



**STATE OF CONNECTICUT  
DEPARTMENT OF ENERGY AND ENVIRONMENTAL  
PROTECTION**

Robert Klee  
Commissioner

Bureau of Natural Resources  
Marine Fisheries Division  
[www.ct.gov/deep/fishing](http://www.ct.gov/deep/fishing)

**A STUDY OF MARINE RECREATIONAL  
FISHERIES IN CONNECTICUT**



Federal Aid in Sport Fish Restoration  
F14AF00296 (F-54-R-34)  
Annual Performance Report  
March 1, 2014 – February 28, 2015



Jobs 7-8 (Seine Surveys)

Cover photo: *Fisheries Biologist (retired) Roderick MacLeod with a trophy striped bass he caught in Long Island Sound.*

Roderick (Rod) MacLeod retired on April 30, 2015, after more than 34 years of service with the Marine Fisheries Division. During that time Rod helped initiate the marine angler survey program including the Volunteer Angler Program – one of the first of its kind on the east coast. Rod headed up the marine angler survey for nearly 30 years including managing the transition from Connecticut's independent creel surveys to participation in the Marine Recreational Fishery Statistics Survey in 1987. Rod also contributed significantly to the design and implementation of our return to independent creel surveys in 2013 intended to complement the federal MRIP survey.

In addition to oversight of state marine angler surveys, Rod served as Connecticut's representative on ASMFC Interstate Tagging and Artificial Reef Committees and on the ACCSP Operations and Recreational Technical Committees.

Rod's day-to-day duties also included heading up fish kill investigations and looking out for anglers' interests in the agency's review of structures and dredging permits, including providing critical advice on the development of fishing access sites whenever such opportunities arose. Rod also played a central role in our outreach efforts targeting the angling community, including producing the weekly fishing reports and helping hundreds of callers over the years looking for a good place to get out fishing or crabbing. His detailed knowledge of fishing and fishing access along the entire coast, gleaned from years of creel survey work and his own extensive fishing experience, has been invaluable to this office and the fishing public.

Rod will be missed not only for the contributions he has made to this agency over more than a third of a century, but also as a longtime friend and colleague. We wish Rod and his family the best as he enters this new and exciting phase in his life in retirement. Try to leave a few fish on the shoal for us weekend warriors, Rod!

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Federal Aid in Sport Fish Restoration  
F14AF00296 (F-54-R-34)  
Annual Performance Report

**Project Title: *A Study of Marine Recreational Fisheries in Connecticut***

Period Covered: March 1, 2014 - February 28, 2015

**Job Title**

Job 1: Marine Angler Survey  
Job 2: Volunteer Angler Survey  
Job 3: Enhanced Shore Fishing  
Job 4: Tackle Shop Co-op Survey  
Job 5: Marine Finfish Survey  
  
Job 6: Studies in Conservation Engineering  
Job 7: Alosine Survey  
Job 8: Estuarine Seine Survey  
  
Job 9: Volunteer Estuarine Fisheries Database  
Job 10: Cooperative Interagency Resource Monitoring  
  
Job 11: Public Outreach  
Job 12: Marine Fisheries GIS

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Date: May 1, 2015

**JOB 7: ALOSINE SURVEY**

**JOB 7: INSHORE SURVEY**

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## **JOB 7: AMERICAN SHAD MONITORING AND INSHORE SEINE SURVEYS**

### **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.*

### **STUDY PERIOD AND AREA**

This report contains information on adult American shad monitoring and seine studies on juvenile American shad (*Alosa sapidissima*), blueback herring (*Alosa aestivalis*), menhaden (*Brevoortia tyrannus*) and common nearshore marine species in 2014. 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 previous funding source are also included.

### **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 is currently a small commercial driftnet fishery that occurs in the lower Connecticut 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 predominantly occurs north of Hartford, CT at River Kilometer (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 CT River since 1974, to monitor annual changes in stock composition. Data are 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 CT 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. 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 (*Tautoga onitis*), winter flounder (*Pseudopleuronectes americanus*) and bluefish (*Pomatomus saltatrix*).

## **METHODS**

### **American shad adults**

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 and number of shad landed by sex.

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. In 2014, all scale samples were obtained from the Holyoke Fish lift. In previous years, samples were collected in the lower portion of the CT River, but this effort was discontinued due to limited staff availability.

Adult shad collected at the Holyoke Lift 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 16th through October 15th, 2014. 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. Clupeids (*Alosa sapidissima*, *A. aestivalis*, *A. pseudoharengus*, and *Brevoortia tyrannus*) were returned to the laboratory for measurement and identification. 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). All fish species other than family clupeidae, were identified, quantified or estimated and released. Invertebrate species are either counted or noted as present.

A relative abundance index was calculated as a geometric mean catch per unit effort for both shad and blueback herring. The geometric mean is the preferred method when reporting to ASMFC for annual compliance reports because it normalizes clustered data. See Job 5 (Gottschall and Pacileo 2013) for methods used to calculate the geometric mean.

### **Thames River Seine Survey**

Eight fixed stations were sampled twice a month from July 17th through August 28th. The method of seine deployment, gear used and sample processing in the Thames River was identical to that used for the Connecticut River seine survey.

## **RESULTS**

### **Commercial Fishery Landings**

The Connecticut River American shad commercial fishery took 12,953 fish in 2014 which is a 34% increase from the 2013 landings (Figure 7.1). The 2014 commercial harvest ranked 10<sup>th</sup> lowest out of last 25 years. The catch is reported as pounds and is converted to numbers of fish by sex (Table 7.1). Sixteen commercial shad licenses were sold in 2014, a number licenses comparable to recent years (Table 7.1, Figure 7.2). Shad landings appear consistent with the fluctuations of passage at the Holyoke fish lift (Figure 7.3), which supports the assertion that the lift numbers represent a consistent percentage of the annual shad spawning stock in the Connecticut River.

Nine boats reported landings in 2014. The number of shad boats fishing annually continues to remain low as few new participants enter the fishery (Figure 7.4). Some shad fishermen continue to purchase the license even if they have not actively fished in several years.

Commercial shad catch reports were skewed towards females (88%), with males accounting for 12% of the reported landings (Table 7.1). Males are most likely 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.

## **Connecticut River Adult American shad**

The Holyoke Fish lift was open for fish passage from April 24 through July 15, 2014 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 2014 (370,506) was the 11th highest value since 1975 (Figure 7.3). The number of American shad lifted upstream annually at the Holyoke Dam has been highly variable through the time series, however 2014 was well above the long term mean of 301,000 (median = 289,000, range 110,000 to 720,000).

The 2014 shad run sex ratio 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 likely not significant enough to affect the composition of the run. The weighted sex ratio of shad sampled at Holyoke was 66% male and 34% female (Figure 7.5).

American shad scales (n=513) were collected on 29 days over a 66 day span during lift operation. The shad age structure from scale samples was expanded based on the number of fish lifted at Holyoke Dam. Scale samples that were able to be aged totaled 496 (187 females and 309 males). Samples not aged had either regenerated scales or were missing data on the fish.

Length frequency of American shad collected at the Holyoke lift ranged from 32.0 to 49.0 cm FL for male shad and 37.0 to 53.5 cm FL among female shad. Length frequencies of both sexes were fairly normally distributed (Figures 7.5 and 7.6). Average size among males was 40.6 cm FL and among females was 46.4 cm FL.

The 2014 male population of spawning adult shad was produced from the 2008-2010 year classes. A large percentage (56%) of male shad scales examined were from four year old fish, while 35% were from 5 year old fish and 6% were 3 year old fish. Six and seven year old fish represented 3.2% and 0.3 % of the population, respectively (Table 7.2).

The majority of female shad (61%) sampled in 2014 were five year old fish from the 2009 year class. Six year old fish contributed to 21.9% of the 2014 run and 12.3% were 4 year old fish. Seven year old fish represented 4.3%. The incidence of overall repeat spawning in 2014 increased. The percentage of repeat spawning fish was 15.9% for males and 22.5% among females, with an overall repeat spawn rate of 18.4% (Table 7.2).

## **Seine Survey**

Juvenile collections in the Connecticut River were conducted from July 16th through October 15th, 2014. A total of 3,358 juvenile American shad were collected for the season (Table 7.3). The highest catch in 2014 was 604 shad collected at the Wilson site (RKM 89) in early September, representing 49% of the total Wilson catch for the season and 18% of the overall catch (Table 7.3). The stations with the largest proportion of the season's catch were Holyoke (43%) and Wilson (36%). A total of 4,903 blueback herring were collected in 2014 (Table 7.4).

The geometric mean CPUE for shad in 2014 more than doubled from 2013 and ranks as the 9th largest in the time series (Table 7.5). The annual index of juvenile abundance (geometric mean catch/haul) has varied without trend over the time series. The geometric mean CPUE for American shad was slightly more than double that of blueback herring.

In the 90 hauls completed in 2014, over 35,000 fish representing 29 species or taxonomic groups were collected (Table 7.6). 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. Estimated catches are noted as such in the database. In 2014, the most abundant species collected were menhaden, shiners, blueback herring and American shad. Shiners, juvenile shad, yellow perch (*Perca flavescens*), sunfish and juvenile bluebacks had the five highest frequencies of occurrence (Table 7.6).

The ratio of blueback catches to shad varied seasonally in 2014 (Figure 7.6) as well as through the time series (Figure 7.7). In 2014, blueback catches exceeded shad catches. Historically, blueback catches would far exceed those of American shad. The 2014 *Alosa spp.* CPUE indices were both below average. The blueback geometric mean CPUE is the 7th lowest in the time series.

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 7.8). The Enfield and Glastonbury sites provided the lowest catches of the season again in 2014. The southernmost station (Essex) produced the highest number of zero catches and fifth lowest catch of the season. The Salmon River site ranks as the highest total catch for blueback herring, with 47% of the season's catch. The single highest seine haul of bluebacks was at Salmon River on August 13th (574) but was only 12% of the season's total catch of blueback herring (Table 7.4).

### **Thames River Seine Survey**

The 2014 Thames River survey was conducted bi-weekly from July 17th through August 28<sup>th</sup> with 27 seine hauls. Over 32,000 fish were collected representing 45 groups or species (Table 7.8). Atlantic silversides had the highest presence in the catch (28%), followed by menhaden, bluefish and *Fundulus spp.* Other notable species collected in 2014 were: Winter flounder, striped bass (*Marone saxatilis*), scup (*Stenotomus chrysops*), snapper bluefish, summer flounder (*Paralichthys dentatus*) and tautog. A longhorn sculpin (*Myoxocephalus octodecemspinosus*) was collected for the first time in this survey in 2014.

Over the time series, menhaden catches have varied widely from a low in 2013 of just 31 fish to over a million fish collected in 2000. The 2014 menhaden index, geometric mean CPUE 22.78, ranked third highest out of 17 (Table 7.8). Juvenile menhaden catches have been variable with the lowest CPUE in 2013 (0.14) and a peak geometric mean CPUE of 117.5 in 2002.

### **MODIFICATIONS**

Job 7 will not be active during the next grant period as the work is being transferred to another source of funds.

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Table 7.1. Annual American shad commercial fishery harvest. Landings are reported by weight (lbs.) and counts, by sex, 1990-2014.

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	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	10	203
2009	40,680	1,156	4,045	3.5	6,437	32,187	5	13	182
2010	24,641	855	2,994	3.5	4,238	21,192	5	7	202
2011	32,183	953	3,334	3.5	5,772	28,849	5	8	218
2012	61,623	2,810	9,835	3.5	10,358	51,788	5	9	160
2013	40,598	1,249	4,371	3.5	7,245	36,227	5	5	85
2014	61,544	2,147	7,516	3.5	10,806	54,028	5	9	160

Table 7.2. Fishery independent spawning history and age distribution of American shad in the upper Connecticut River, 2014

<b>2014 American Shad Age Structure</b>							
	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>Total</b>	<b>% Repeat Spawn</b>
<b>Bucks</b>	18	173	108	10	1	309	15.86
%	5.8	56.0	35.0	3.2	0.3		
Shad (n)	14,245	136,907	85,468	7,914	791	244,534	
		<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>Total</b>	<b>% Repeat Spawn</b>
<b>Roes</b>		23	114	41	8	187	22.46
%		12.3	60.96	21.93	4.28		
Shad (n)		15,494	76,796	27,620	5,389	125,298	
	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>		<b>% Repeat Spawn</b>
<b>Combined</b>	18	196	222	51	9	496	18.35
%	3.63	39.52	44.76	10.28	1.81		
Shad (n)	13,446	146,410	165,831	38,096	6,723	370,506	

Table 7.3. Catch and effort of juvenile American shad from the 2014 CT River seine survey.

Date	HOLYOKE	ENFIELD	WILSON	GLASTONBURY	SALMON RIVER	DEEP RIVER	ESSEX	Catch	Effort
7/16/2014	3	25	3	0	20	4	27	82	7
7/23/2014	0	11	46	2	2	42	6	109	7
7/30/2014	214	19	6	4	6	6	0	255	7
8/6/2014	0	20	143	10	6	3	40	222	7
8/13/2014	472	0	94	32	16	72	17	703	7
8/20/2014	1	0	162	6	8	22	41	240	7
8/27/2014	76	19	47	12	3	10	0	167	7
9/3/2014	39	1	74	0	7	20	0	141	7
9/10/2014	104	0	604	5	16	4	19	752	7
9/17/2014	17	0	18		11	6	0	52	6
9/24/2014	360	0	0		43	17	0	420	6
10/1/2014	144		17		9	12	0	182	5
10/8/2014	0		9		8	0	0	17	5
10/15/2014	0		0		8	0	8	16	5
Total	1430	95	1223	71	163	218	158	3358	90

Table 7.4. Catch and effort of juvenile blueback herring from the 2014 CT River seine survey.

