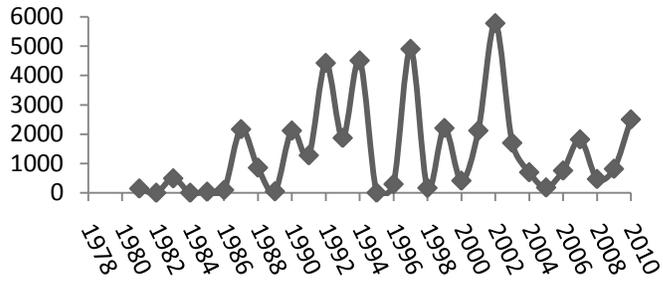
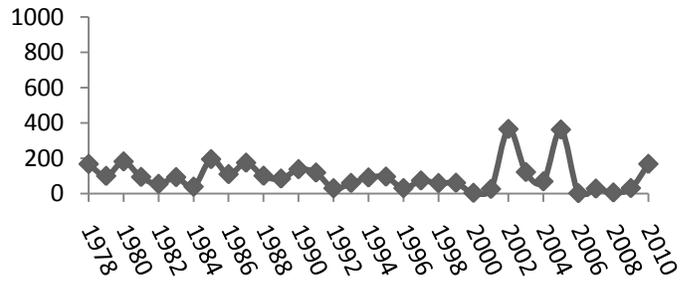


Figure 3.2. Length frequencies (rounded to the nearest 0.5 cm) of American shad scale samples collected at the Holyoke lift in 2010.

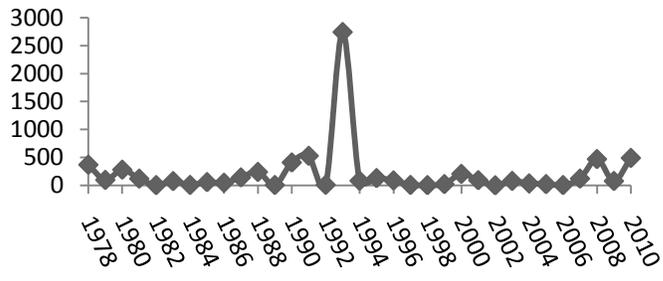
HOLYOKE



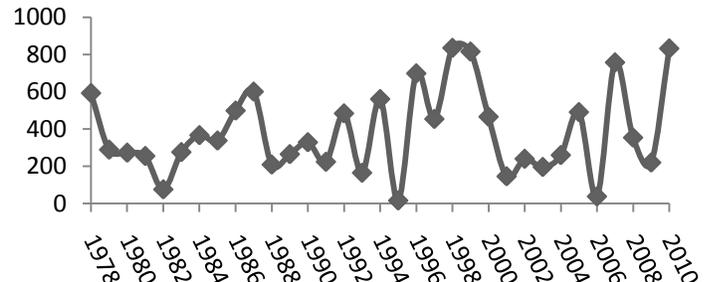
GLASTONBURY



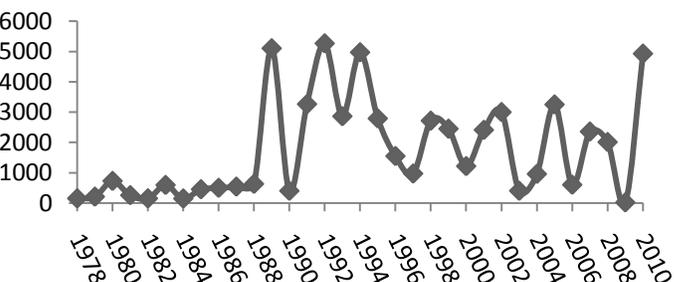
ENFIELD



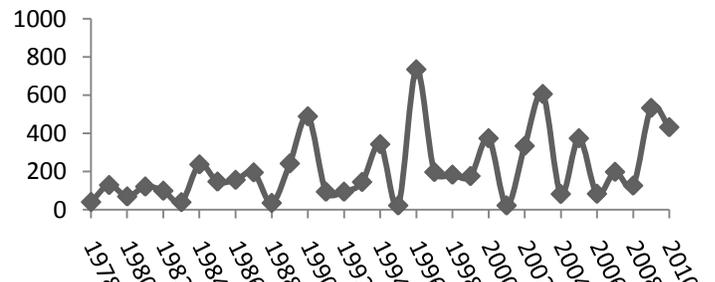
SALMON RIVER



WILSON



DEEP RIVER



ESSEX

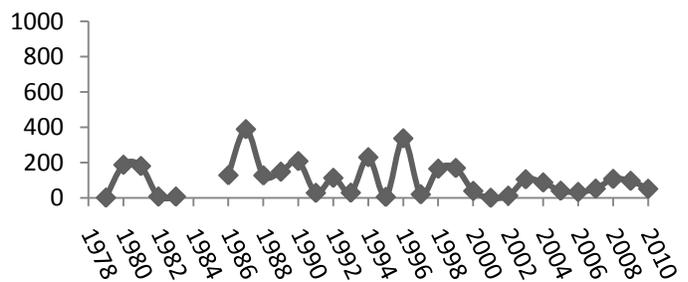


Figure 3.3. Total catches of juvenile American shad by site, 1978-2010.

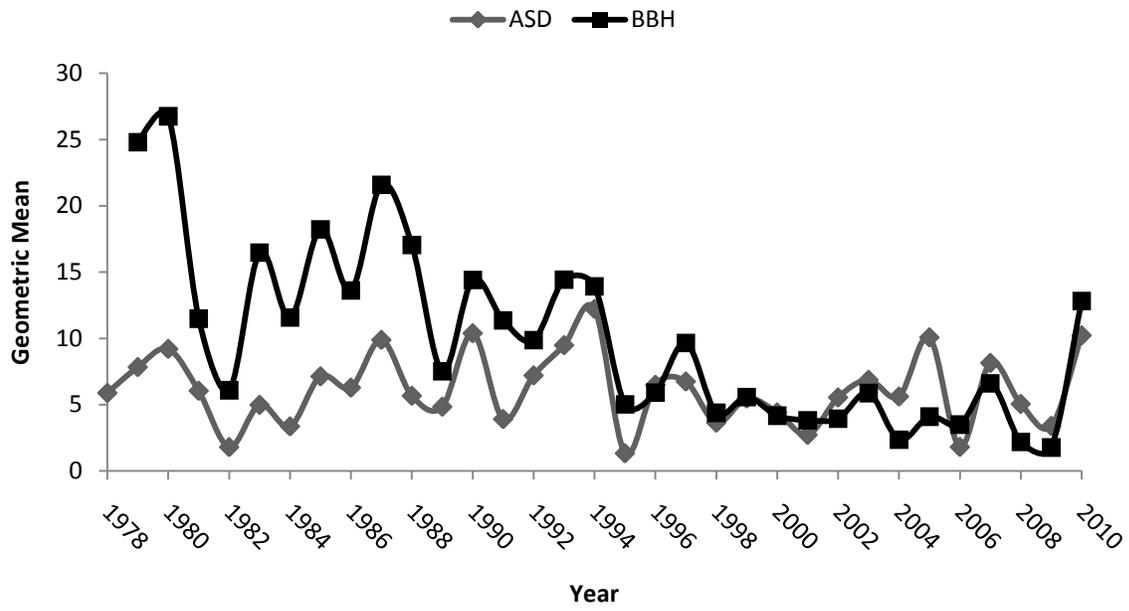


Figure 3.4. Geometric mean catch per haul of American shad and blueback herring in the Connecticut River 1978-2010.