Date	HOLYOKE	ENFIELD	WILSON	GLASTONBURY	SALMON RIVER	DEEP RIVER	ESSEX	Catch	Effort
7/16/2014	0	0	1	0	5	16	20	42	7
7/23/2014	0	1	0	0	3	42	56	102	7
7/30/2014	0	0	0	1	6	0	0	7	7
8/6/2014	0	0	1	1	273	77	178	530	7
8/13/2014	0	0	0	37	574	0	0	611	7
8/20/2014	0	0	0	23	188	411	20	642	7
8/27/2014	0	0	0	3	44	0	5	52	7
9/3/2014	0	0	0	0	490	439	0	929	7
9/10/2014	0	0	0	7	162	18	0	187	7
9/17/2014	0	0	0		460	452	0	912	6
9/24/2014	0	0	0		33	556	0	589	6
10/1/2014	0		0		48	116	0	164	5
10/8/2014	0		1		0	8	80	89	5
10/15/2014	0		0		3	4	40	47	5
Total	0	1	3	72	2289	2139	399	4903	90

Table 7.5. Geometric mean relative abundance index (CPUE) of juvenile American shad and blueback herring, 1978-2014.

<b>Year</b>	<b>Juv Shad</b>	<b>Juv BBH</b>
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
2013	3.16	6.89
2014	8.03	3.69

Table 7.6. List of fish species or group and percent frequency of occurrence of fish collected in Connecticut River seine survey, 2008-2014.

*\*includes more than one species*

Species	2008	2009	2010	2011	2012	2013	2014
alewife	6.98	9.28	7.77	12.05	14.77	6.59	6.67
American eel	13.95	19.59	17.48	8.43	18.18	12.09	12.22
American shad	61.63	60.82	72.82	63.86	48.86	63.74	75.56
Atlantic needlefish					3.41	1.1	
Atlantic silverside	3.49	5.15	14.56	2.41	12.5		4.44
bay anchovy	2.33	2.06	0.97	4.82	10.23	6.59	5.56
black crappie	13.95	6.19	20.39	20.48	21.59	18.68	16.67
blue crab		7.22	17.48	6.02	12.5	12.09	5.56
blueback herring	46.51	36.08	60.19	45.78	36.36	51.65	45.56
bluefish	1.16	6.19	11.65	6.02	12.5	5.49	8.89
carp	4.65	5.15	19.42	12.05	15.91	15.38	3.33
catfish*	16.28	11.34	27.18	10.84	15.91	17.58	24.44
crevalle jack			3.88				
fallfish	4.65	3.09	3.88	2.41	3.41	5.49	4.44
gizzard shad			4.85		1.14		
goby		1.03					
golden shiner	15.12	12.37	28.16	15.66	19.32	13.19	8.89
hickory shad	4.65	3.09				1.1	2.22
hogchoker	2.33	8.25	15.53	18.07	18.18	26.37	10
killifish & mummichog*	43.02	27.84	37.86	55.42	42.05	41.76	35.56
largemouth bass	26.74	18.56	25.24	19.28	26.14	13.19	23.33
menhaden	3.49	11.34	13.59	4.82	18.18	12.09	26.67
northern kingfish			0.97				
northern pike	13.95	5.15	1.94	9.64	5.68	8.79	13.33
chain pickerel	1.16		0.97	4.82	3.41		
pipefish			4.85	1.2	2.27		
rock bass	19.77	5.15	25.24	13.25	10.23	2.2	10
smallmouth bass	39.53	14.43	20.39	30.12	22.73	23.08	28.89
shiner*	73.26	59.79	64.08	65.06	55.68	51.65	75.56
stickleback*	4.65	5.15	13.59	1.2	1.14	1.1	4.44
striped bass			2.91	2.41	1.14	2.2	3.33
summer flounder	1.16				1.14		
sunfish*	52.33	38.14	59.22	53.01	57.95	48.35	46.67
tessellated darter	33.72	26.8	31.07	30.12	39.77	29.67	36.67
white perch	22.09	7.22	18.45	16.87	10.23	1.1	4.44
white sucker	11.63	12.37	27.18	12.05	9.09	4.4	37.78
winter flounder			0.97				
yellow perch	47.67	29.9	44.66	50.6	35.23	50.55	55.56

Table 7.7. List of fish species or group and percent frequency of occurrence of fish collected in Thames River seine survey, 2005-2014. *\*includes more than one species*

Species	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
alewife	6.67	1.56	17.86	1.59	8.06	1.77	5.36	7.50	5.26	1.11
American eel		6.25		1.59	4.84	0.71	1.79	2.50	1.32	
American shad			5.36		6.45		1.79	5.00		
Atlantic herring					3.23					
Atlantic needlefish	6.67	1.56								1.11
Atlantic silverside	80.00		82.14	74.60	80.65	21.63	98.21	100.00	75.00	27.78
bay anchovy		10.94	7.14	14.29	9.68	3.55	10.71	27.50	10.53	1.11
blueback herring			1.79	1.59	1.61	0.35		2.50	2.63	2.22
bluefish	60.00	45.31	44.64	31.75	46.77	15.25	41.07	85.00	48.68	13.33
brown trout							1.79			
butterfish	3.33			1.59	4.84	1.06	1.79			1.11
carp		1.56	1.79			0.35				
catfish*				1.59						
crevalle jack	23.33	12.50	5.36	1.59	11.29	3.55				1.11
cunner					1.61			5.00		
darter				1.59			1.79			
gizzard shad								2.50		
golden shiner							1.79		1.32	
hogchoker							17.86	7.50	7.89	3.33
horseshoe crab	3.33									
killifish & mummichog*	43.33	25.00	32.14	42.86	20.97	6.03	69.64	52.50	60.53	12.22
longhorn sculpin										1.11
largemouth bass		1.56							2.63	
lizardfish		6.25	5.36					2.50	1.32	
menhaden	20.00	35.94	42.86	12.70	22.58	2.13	17.86	50.00	10.53	15.56
naked goby		3.13	8.93	9.52		1.77	16.07	15.00	9.21	3.33
northern kingfish	3.33						7.14	10.00	1.32	1.11
northern pike	3.33						3.57			
oyster toadfish						0.35				
pipefish	13.33	15.63	26.79	11.11	9.68	1.42		20.00	3.95	
scup	6.67		14.29					20.00	1.32	1.11
sheepshead										
minnow	3.33		3.57	3.17			1.79		2.63	
spot			1.79	1.59				10.00	1.32	
spottail shiner	6.67	9.38	3.57	6.35	3.23	1.06	7.14	5.00		3.33
stickleback*	16.67	12.50	5.36	36.51	32.26	2.13	42.86	5.00	11.84	3.33
striped bass	3.33	6.25	21.43	11.11	8.06	1.77	7.14	17.50	21.05	1.11
striped mullet									5.26	
striped sea robin			3.57					2.50		
summer flounder		4.69	5.36	15.87	4.84	0.35	3.57		10.53	6.67
sunfish*		1.56					7.14		3.95	1.11
tautog	20.00	6.25	21.43	12.70	1.61	1.77	3.57	12.50	2.63	
tomcod			3.57	4.76	3.23	0.35	1.79	2.50	5.26	
white mullet		4.69		3.17	1.61	3.90	1.79	7.50	2.63	
white perch	13.33	3.13	8.93	1.59	1.61	0.35	1.79		2.63	
white sucker									1.32	
windowpane flounder			7.14				1.79			
winter flounder	23.33	10.94	37.50	26.98	9.68	1.77	3.57	20.00	15.79	4.44
yellow perch									1.32	

Table 7.8. Number collected, number of seine hauls and geometric mean catch per haul (G Mn) of Thames River juvenile menhaden, 1998-2014.

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
2013	31	76	0.14
2014	27,332	27	22.78

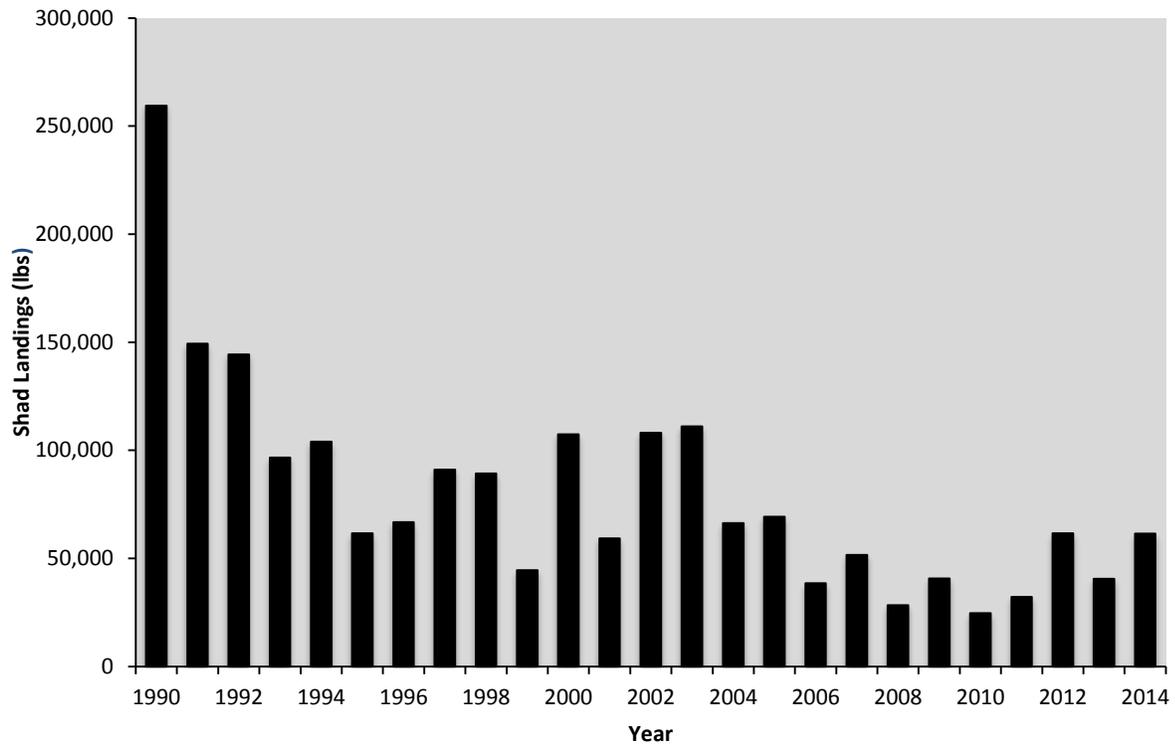


Figure 7.1 Commercial Landings (lbs) for Adult American shad, 1990-2014.

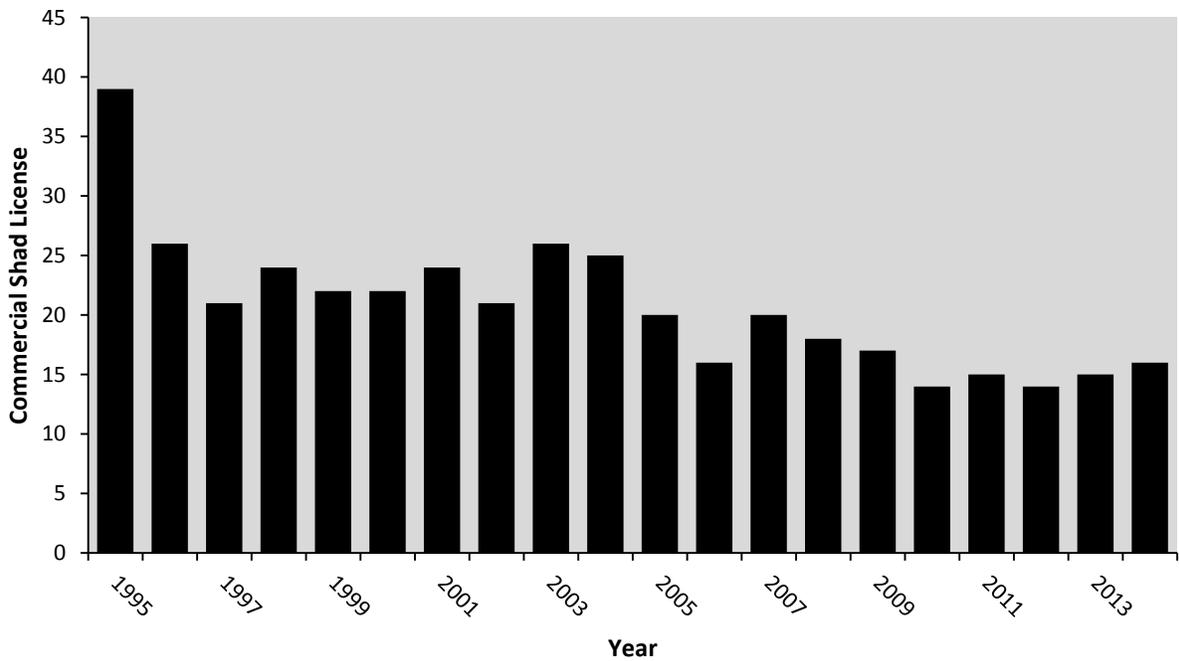


Figure 7.2. Number of Commercial shad license sales, 1995-2014.

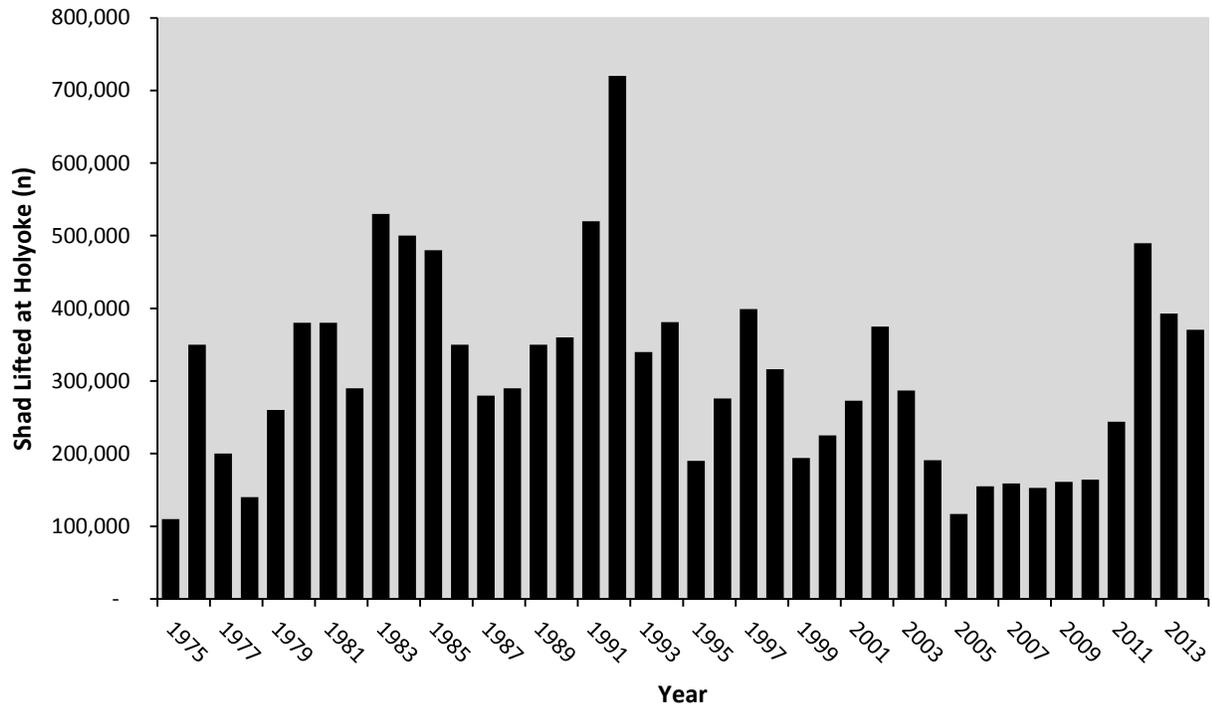


Figure 7.3. Number of adult shad lifted at the Connecticut River Holyoke Dam (RKM 140), 1975-2014.

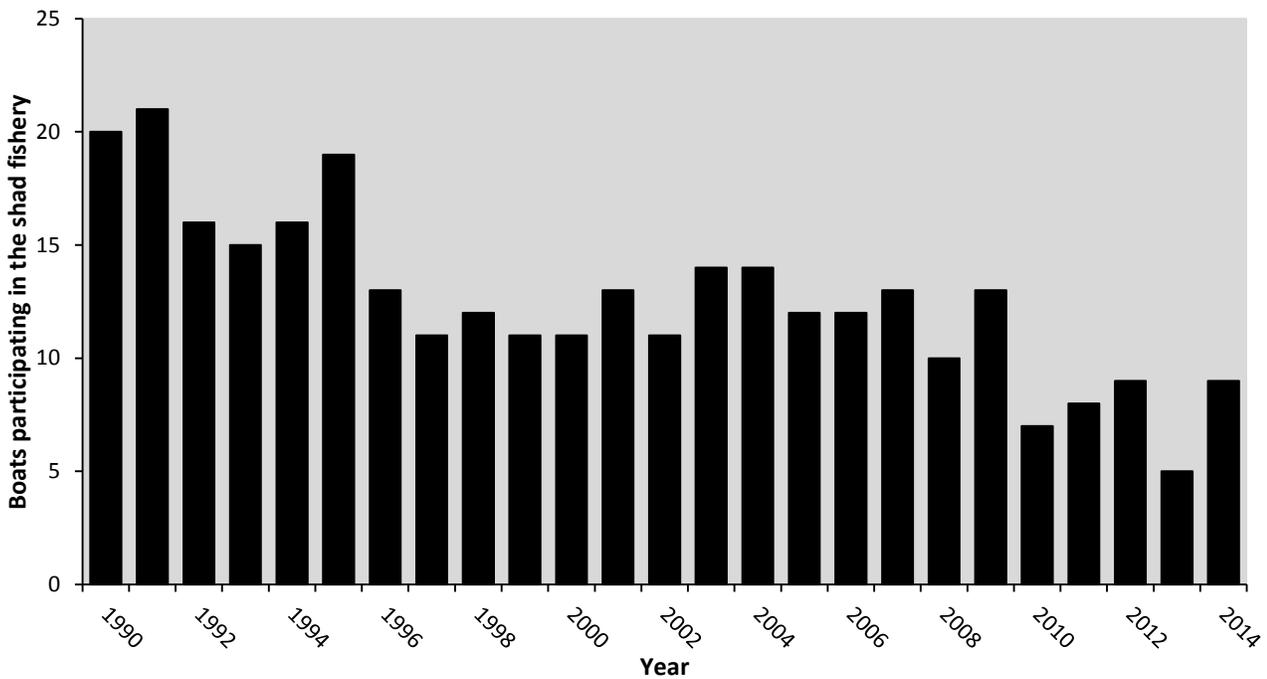


Figure 7.4. Number of boats participating in the commercial shad fishery, 1990-2014.

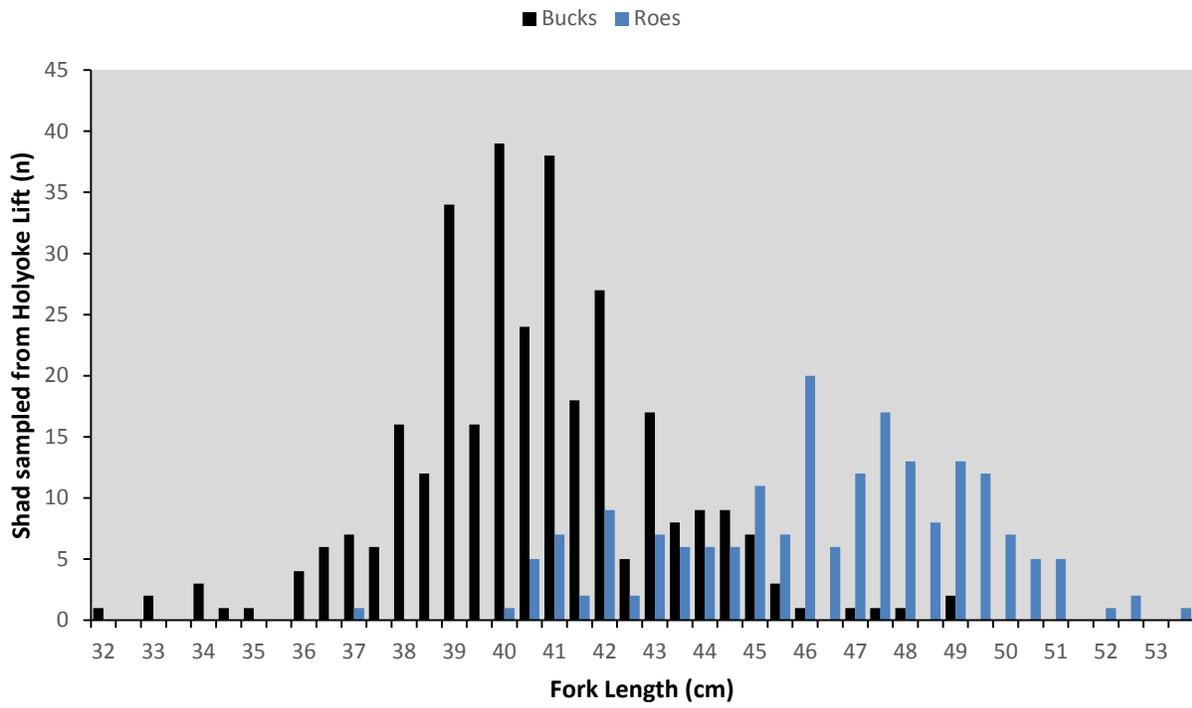


Figure 7.5 American shad length frequencies (FL, cm) by sex based on collections at the Holyoke Lift, 2014.

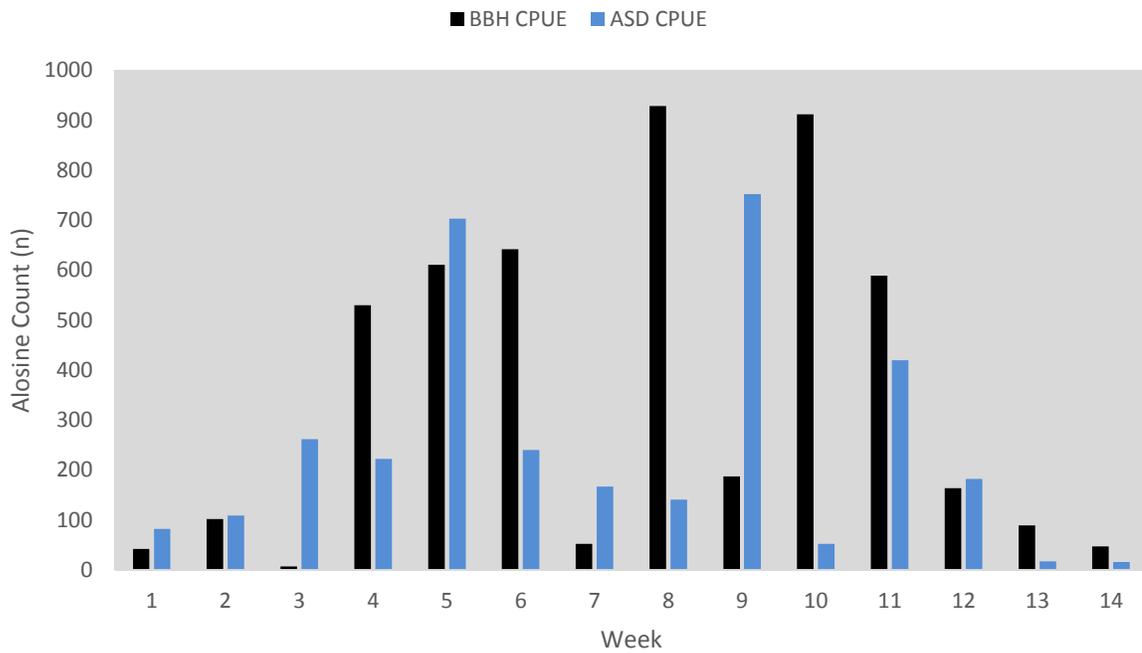


Figure 7.6. Weekly catch per unit effort of juvenile shad and blueback herring, 2014.

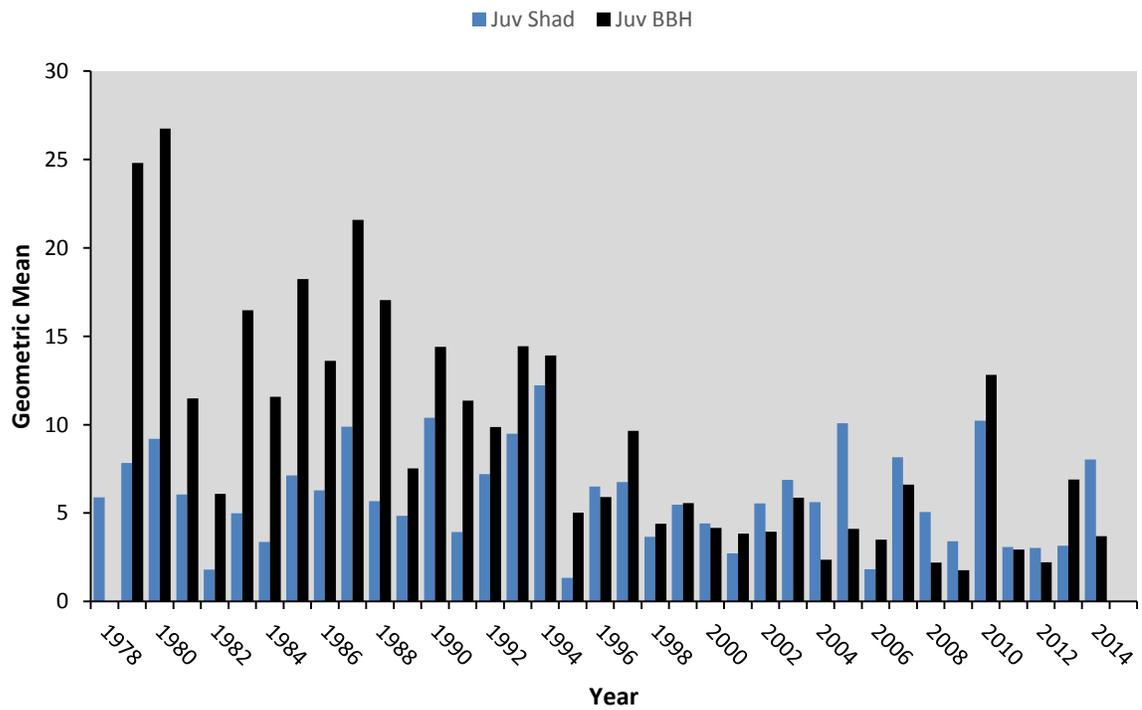


Figure 7.7 Annual Geometric mean cpue of juvenile shad and blueback herring, 1978-2014.

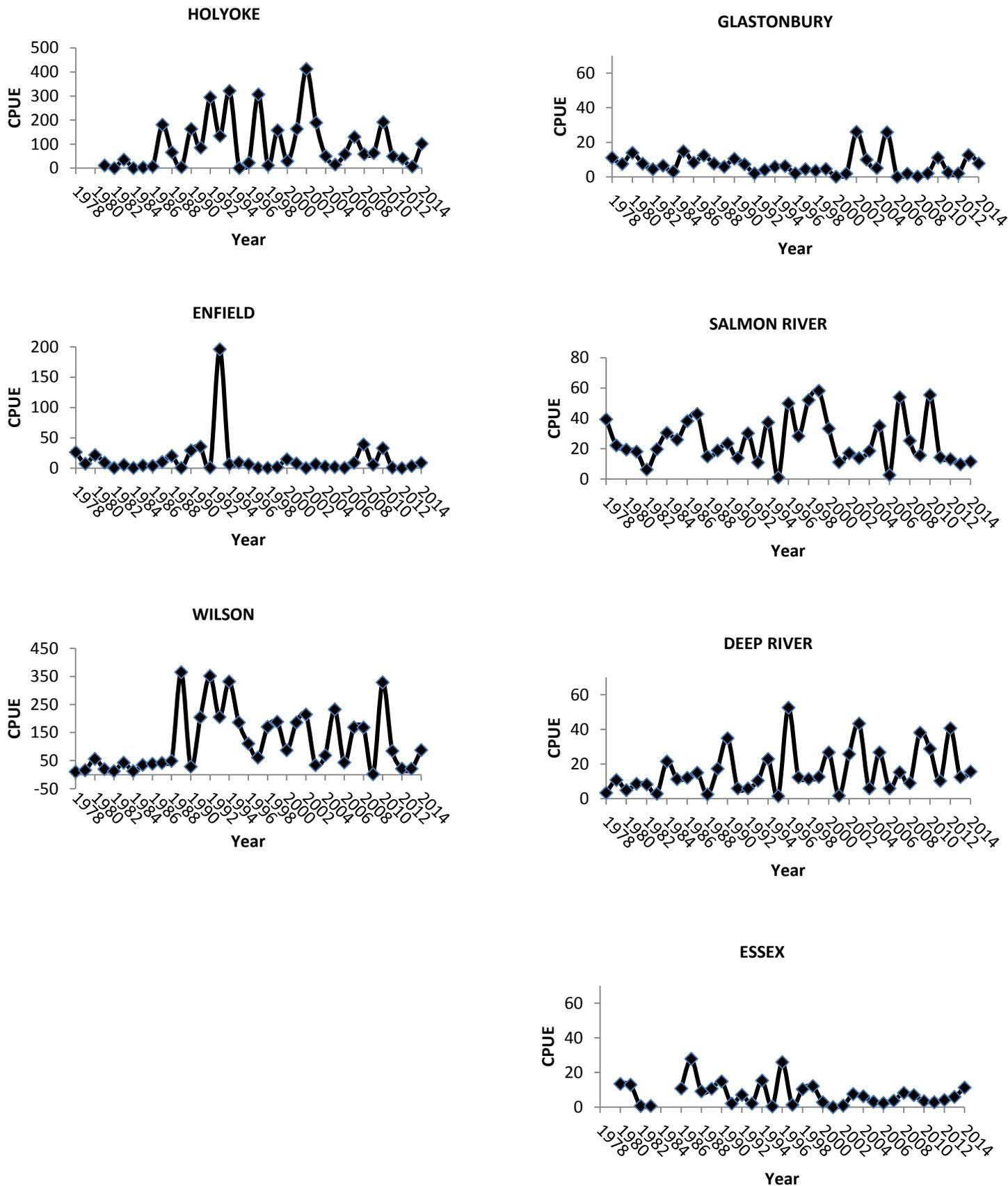


Figure 7.8. Annual CPUE of Connecticut River juvenile American shad by station, 1978-2014.

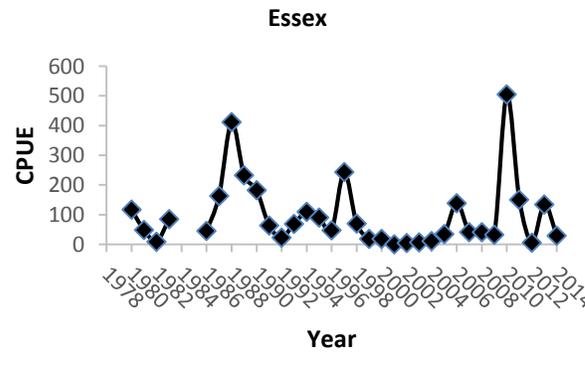
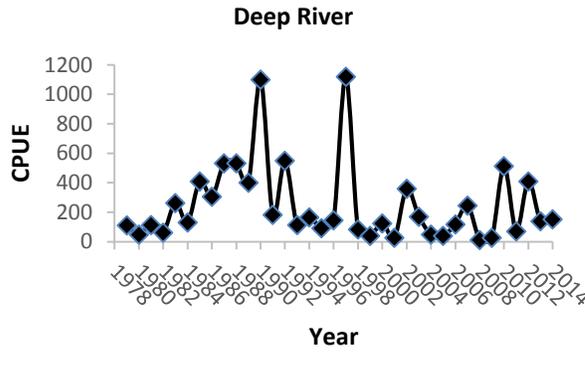
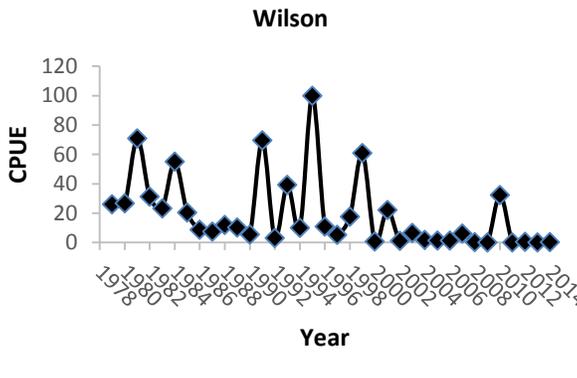
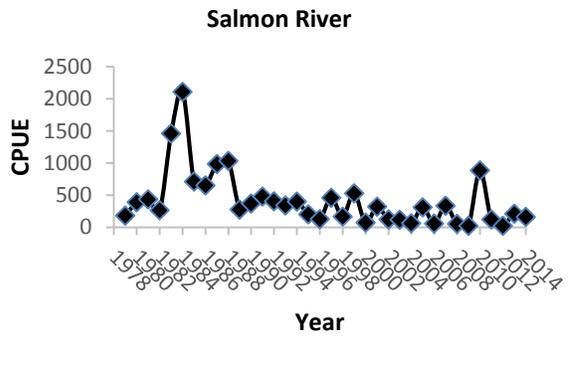
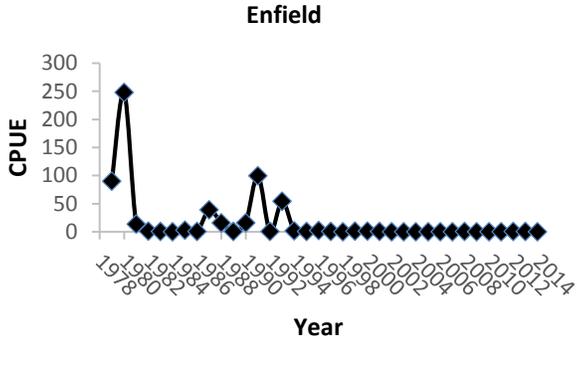
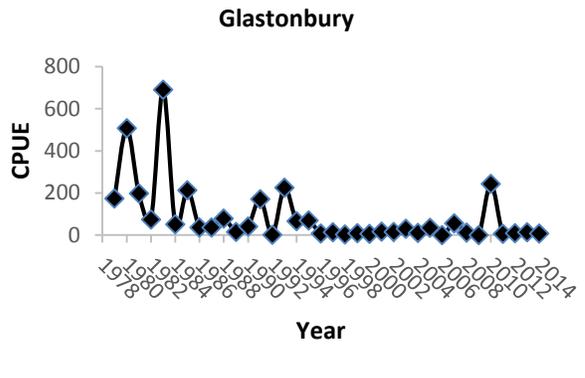
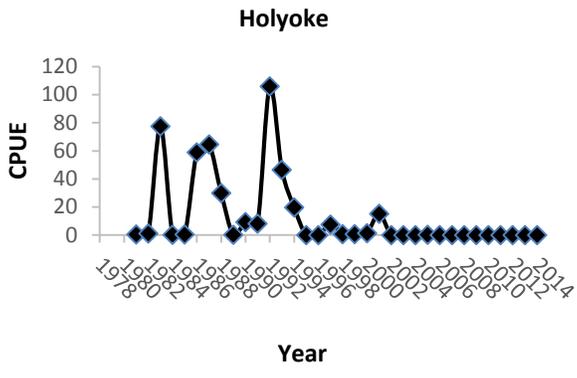


Figure 7.9. Annual CPUE of Connecticut River juvenile blueback herring by station, 1978-2014.

# JOB 8: ESTUARINE SEINE SURVEY

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## **JOB 8: ESTUARINE SEINE SURVEY**

### **OBJECTIVES**

1) *Provide an annual index of recruitment for winter flounder (Age0, 1+), all finfish species taken, and all crab species.*

The 2014 annual index of recruitment for young-of-year winter flounder (0.47 fish/haul) ranked the third lowest out of 27 annual indices.

2) *Provide an annual total count for all finfish taken.*

Mean catch of all finfish (301 fish/haul) ranked the second highest out of 27 annual indices and extremely higher than the series average of 146 fish/haul (Figure 8.2). Geometric means were calculated for 22 species commonly captured since the survey began in 1988 (Table 8.1).

3) *Provide an index for shallow subtidal forage species abundance.*

An index of forage abundance was generated using the catch of four of the most common forage species caught: Atlantic silversides, striped killifish, mummichog, and sheepshead minnow. The index for 2014 (104 forage fish/haul) was the eleventh highest of the 27-year series, and well above the time series average of 95 forage fish/haul.

### **METHODS**

Eight sites (Figure 8.1) are sampled during September using an eight-meter (25 ft.) bag seine with 6.4mm (0.25 in.) bar mesh. Area swept is standardized to 4.6 m (15 ft.), width by means of a taut spreader rope and a 30m (98 ft.), measured distance, parallel to, or at a 45° angle to the shoreline, against the current or tide if present. At each site, six seine hauls are taken within two hours before and after low slack tide during daylight hours. Sites in Groton, Waterford, Old Lyme, Clinton, New Haven, Bridgeport and Greenwich have been sampled since 1988. The Milford site was added in 1990. In addition to September sampling, the original seven sites were sampled in June, July, and August 2013 to compare with samples taken in these months in 1988-1990. Sampling methods were the same as described above.

Finfish, crabs, and other invertebrates taken in each sample are identified to species or lowest practical taxon (full listing given in Appendix 8.1, 8.2) and counted. One exception is inland silversides, which are not separated from Atlantic silversides because they are rare and difficult to identify. Qualitative counts were used for menhaden when abundant ( $n > 1000$ ) to minimize discard mortality. Winter flounder are measured to total length (mm), and classified as young-of-year (YOY) if less than 12 cm and age 1+ if 12cm or larger. The age of flounder near this size was verified in 1990-1992 by examination of the sagittal otolith. Physical data recorded at each seine location included water temperature and salinity at one-meter depth. The geometric or retransformed natural log mean catch per standard haul is calculated for catches at each site and collectively for the 22 most

abundant species, with separate indices for young-of-year and winter flounder age 1 and older. Confidence intervals (95%) for each geometric mean are retransformations of the corresponding log intervals. Frequency of occurrence is given as a percentage of all samples taken each year.

Diversity in the catch, or species richness, was computed for finfish species captured in the Survey over the time series. Species were divided into three groups based on their temperature preferences and seasonal spawning habits as documented in the literature. Criteria used to assign species into a cold temperate group, warm temperate group, or subtropical group are listed in Job 5.

## RESULTS

A total of 48 seine hauls were taken in 2014 at eight sites, yielding a total catch of 14,425 fish of 29 species and 10,752 invertebrates of eleven species. Mean catch of all finfish (301 fish/tow) was the second highest in the 27 year time series (Figure 8.2). This catch is significantly above the long-term mean of 146 fish/tow which can be attributed to above average catches of black sea bass, tautog, scup (porgy), northern kingfish, striped searobin and large catches of bay anchovy along with yoy menhaden. Atlantic silversides were caught in slightly below average abundance. All other forage fish abundances were two or three times above the time series average.

Geometric means were calculated for 22 species commonly captured since the survey began in 1988 (Table 8.1). The most frequently caught species was Atlantic silversides, which occurred in all samples, followed by striped killifish (88%), black sea bass (77%), northern pipefish (69%), tautog (63%), inshore lizardfish (60%), mummichog (54%), northern puffer (48%), scup (48%), striped searobin (46%), and northern kingfish (40%). This rank order has changed from the previous years, with a notable decrease in winter flounder (age 0 and age 1+), mummichog, grubby and windowpane flounder occurrence rates and an increase in black sea bass, northern pipefish, northern puffer inshore lizardfish and northern kingfish occurrence. Fifteen of the 22 species monitored increased in abundance in 2014, four other fish species decreased slightly and three were unchanged. Tautog abundance and occurrence rate increased significantly in 2014 to record highs (Figure 8.4). Tautog abundance and occurrence rate increased significantly in 1998-99, returned to the series average in 2005, 2010 and 2011 after a previous record year in 2007. Previous to 2005, tautog relative abundance significantly increased to all-time abundance levels in 2002-04 and 2012 (Figure 8.4). The abundance of cunner, the other labridae species commonly seen in the survey, fell in 2011 and 2013 but rebounded above the time series averages in 2012 and 2014 after declining in abundance since 2007.

In 2014, only one of the forage species monitored decreased slightly in abundance from the previous year (Atlantic silverside). Three of the forage species monitored increased in abundance by a factor of 2 to 3 times their previous year abundance. Forage fish species Atlantic silverside was slightly below the 27 year time-series average in 2014. Scup occurrence and abundance increased well above the 27 year time series average in 2014,

increasing to its largest abundance in 27 years. Snapper bluefish also occurred in record abundance in 2014. Striped bass and weakfish were not observed in the survey in 2014. Weakfish young-of-year were present in 2014 and also occurred in 2003. Black sea bass and northern kingfish occurred in record abundance in 2014. Striped and northern sea robin, inshore lizardfish occurrence ranked second highest in the 27 year time series. In 2014, cunner reached its third highest abundance. All other species occurred in less than 10% of all samples, with occurrence rates similar to previous years.

Bay scallop occurred for the first time in the time series. Four-spine stickleback re-occurred in 2014, absent from the survey in 2012-13. Two blue-spotted coronetfish were also captured. Three juvenile summer flounder were captured in 2014. Juvenile summer flounder have also occurred in 2006-08, 2010 and 2013 of the 27 year time series. Windowpane flounder re-occurred at low abundance in 2011 after being absent in 2009-10 and 2012-14. Other notable catches: black sea bass, bay scallop, scup, American eel, tautog, oyster toadfish, and menhaden along with inshore lizardfish at the Waterford site. The Clinton site saw large numbers of YOY black sea bass, scup, tautog, striped searobin, northern searobin and cunner. The Greenwich site saw age 1 winter flounder, tautog, fourspine stickleback, scup, along with forage species Atlantic silverside and striped killifish. The New Haven site saw many black sea bass and bay anchovy along with weakfish. Black sea bass, scup, striped searobin, northern kingfish, menhaden, spot and large numbers of forage species were captured at the Old Lyme site. Bridgeport saw the lowest species diversity with Atlantic silverside and snapper bluefish being common. The Groton (Bluff Point) site saw largest numbers of YOY winter flounder, along with black sea bass, blue-spotted coronetfish, sheepshead minnow, naked goby, fourspine stickleback and northern searobin.

### **Relative Abundance of Juvenile Winter Flounder and Tautog**

The 2014 index of YOY winter flounder (0.47 fish/haul) ranked third lowest out of the 27 annual indices (Table 8.2, Figure 8.3 and 8.7). Overall, the time series indicates that relatively strong year classes were only produced many years ago in 1988, 1992, 1994, and 1996 (Figure 8.3).

The 2014 index of YOY tautog (3.5 fish/haul) was the highest ranking out of 27 annual indices (Table 8.1, Figure 8.4), significantly higher than the series average of 0.8 tautog / haul. Overall, the time series indicates an increasing trend in abundance of young-of-year tautog from 1988 to 2008, with relatively abundant year classes produced in 1998-99, 2002-04, 2007-08, 2012 and 2014. The 2006, 2009-11 and 2013 mean was below the long-term average. ( $P \leq 0.05$ ,  $t=2.3$ ,  $df=26$ ), (Table 8.1, Figure 8.4).

### **Presence of Other Important Recreational Finfish**

YOY scup is a recent addition to the seine survey. The species occurred in 1999, with the highest relative abundance in the last ten years of the time series. In 2014, the species was present in record numbers, reflecting excellent recruitment and survival for the species in

2014 (Table 8.3, Figure 8.7). Juvenile striped bass first occurred in the survey in 1999 with one individual captured. In 2003, six more YOY striped bass were taken (Table 8.3, Figure 8.8). One large individual (369mm) was captured in 2008. Four juvenile weakfish occurred in 2014, the first time since 2003 and only the second time in the entire time series. YOY summer flounder have occurred in eleven years (more recently) in the 27-year time series (1993, 1994, 1996, and 1998, 2006 – 2010, 2012-14). The 2006 summer flounder abundances were the highest of the time series, followed by 2007, 2008, 2010, 2012 and 2014. No summer flounder were captured in 2011. YOY black sea bass first appeared in 1991 and every year since 1997, reaching their record highest abundance in 2014 (Figure 8.7). Snapper bluefish occurred in 21 out of 27 years of the time series, reaching peak abundance in 1999 and 2014. Juvenile tautog occurred every year in the seine survey except 1989 and reached record abundance in 2014. White perch appeared in record numbers in 2008 and only once prior, (2005) were present in 2011, and absent in 2012-14. Atlantic tomcod, a threatened species re-appeared in 2008 and 2011, none were present in 2009, 2010 and 2012-14. Inshore lizardfish were captured at above average abundances for the time series in 2014 (second highest). Fourspine stickleback were absent in 2012-13, and appear to be dropping out of the survey, occurring only five times in the past decade. However, they re-occurred in 2014 at three of the eight sites.

### **Relative Abundance of Forage Species**

Seine survey catches are numerically dominated by forage species, defined here as short-lived, highly fecund species that spend the majority of their life cycle inshore where they are common food items for piscivorous fish. An index of forage fish abundance was generated using the catch of four of the most common forage species caught: Atlantic silversides, striped killifish, mummichog, and sheepshead minnow (Figure 8.5, Figure 8.6). The index for 2014 was the eleventh highest in the 27 year time series. Three of the four forage fish species increased in abundance and occurrence in 2014. Atlantic silverside abundance increased in 2014 (65 fish/haul) and was exactly at the series mean of 65 fish/haul for the time series (Table 8.1). Atlantic silversides were the most abundant, and the only species present at all sites in all samples (Table 8.1). There was a substantial increase in striped killifish, and mummichog abundance in 2014. A decrease in these species' abundance in 2012-13 reversed a five-year trend of increasing abundance from 2007-2011 and 2014. Striped killifish increased substantially in abundance in 2014, to the seventh highest in the time series. This species of killifish abundance and occurrence (14.5 fish/tow, 88% occurrence) was well above the series mean of 11 fish/tow. In 2014, mummichog abundance (5 fish/haul) was also well above the long-term average of 2.75 in 2014. Sheepshead minnow had record abundance (3.35) in 2007 and decreased in 2008 through 2010 and 2013. Sheepshead increased slightly in 2011 and again in 2012, the index of abundance of this forage fish in 2014 (0.6 fish/haul) was substantially higher, ranking fifth in the time series. Collectively, forage fish abundance has declined since 2003 (Figure 8.5) but the trend was reversed in 2014, with forage fish abundance ranking eleventh highest in the time series.

Forage fish abundance had shown a general increase since 1997 (Figure 8.5) after a period of lower abundance (decreasing trend) from 1991-1996. In 2013, forage fish abundance was again below the series mean of 98 fish/haul, with a mean catch of 46 fish per haul

(large decline from 2007). Forage fish abundance is driven numerically by the occurrence of adult Atlantic silverside (Figure 8.6) and more recently striped killifish, mummichog and sheepshead minnow, the second, third and fourth most abundant forage species. Striped killifish are more suited to marine habitats, than other 'Fundulus' species captured in the estuarine seine survey. Striped killifish were captured at extremely low numbers in 2012-13, suggesting very poor year class production and survival 2–3 years ago, since the survey captures adults more effectively. Mummichog, the third most abundant forage fish (Table 8.3) in the survey, peaked in abundance in 2007. The lowest time series abundance occurred in 1997. Mummichog appeared to be stable with an above average catches since 1999 but are more recently declining in abundance until 2014 (trend reversed). Sheepshead minnow the least abundant of the four forage fish species monitored has recently shown elevated abundances in 2002-04 and 2007-09, with a record year in 2007 (3.35 fish/tow) and above average catches in 2008 (1.2 fish/tow) followed by slight decreases in 2009 and 2010. In 2011, 2012 and 2014, the sheepshead minnow catch rebounded and was slightly above the series average. The 2014 mean catch was 0.6 fish per tow, above the series mean of 0.5 fish/tow.

### **Relative Abundance of Invertebrate Species**

A total of 10,752 invertebrates of eleven species were captured in 2014 (Table 8.3), (Appendix 8.2). Six crab species were present in the seine hauls, along with two shrimp species, one gastropod and bivalve. Mud snail, sand shrimp, shore shrimp, green crab, and hermit crab were the most abundant. Mud snails, shore shrimp, sand shrimp, hermit and green crab had greater than 50% occurrence in 2014 (Table 8.3). Blue crab abundance continued to remain low in 2014 (12 crabs) from an all-time high in 2009 (333 crabs). The Asian shore crab (Japanese crab) re-appeared in 2011 and 2012 but were absent from 2008-10, 2013 and 2014. The shore shrimp increased substantially in abundance in 2014 from the previous year (Table 8.3). Sand shrimp decrease significantly in abundance in 2014. Mud snail abundance was again above the time series average (2013-14). Mud crabs reached an all-time high abundance in 2013 after dropping in 2011, 2012 and 2014 from a previous higher abundance in 2010. Spider crab abundance was at a time-series high in 2011 and increased slightly above the time series average in 2013 and 2014.

### **Comparison of 2013-2014 Summer Samples with 1988-1990**

A total of 39 seine hauls were taken in June, July, and August 2014 (six hauls at seven sites except three at Greenwich in June due to heavy surf). Combined with data taken in the same manner in June-September 2013 (N=42), mean catch of all finfish at the seven sites varied from 12.9-66.8 fish/sample in June and July, respectively, to 95.5-134.2, respectively, in August and September.

This seasonal pattern was similar to the pattern seen in 1988-1990 (June=35.0, July=44.6, August=114.0, September=100.7 fish/sample) with lowest abundance in June and peak abundance in August and September. This seasonal progression probably reflects resident and migrant species moving into the nursery grounds and/or recruiting to the mesh size of the sampling gear. Standard errors for these monthly mean values (CV range of 24-42%) make them statistically indistinguishable with the exception of the low value in June 2013-2014.

In contrast to the seasonal increase in abundance seen in total finfish from June through September, winter flounder YOY abundance was highest in June and declined over the summer. Although a seasonal decline in abundance was also noted in June-September of 1988 -1990 (slope = -0.13,  $r^2=0.53$ ), the slope of the decline in 2013-4 was almost three times as steep (slope= -0. 37,  $r^2=0.91$ ). This increased decline in abundance reduced moderate production seen in June 2013 and 2014, which was not statistically different from values recorded in June 1988-1990, to the extremely low abundance recorded in September 2013-2014 (Figure 8.7). Mean water temperature for these beach sites was not significantly different by month, with lowest values in June (mean1988-90 = 21.2<sup>0</sup>C, SE=0.23; mean 2013-14 = 20.7<sup>0</sup>C, SE=0.45) and highest values in July (mean 1988-90 = 24.9<sup>0</sup>C, SE=0.20; mean 2013-14 = 24.0<sup>0</sup>C, SE=0.52).

### **Finfish Species Richness**

Over the time series, the mean number of cold temperate species captured per seine haul (Figure 8.8, Table 8.4) varied from 1.6 to 2.8 with a slight negative trend ( $r^2=0.11$ ,  $p=0.049$ ) while the mean number of warm temperate species increased significantly ( $r^2=0.58$ ,  $p<0.001$ ). The mean number of warm temperate species increased from about three species per sample to more than five over the 27-year time series. These changes primarily reflect a decreasingly frequent catch of winter flounder and windowpane flounder (cold-temperate species), and an increasingly frequent catch of black sea bass, northern kingfish, and smallmouth flounder (warm temperate species). Subtropical species richness showed no trend, averaging about one species per haul almost every year.

### **MODIFICATIONS**

In 2015 the seven original seine sites (all sites except Milford) will be sampled in June, July, and August as well as September. These catch data will be compared to catches made in the same summer months in 1988-1990.

**Table 8.1: Geometric mean catch of species commonly taken in seine samples, 1988-2014.** *See Appendix 8.1 for complete species names.*

<b>Species</b>	<b>1988</b>	<b>1989</b>	<b>1990</b>	<b>1991</b>	<b>1992</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>
alewife	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
American sand lance	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
American shad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic menhaden	0.1	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.0	0.1	0.4	0.4	0.4
Atlantic silverside	68.2	31.6	45.0	88.5	51.2	42.7	37.7	27.0	17.7	23.1	74.3	102.5	99.7
Atlantic tomcod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
black sea bass	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.1	0.1	0.0
blueback herring	0.0	0.1	0.0	0.5	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0
bluefish	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.9	0.0
cunner	0.2	0.3	0.0	0.1	0.2	0.0	0.3	0.2	0.3	0.0	0.3	0.5	0.3
fourspine stickleback	0.3	0.4	0.0	0.7	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0
grubby	0.8	0.1	0.0	0.1	0.5	0.1	0.4	0.3	0.2	0.3	0.2	0.5	0.1
inshore lizardfish	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.4	0.1	0.2	0.2
mummichog	2.8	1.6	1.1	1.9	1.6	3.7	3.3	0.7	1.2	0.5	2.0	0.8	3.2
naked goby	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
northern kingfish	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.1	0.0	0.1	0.1	0.1	0.0
northern pipefish	0.7	0.3	0.4	1.0	0.9	0.9	1.1	0.5	1.0	0.4	2.1	1.0	1.0
northern puffer	0.1	0.3	0.1	0.4	0.1	0.4	0.2	0.5	0.2	0.1	0.1	0.2	0.6
rainbow smelt	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
scup	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sheepshead minnow	0.8	1.0	0.1	0.6	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.4
smallmouth flounder	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.3	0.0
striped bass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
striped killifish	11.9	7.9	5.9	4.2	3.1	4.9	5.1	3.9	2.0	1.5	7.2	4.5	8.6
striped searobin	0.2	0.2	0.1	0.2	0.1	0.9	0.1	0.0	0.1	0.4	1.9	0.6	0.1
summer flounder	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
tautog	0.3	0.1	0.3	0.7	0.4	0.2	0.8	0.7	0.3	0.2	0.9	1.3	0.5
weakfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
windowpane flounder	0.6	0.1	0.2	0.2	0.3	0.3	0.1	0.2	0.7	0.4	0.1	0.1	0.1
winter flounder	0.2	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
winter flounder YOY	15.4	1.7	2.9	5.2	11.9	5.7	14.2	10.1	19.2	7.5	9.2	8.7	4.3

**Table 8.1: Geometric mean catch of species commonly taken in seine samples, 1988-2014.** *See Appendix 8.1 for complete species names.*

<b>Species</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Alewife	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>
American sand lance	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	<b>0.0</b>
American shad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>
Atlantic menhaden	0.0	1.0	8.2	0.4	0.2	0.4	0.6	0.1	0.3	0.0	0.1	0.03	0.08	<b>1.2</b>
Atlantic silverside	36.1	80.1	113.6	85.1	81.3	37.7	74.9	57.5	66.8	96.9	66.5	44.9	34.9	<b>64.8</b>
Atlantic tomcod	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	<b>0.0</b>
black sea bass	1.0	0.4	0.2	0.4	0.1	0.5	0.6	0.3	1.1	0.4	3.2	5.2	3.7	<b>10.8</b>
blueback herring	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01	<b>0.0</b>
bluefish	0.1	0.0	0.2	0.2	0.1	0.2	0.0	0.0	0.3	0.0	0.2	0.4	0.2	<b>0.8</b>
cunner	0.2	0.3	0.2	0.5	0.3	0.1	0.5	0.1	0.2	0.1	0.0	0.4	0.02	<b>0.5</b>
fourspine stickleback	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.15</b>
grubby	0.2	0.3	0.5	1.3	0.8	0.3	0.3	0.2	0.5	0.3	0.7	0.2	0.2	<b>0.2</b>
inshore lizardfish	1.2	0.0	0.0	0.0	0.0	1.9	0.2	0.3	0.2	0.1	0.2	0.2	0.13	<b>1.6</b>
mummichog	1.4	3.4	2.9	2.3	1.5	2.5	7.3	2.9	3.8	1.7	3.1	1.6	0.9	<b>5.0</b>
naked goby	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.06	0.05	<b>0.08</b>
northern kingfish	0.2	0.1	0.2	0.3	0.1	0.0	0.0	0.2	0.3	0.5	0.2	0.5	0.7	<b>1.1</b>
northern pipefish	1.4	0.5	0.3	0.7	0.5	0.6	0.8	0.7	1.9	0.6	1.1	1.4	1.7	<b>2.6</b>
northern puffer	0.2	0.7	0.7	0.7	0.5	0.4	1.2	0.2	0.3	0.4	0.4	0.9	1.1	<b>1.1</b>
rainbow smelt	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>
scup	0.5	1.0	0.6	0.2	0.9	0.1	1.0	0.1	1.9	0.1	0.2	2.1	0.12	<b>2.6</b>
sheepshead minnow	0.2	0.6	0.7	0.5	0.2	0.2	3.3	1.2	0.5	0.3	0.5	0.8	0.2	<b>0.6</b>
smallmouth flounder	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.1	0.9	0.4	0.5	<b>0.1</b>
striped bass	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</b>
striped killifish	7.5	14.5	14.9	12.9	19.4	7.1	21.2	21.7	12.3	15.9	28.7	5.3	3.8	<b>14.5</b>
striped searobin	0.4	0.3	0.7	0.5	0.2	0.1	0.3	0.3	0.8	0.2	0.1	0.08	0.17	<b>1.1</b>
summer flounder	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.1	0.0	0.08	0.1	<b>0.04</b>
tautog	0.6	1.5	1.1	1.4	0.7	0.4	2.4	1.0	0.4	0.4	0.3	1.3	0.6	<b>3.5</b>
weakfish	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.03</b>
windowpane flounder	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.0	<b>0.03</b>
winter flounder	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.02	0.0	<b>0.04</b>
winter flounder YOY	1.3	3.1	8.1	11.0	5.6	0.9	4.7	2.0	0.8	1.0	1.1	0.3	0.27	<b>0.47</b>

**Table 8.1 cont.: Percent occurrence of species commonly taken in seine samples, 1988-2014.** See Appendix 8.1 for species names.

<b>Species</b>	<b>1988</b>	<b>1989</b>	<b>1990</b>	<b>1991</b>	<b>1992</b>	<b>1993</b>	<b>1994</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>
alewife	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
American sand lance	0.00	0.00	0.00	0.00	0.02	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
American shad	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic menhaden	0.06	0.05	0.04	0.04	0.19	0.06	0.10	0.04	0.00	0.06	0.06	0.15	0.10
Atlantic silverside	0.97	0.93	0.96	1.00	1.00	0.96	1.00	0.96	0.94	0.92	0.98	0.94	1.00
Atlantic tomcod	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.00
black sea bass	0.00	0.00	0.00	0.04	0.00	0.00	0.15	0.04	0.00	0.00	0.06	0.08	0.02
blueback herring	0.00	0.05	0.04	0.13	0.04	0.00	0.06	0.02	0.00	0.00	0.02	0.08	0.02
bluefish	0.00	0.00	0.00	0.10	0.02	0.00	0.02	0.00	0.00	0.02	0.13	0.46	0.04
cunner	0.17	0.19	0.04	0.10	0.15	0.00	0.23	0.15	0.13	0.02	0.21	0.23	0.19
fourspine stickleback	0.17	0.19	0.00	0.23	0.15	0.04	0.02	0.00	0.04	0.00	0.13	0.04	0.02
grubby	0.33	0.07	0.04	0.10	0.31	0.06	0.33	0.25	0.19	0.29	0.17	0.27	0.10
inshore lizardfish	0.06	0.00	0.04	0.00	0.00	0.06	0.10	0.00	0.00	0.29	0.06	0.17	0.19
mummichog	0.47	0.48	0.35	0.40	0.38	0.50	0.42	0.35	0.42	0.15	0.42	0.29	0.44
naked goby	0.00	0.00	0.02	0.06	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.02	0.00
northern kingfish	0.00	0.00	0.00	0.06	0.08	0.10	0.04	0.15	0.04	0.13	0.10	0.08	0.04
northern pipefish	0.42	0.31	0.37	0.63	0.35	0.50	0.58	0.33	0.44	0.33	0.73	0.48	0.54
northern puffer	0.08	0.24	0.09	0.27	0.08	0.31	0.17	0.40	0.15	0.06	0.10	0.19	0.35
rainbow smelt	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
scup	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
sheepshead minnow	0.31	0.31	0.09	0.21	0.04	0.02	0.02	0.04	0.00	0.04	0.04	0.06	0.17
smallmouth flounder	0.03	0.00	0.00	0.02	0.00	0.13	0.10	0.06	0.04	0.04	0.00	0.21	0.06
striped bass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
striped killifish	0.78	0.67	0.65	0.73	0.58	0.65	0.58	0.69	0.54	0.40	0.75	0.67	0.63
striped searobin	0.11	0.12	0.11	0.10	0.08	0.48	0.10	0.02	0.10	0.35	0.60	0.38	0.10
summer flounder	0.00	0.00	0.00	0.00	0.00	0.04	0.10	0.00	0.02	0.00	0.02	0.00	0.00
tautog	0.22	0.05	0.22	0.42	0.31	0.19	0.33	0.33	0.13	0.17	0.38	0.46	0.23
weakfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
windowpane flounder	0.31	0.10	0.13	0.23	0.23	0.19	0.17	0.19	0.35	0.23	0.13	0.13	0.06
winter flounder	0.25	0.12	0.00	0.15	0.08	0.23	0.17	0.19	0.10	0.15	0.10	0.06	0.15
winter flounder YOY	0.97	0.71	0.74	0.92	0.98	0.88	0.98	0.94	1.00	0.94	0.92	0.88	0.77

**Table 8.1 cont.: Percent occurrence of species commonly taken in seine samples, 1988-2014.** See Appendix 8.1 for species names.

<b>Species</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
alewife	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>
American sand lance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	<b>0.00</b>
American shad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>
Atlantic menhaden	0.02	0.27	0.58	0.08	0.06	0.13	0.17	0.02	0.15	0.02	0.02	0.04	0.04	<b>0.23</b>
Atlantic silverside	0.92	1.00	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	1.00	<b>1.00</b>
Atlantic tomcod	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02	0.00	0.00	0.06	0.00	0.00	<b>0.00</b>
black sea bass	0.25	0.17	0.13	0.25	0.08	0.23	0.23	0.15	0.27	0.13	0.58	0.75	0.58	<b>0.77</b>
blueback herring	0.00	0.04	0.06	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.02	0.00	<b>0.00</b>
bluefish	0.13	0.02	0.10	0.15	0.04	0.08	0.00	0.02	0.15	0.02	0.10	0.21	0.08	<b>0.23</b>
cunner	0.15	0.13	0.17	0.29	0.21	0.13	0.25	0.10	0.17	0.08	0.04	0.23	0.02	<b>0.31</b>
fourspine stickleback	0.06	0.00	0.00	0.02	0.00	0.02	0.00	0.00	0.02	0.00	0.04	0.00	0.00	<b>0.15</b>
grubby	0.17	0.21	0.29	0.50	0.46	0.27	0.15	0.19	0.27	0.21	0.42	0.23	0.20	<b>0.19</b>
inshore lizardfish	0.56	0.04	0.00	0.06	0.00	0.60	0.13	0.19	0.15	0.13	0.10	0.15	0.13	<b>0.60</b>
mummichog	0.42	0.54	0.44	0.35	0.27	0.48	0.65	0.48	0.50	0.40	0.42	0.35	0.27	<b>0.54</b>
naked goby	0.08	0.02	0.02	0.04	0.00	0.08	0.00	0.02	0.00	0.00	0.02	0.08	0.06	<b>0.08</b>
northern kingfish	0.13	0.04	0.15	0.17	0.10	0.02	0.02	0.19	0.17	0.23	0.13	0.29	0.35	<b>0.40</b>
northern pipefish	0.48	0.19	0.25	0.48	0.25	0.29	0.42	0.23	0.52	0.40	0.44	0.60	0.60	<b>0.69</b>
northern puffer	0.17	0.35	0.31	0.40	0.31	0.29	0.44	0.23	0.23	0.21	0.31	0.42	0.38	<b>0.48</b>
rainbow smelt	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>
scup	0.23	0.35	0.25	0.13	0.29	0.04	0.29	0.02	0.38	0.04	0.06	0.42	0.08	<b>0.48</b>
sheepshead minnow	0.10	0.15	0.19	0.15	0.15	0.06	0.40	0.27	0.13	0.10	0.13	0.25	0.07	<b>0.17</b>
smallmouth flounder	0.13	0.00	0.00	0.00	0.00	0.02	0.00	0.13	0.15	0.06	0.40	0.17	0.29	<b>0.06</b>
striped bass	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	<b>0.00</b>
striped killifish	0.71	0.85	0.81	0.73	0.96	0.65	0.88	0.94	0.75	0.90	0.98	0.65	0.58	<b>0.88</b>
striped searobin	0.29	0.25	0.40	0.38	0.13	0.13	0.27	0.19	0.40	0.17	0.06	0.08	0.15	<b>0.49</b>
summer flounder	0.00	0.00	0.00	0.00	0.00	0.19	0.06	0.15	0.02	0.04	0.00	0.08	0.12	<b>0.06</b>
tautog	0.40	0.54	0.50	0.54	0.42	0.17	0.54	0.42	0.35	0.31	0.23	0.60	0.33	<b>0.63</b>
weakfish	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.02</b>
windowpane flounder	0.00	0.02	0.10	0.21	0.15	0.06	0.04	0.10	0.00	0.04	0.02	0.00	0.00	<b>0.04</b>
winter flounder	0.04	0.02	0.00	0.17	0.21	0.15	0.08	0.15	0.04	0.04	0.04	0.04	0.00	<b>0.06</b>
winter flounder YOY	0.58	0.79	0.85	0.98	0.94	0.46	0.92	0.71	0.52	0.60	0.63	0.27	0.23	<b>0.33</b>

**Table 8.2: Mean catch of young-of-year winter flounder at eight sites sampled by seine, 1988-2014.**

<u>Year</u>	<b>BPT</b>	<b>CLT</b>	<b>GRT</b>	<b>GRW</b>	<b>MIL</b>	<b>NHH</b>	<b>OLM</b>	<b>WTF</b>	<b>All Sites</b>
<b>1988</b>	*18.72	2.73	11.39	9.63		38.66	58.19	29.57	<b>15.4</b>
<b>1989</b>	1.7	1.14	1.53	0.7		2.14	2.04	2.99	<b>1.7</b>
<b>1990</b>	3.97	0.19	2.21	0.51	1.62	5.69	16.83	2.64	<b>2.9</b>
<b>1991</b>	1.77	4.1	5.62	1.99	2.46	6.45	15.32	18.25	<b>5.2</b>
<b>1992</b>	3.34	5.53	6.25	9.42	4.29	40.15	47.99	32.52	<b>11.9</b>
<b>1993</b>	1.22	1.4	8.59	4.33	3.62	11.47	13.34	16.66	<b>5.7</b>
<b>1994</b>	4.46	8.11	38.36	4.26	4.62	35.34	61.65	21.03	<b>14.2</b>
<b>1995</b>	1.94	3.19	30.28	7.22	1.77	18.93	34.23	36.58	<b>10.1</b>
<b>1996</b>	7.67	11.81	15.67	*12.61	*6.58	*49.29	91.34	30.53	<b>*19.2</b>
<b>1997</b>	2.87	6.61	23.69	3.43	1.64	3.79	52.01	11.25	<b>7.5</b>
<b>1998</b>	1.24	4.03	17.63	8.12	0.91	22.37	57.19	21.89	<b>9.2</b>
<b>1999</b>	1.04	2.6	25.7	7.95	3.49	0.94	*137.07	36.12	<b>8.7</b>
<b>2000</b>	2.14	0.51	0.76	6.65	0.78	1.74	48.34	*41.56	<b>4.3</b>
<b>2001</b>	0.2	1.12	4.12	1.24	0.59	0	0.91	9.1	<b>1.3</b>
<b>2002</b>	0.91	2.66	3.06	5.08	0.26	1.08	15.55	8.98	<b>3.1</b>
<b>2003</b>	1.88	4.61	*45.78	5.88	0.89	1.7	51.13	32.3	<b>8.1</b>
<b>2004</b>	1	*18.36	33.84	11.27	3.36	33.06	11.13	13.04	<b>11.0</b>
<b>2005</b>	1.94	11.14	16.7	7.71	5.14	1.64	4.06	7.3	<b>5.6</b>
<b>2006</b>	0.12	1.38	5.53	0.12	0	0	3.3	1.29	<b>0.9</b>
<b>2007</b>	0.78	5.65	17.9	4.44	0.78	6.42	7.89	7.11	<b>4.7</b>
<b>2008</b>	0.51	2.45	10.84	0.51	0	1.57	2.62	5.94	<b>2.0</b>
<b>2009</b>	0.91	1.62	2.29	0.12	0.51	0.12	0.12	1.75	<b>0.8</b>
<b>2010</b>	0.41	1.11	1.71	1.33	0.12	0.41	1.88	1.57	<b>1.0</b>
<b>2011</b>	0.12	0.98	1.18	2.26	0.78	0.12	4.27	1.45	<b>1.1</b>
<b>2012</b>	0.00	0.26	0.70	0.76	0.00	0.12	0.26	0.44	<b>0.3</b>
<b>2013</b>	0.00	0.00	1.14	0.26	0.00	0.00	0.65	0.57	<b>**0.275</b>
<b>2014</b>	<b>0.12</b>	<b>0.12</b>	<b>1.82</b>	<b>0.26</b>	<b>0.12</b>	<b>0.12</b>	<b>1.35</b>	<b>0.65</b>	<b>0.47</b>

\*record high for a site/year.

\*\*record low for time-series

**Table 8.3: Total catch 1988-2014.** Invertebrates not counted 1988-2003.

<u>Species</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
<b>alewife</b>					1								28	1
<b>American eel</b>					1				5					
<b>American sand lance</b>			1		10									
<b>American shad</b>	1													
<b>American shad (1+)</b>									151					
<b>Anchovy, spp (YOY)</b>														
<b>Atlantic menhaden</b>	2	4	1,074	3	9	2		11	2,003	377	1,236	1	1,284	5,098
<b>Atlantic needlefish</b>														
<b>Atlantic silverside</b>	5,356	6,383	5,468	5,263	6,311	2,352	1,942	3,249	6,345	10,120	8,738	4,417	5,730	13,278
<b>Atlantic tomcod</b>				3					1					
<b>banded gunnel</b>									2	3				
<b>banded rudderfish</b>														
<b>bay anchovy</b>						4	69		27			1	11	
<b>black sea bass</b>		10			41	43			27	14	2	687	63	27
<b>blue spotted coronet fish</b>										1				
<b>blueback herring</b>	3	194	10		5	2			3	24	1		13	5
<b>bluecrab</b>														
<b>bluefish</b>		15	2		1			1	9	142	3	8	2	17
<b>boreal squid</b>														
<b>brown shrimp</b>														
<b>burrfish, striped</b>										1				
<b>butterfish</b>						1								
<b>channeled whelk</b>														
<b>common slipper shell</b>														
<b>crevalle jack</b>														
<b>cunner</b>	2	5	19		42	24	63	1	23	142	26	15	110	15
<b>flat claw hermit crab</b>														
<b>flying gurnard</b>														
<b>fourspine stickleback</b>		183	11	21	1		3		24	3	1	7		
<b>gizzard shad</b>														
<b>green crab</b>														
<b>grey snapper</b>	1													
<b>grubby</b>	2	7	61	6	38	19	21	28	17	55	15	73	33	95
<b>hogchoker</b>							2							

Table 8.3 continued

<u>Species</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>	<u>Total</u>
alewife												30
American eel									1		2	13
American sand lance							13					24
American shad												1
American shad (1+)												169
Anchovy, spp (YOY)					15							15
Atlantic menhaden	1,117	75	117	144	21	54	3	43	2	14	3404	16100
Atlantic needlefish					2							2
Atlantic silverside	5,122	5,089	3,267	5,087	3,245	4,156	7,063	4,657	4,142	3,958	3832	142636
Atlantic tomcod	1	3			1			8				17
banded gunnel	4	2	3	1	3			1				19
banded rudderfish							1					1
bay anchovy	1	12					1				520	686
black sea bass	110	15	82	109	33	304	86	489	783	1,197	1950	6072
blue spotted coronet fish											2	3
blueback herring				9			3		1	1		299
<i>bluecrab</i>	1	2	84	31	4	333	35	23	27	18	17	675
bluefish	23	8	30		7	53	1	26	54	17	194	613
<i>boreal squid</i>				1								1
<i>brown shrimp</i>			11									11
burrfish, striped								10		4		15
butterfish										21		22
<i>channeled whelk</i>							1				3	4
<i>common slipper shell</i>			13									13
crevalle jack							1					7
cunner	54	35	18	58	8	28	15	2	42	1	73	863
feather blenny									36			36
<i>flat claw hermit crab</i>	761	532	703	153	244	539	558	441	283	367	562	5093
flying gurnard				1								1
fourspine stickleback	9		2			8		2			13	397
gizzard shad								4				4
<i>green crab</i>	234	266	341	147	644	176	308	228	175	253	273	2995
grey snapper												1
grubby	143	76	31	32	16	51	25	55	18	19	18	1087
hogchoker						1						3

**Table 8.3: continued**

<u>Species</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>
inshore lizardfish	5		2			4	6			46	6	16	15	103	2
<i>Japanese shore crab</i>															
<i>Jonah crab</i>															
<i>lady crab</i>															
lined seahorse							4			1			2		
little skate										1					1
<i>mantis shrimp</i>															
<i>mole crab</i>															
<i>moon jelly</i>															
<i>mud crabs</i>															
<i>mud snail</i>															
mummichog	1,031	197	171	765	573	1,256	1,943	78	149	190	396	115	1,008	246	811
naked goby			1	4				1			1	1		4	2
<i>northern comb jelly</i>															
northern kingfish				3	4	23	2	9	3	10	7	6	5	17	5
northern pipefish	65	23	33	106	120	82	117	52	241	38	295	141	96	189	87
northern puffer	4	22	13	34	4	37	15	40	25	5	5	13	63	14	79
northern searobin		2	1				1	1					3	40	24
northern sennet															
northern star gazer		5													
<i>oyster drill</i>															
oyster toadfish	5			1						1	1			1	
pumpkinseed				2											
rainbow smelt						5	2								
rainwater killifish									3	4			2		6
<i>rock crab</i>															
rock gunnel			1		1	1	1			3					
<i>sand shrimp</i>															
scup												1		58	172
sheepshead minnow	174	815	5	345	4	1	2	30		14	19	12	267	59	402
<i>shore shrimp</i>															
smallmouth flounder	1			1		8	14	7	2	5		40	3	12	
smooth dogfish			1												
<i>spider crab</i>															
<i>starfish spp.</i>															
striped anchovy															
striped bass												1			

**Table 8.3: continued**

<u>Species</u>	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>
<b>inshore lizardfish</b>		3		169	18	26	22	10	16	23	11
<b>Japanese shore crab</b>		1		1	1				6	1	
<b>Jonah crab</b>							2				
<b>lady crab</b>		298	119	66	195	92	42	19	24	18	13
<b>lined seahorse</b>					2	7	2	1	2		
<b>little skate</b>											
<b>mantis shrimp</b>										1	
<b>mole crab</b>		1	5								
<b>moon jelly</b>								319			
<b>mud crabs</b>		60	55	74	30	85	67	308	80	80	1107
<b>mud snail</b>		948	2,071	4,478	3,569	3,810	3,128	2,699	2,683	3072	5,787
<b>mummichog</b>	702	637	543	398	1,203	498	857	299	775	329	199
<b>naked goby</b>	2	2		13		2			2	4	4
<b>northern comb jelly</b>							346	36			3,620
<b>northern kingfish</b>	21	38	11	1	1	23	42	76	30	54	81
<b>northern pipefish</b>	25	72	92	82	75	156	307	49	248	152	204
<b>northern puffer</b>	101	75	93	34	241	19	41	51	28	98	202
<b>northern searobin</b>	5	4	13	2	10			1	9		6
<b>northern sennet</b>				1							
<b>northern star gazer</b>											
<b>oyster drill</b>				38							
<b>oyster toadfish</b>	1	2	1	1	1	2	1				6
<b>pumpkinseed</b>		3									
<b>rainbow smelt</b>		34									
<b>rainwater killifish</b>	35	53	19	3							
<b>rock crab</b>		2						1			
<b>rock gunnel</b>		1				1					
<b>sand shrimp</b>		278	373	1,027	525	2,625	762	902	1,507	246	1,794
<b>scup</b>	131	50	154	6	170	14	413	21	30	375	18
<b>sheepshead minnow</b>	276	205	28	104	1,439	304	203	82	219	238	59
<b>shore shrimp</b>		990	404	1,149	707	1,390	535	619	762	402	511
<b>smallmouth flounder</b>				1		14	21	5	114	63	49
<b>smooth dogfish</b>											
<b>spider crab</b>		4	5	6	1	3	1	7	33	13	20
<b>starfish spp.</b>								1			
<b>striped anchovy</b>							3				
<b>striped bass</b>	6					1					

**Table 8.3: continued**

<u>Species</u>	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>	<u>2021</u>	<u>2022</u>	<u>2023</u>	<u>2024</u>	<u>Total</u>
inshore lizardfish	135											638
<i>Japanese shore crab</i>												10
<i>Jonah crab</i>												2
<i>lady crab</i>	41											937
lined seahorse												21
little skate												2
<i>mantis shrimp</i>												1
<i>mole crab</i>												6
<i>moon jelly</i>												319
<i>mud crabs</i>												1,866
<i>mud snail</i>	6938											39283
mummichog	1098											16467
naked goby	6											49
<i>northern comb jelly</i>	1200											5,202
northern kingfish	149											621
northern pipefish	413											3560
northern puffer	97											1453
northern searobin	35											157
northern sennet												1
northern star gazer												5
<i>oyster drill</i>												38
oyster toadfish	2											26
pumpkinseed												5
rainbow smelt												41
rainwater killifish												125
<i>rock crab</i>												3
rock gunnel												9
<i>sand shrimp</i>	662											10,701
<i>scallop (bay)</i>	3											3
scup	485											2098
sheepshead minnow	154											5460
<i>shore shrimp</i>	1011											8460
smallmouth flounder	15											375
smooth dogfish												1
<i>spider crab</i>	14											1073
spot	6											6
starfish spp.												1
striped anchovy												3
striped bass												8

**Table 8.3: continued.**

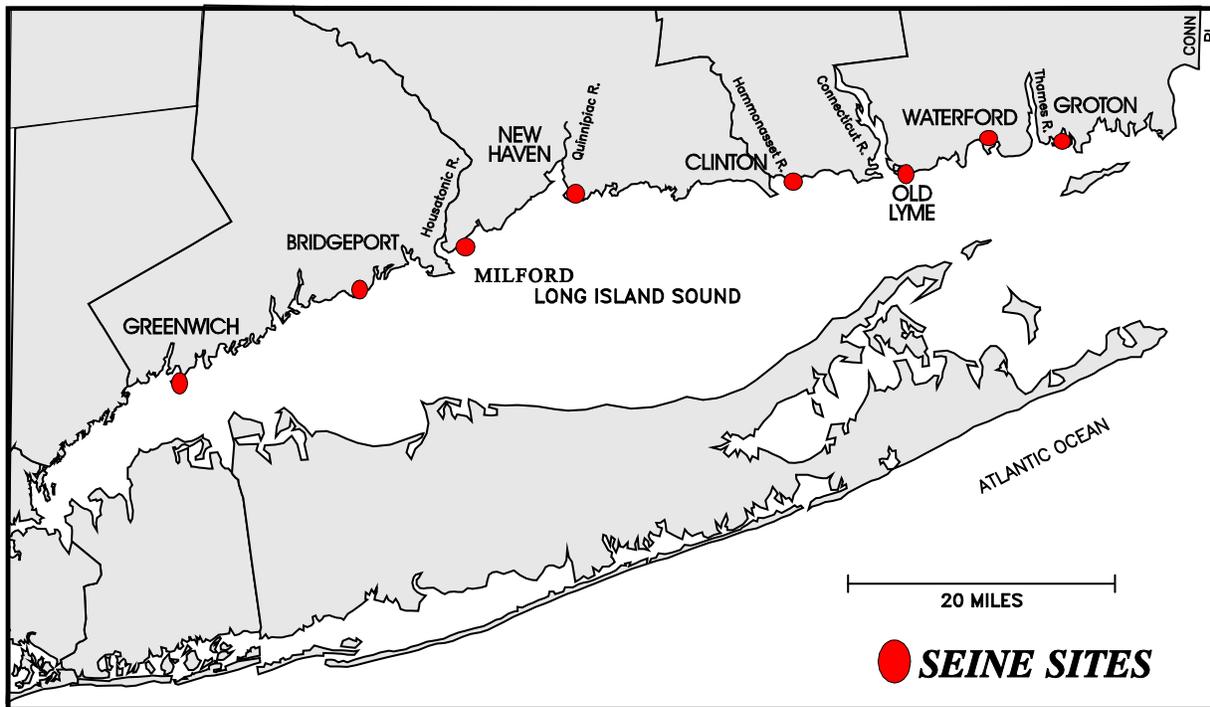
<u>Species</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>
<b>striped killifish</b>	1,511	1,383	748	659	465	773	1,923	520	269	289	1,066	539	1,797	1,494
<b>striped searobin</b>	22	12	5	94	5	71	5	1	9	40	178	51	7	33
<b>summer flounder</b>						2	6		1		1			
<b>tautog</b>	23	5	23	72	32	16	104	88	42	19	135	174	67	59
<b>threespine stickleback</b>														11
<b>weakfish</b>														
<b>web burrfish</b>														
<b>white mullet</b>	1	1	8		3									
<b>white perch</b>														
<b>windowpane flounder</b>	49	4	22	19	35	30	9	13	71	50	12	10	4	
<b>winter flounder</b>	12	6		7	6	14	13	12	21	282	9	4	7	2
<b>winter flounder YOY</b>	900	117	276	410	1,055	483	1,401	916	1,486	874	999	1,497	708	138
<b>yellow jack</b>														
<b>Grand Total</b>	8,722	6,063	6,677	9,323	8,953	8,102	12,028	4,215	4,422	5,162	11,767	13,503	14,076	7,689

<u>Species</u>	<u>2002</u>	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>	<u>Total</u>
<b>striped killifish</b>	1,698	3,410	1,548	1,470	1,063	1,994	1,874	1,508	1,300	1,964	720	493	1158	33636
<b>striped searobin</b>	33	62	38	19	6	32	36	82	14	4	7	14	121	1101
<b>summer flounder</b>					16	8	8	1	6		6	7	3	65
<b>tautog</b>	153	140	145	64	93	321	131	25	33	27	123	73	467	2657
<b>threespine stickleback</b>														11
<b>weakfish</b>		15											4	19
<b>web burrfish</b>					1				1					2
<b>white mullet</b>	1				7	7	11		75	68		22		194
<b>white perch</b>				3			11			6				20
<b>windowpane flounder</b>	1	5	15	15	3	2	17		2	4			2	394
<b>winter flounder</b>	3		9	11	7	6	13	2	2	2	2		3	455
<b>winter flounder YOY</b>	302	1,310	914	470	110	365	190	72	71	86	22	24	48	15244
<b>yellow jack</b>									1					1
<b>Grand Total</b>	11,056	24,783	14,010	12,153	13,662	16,696	15,606	14,188	15,125	14,718	11,641	20,194	14,425	304,534

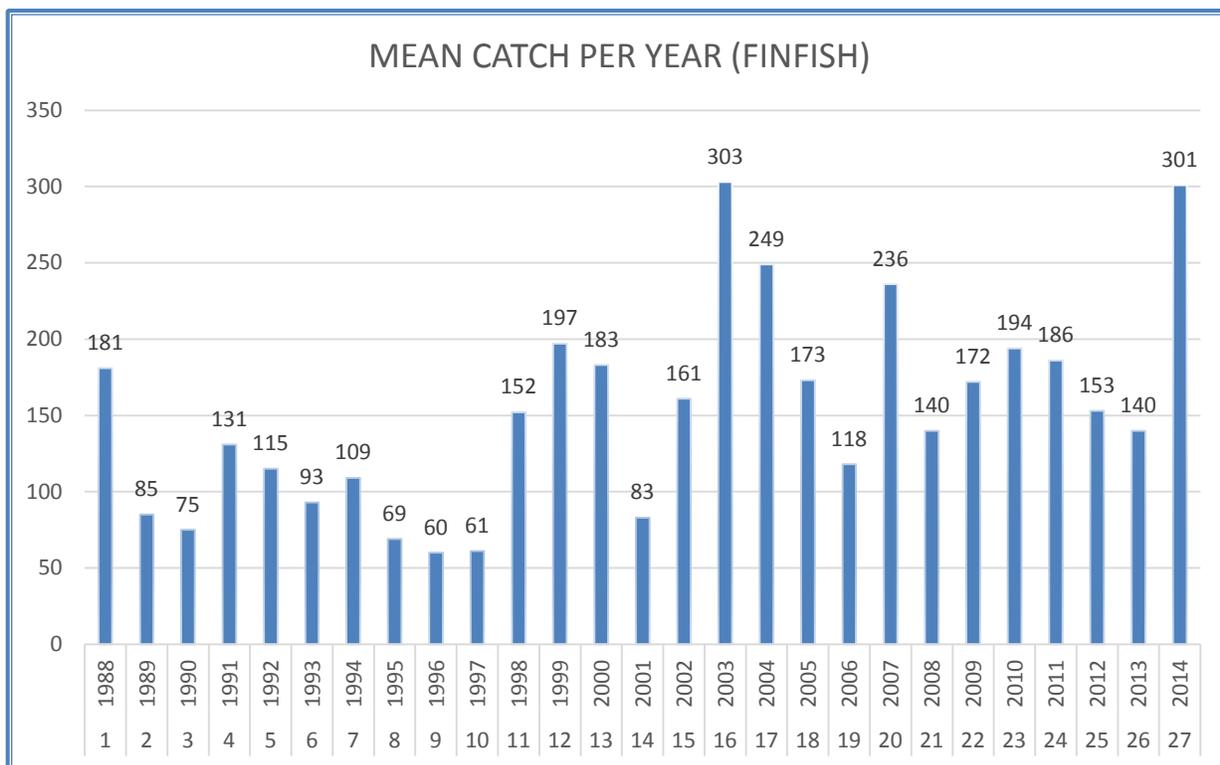
**Table 8.4: Cold and warm temperate species captured in the Estuarine Seine Survey.**

<b>Cold Temperate Species</b>		<b>Warm Temperate Species</b>	
<b>Common name</b>	<b>Scientific Name</b>	<b>Common name</b>	<b>Scientific Name</b>
alewife	<i>Alosa pseudoharengus</i>	American eel	<i>Anguilla rostrata</i>
American sand lance	<i>Ammodytes americanus</i>	American shad	<i>Alosa sapidissima</i>
Atlantic tomcod	<i>Microgadus tomcod</i>	Atlantic silversides	<i>Menidia menidia</i>
cunner	<i>Tautoglabrus adspersus</i>	bay anchovy	<i>Anchoa mitchilli</i>
grubby	<i>Myoxocephalus aeneus</i>	blueback herring	<i>Alosa aestivalis</i>
little skate	<i>Leucoraja erinacea</i>	black seabass	<i>Centropristis striata</i>
northern pipefish	<i>Syngnathus fuscus</i>	bluefish	<i>Pomatomus saltatrix</i>
rock gunnel	<i>Pholis gunnellus</i>	butterfish	<i>Peprilus triacanthus</i>
rainbow smelt	<i>Osmerus mordax</i>	feather blenny	<i>Hypsoblennius hentz</i>
winter flounder	<i>Pseudopleuronectes americanus</i>	gizzard shad	<i>Dorosoma cepedianum</i>
windowpane flounder	<i>Scophthalmus aquosus</i>	hogchoker	<i>Trinectes maculatus</i>
		lined seahorse	<i>Hippocampus erectus</i>
		menhaden	<i>Brevoortia tyrannus</i>
		naked goby	<i>Gobiosoma boscii</i>
		northern kingfish	<i>Menticirrhus saxatilis</i>
		northern puffer	<i>Sphoeroides maculatus</i>
		northern searobin	<i>Prionotus carolinus</i>
		northern stargazer	<i>Astroscopus guttatus</i>
		oyster toadfish	<i>Opsanus tau</i>
		pumpkinseed	<i>Lepomis gibbosus</i>
		scup	<i>Stenotomus chrysops</i>
		silver perch	<i>Bairdiella chrysoura</i>
		smooth dogfish	<i>Mustelus canis</i>
		smallmouth flounder	<i>Etropus microstomus</i>
		spotted hake	<i>Urophycis regia</i>
		spot	<i>Leiostomus xanthurus</i>
		striped searobin	<i>Prionotus evolans</i>
		striped anchovy	<i>Anchoa hepsetus</i>
		striped bass	<i>Morone saxatilis</i>
		summer flounder	<i>Paralichthys dentatus</i>
		tautog (blackfish)	<i>Tautoga onitis</i>
		white perch	<i>Morone Americana</i>
		weakfish	<i>Cynoscion regalis</i>

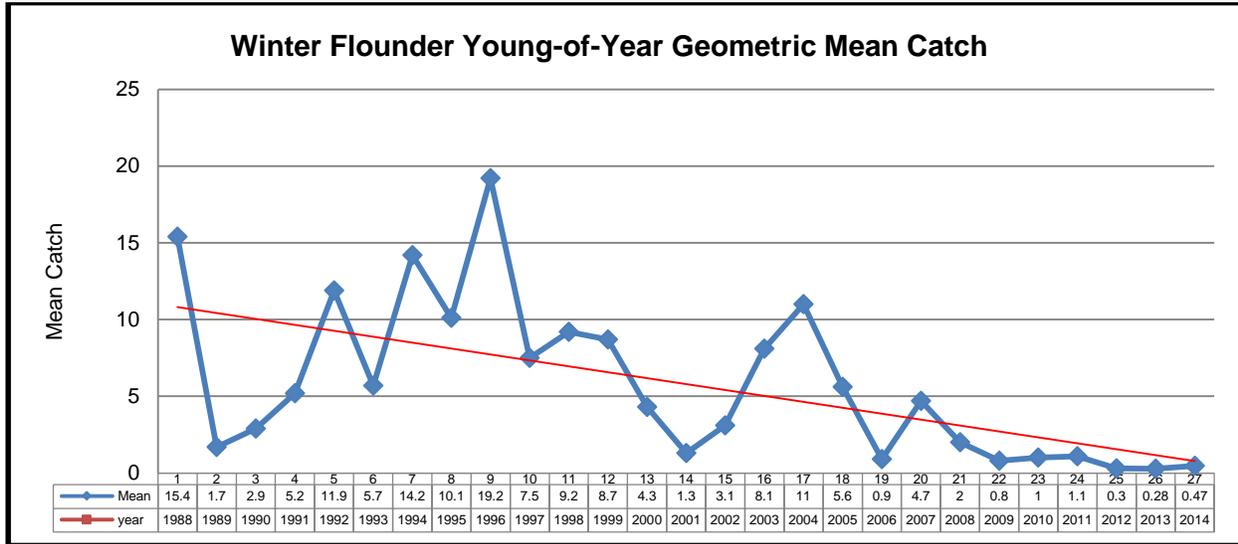
**Figure 8.1:** Sampling locations of the seine survey along the coast of Connecticut.



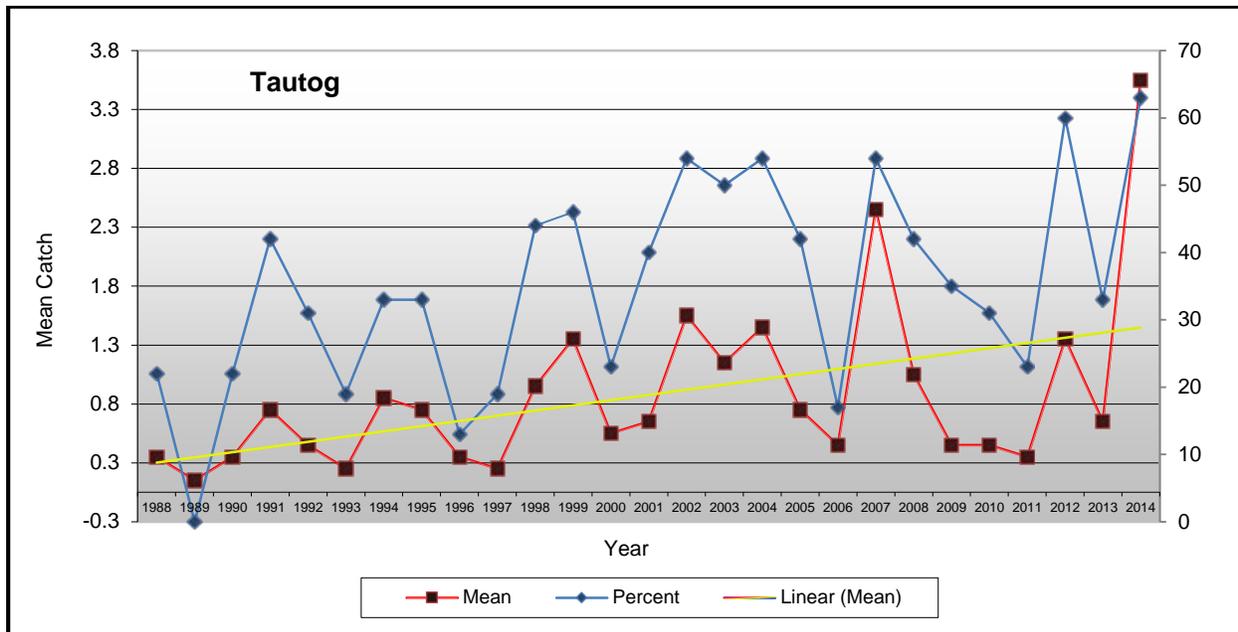
**Figure 8.2: Mean catch (numbers) of all finfish taken in seine samples, 1988-2014.**  
 Mean catch per haul includes samples at all sites. Note that sampling at the Milford site began in 1990.



**Figure 8.3: Mean catch of young-of-year winter flounder, 1988-2014.** The trend line is shown as a horizontal line with an arrow. Note that all sites are included with sampling at the Milford site beginning in 1990.



**Figure 8.4: Mean catch of young-of-year tautog taken in seine samples, 1988-2014.** Geometric mean catch per haul (numbers) and occurrence (percent) includes samples at all sites. The time series trend line is shown by the yellow line. Note that sampling at the Milford site began in 1990.



**Figure 8.5: Mean catch of forage fish at eight sites sampled by seine, 1988-2014.**  
 Forage species include Atlantic silversides, mummichog, sheepshead minnow, and striped killifish.  
 The 95% confidence interval (CI) for each mean is also listed. See Appendix 2.1 for complete species names.

**MEAN CATCH PER STANDARD HAUL**

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MEAN	139	62	65	110	71	65	57	43	26	32	100	127	146
95% CI	97-189	52-107	45-94	81-149	52-104	41-103	34-99	32-57	18-36	20-50	83-145	85-190	108-197

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
MEAN	52	125	206	130	122	59	150	100	106	137	127	60
95% CI	32-86	97-162	152-281	108-155	101-147	43-82	119-187	82-121	86-131	112-167	105-153	41-89

YEAR	2013	2014
MEAN	46	104
95% CI	31-68	85-128

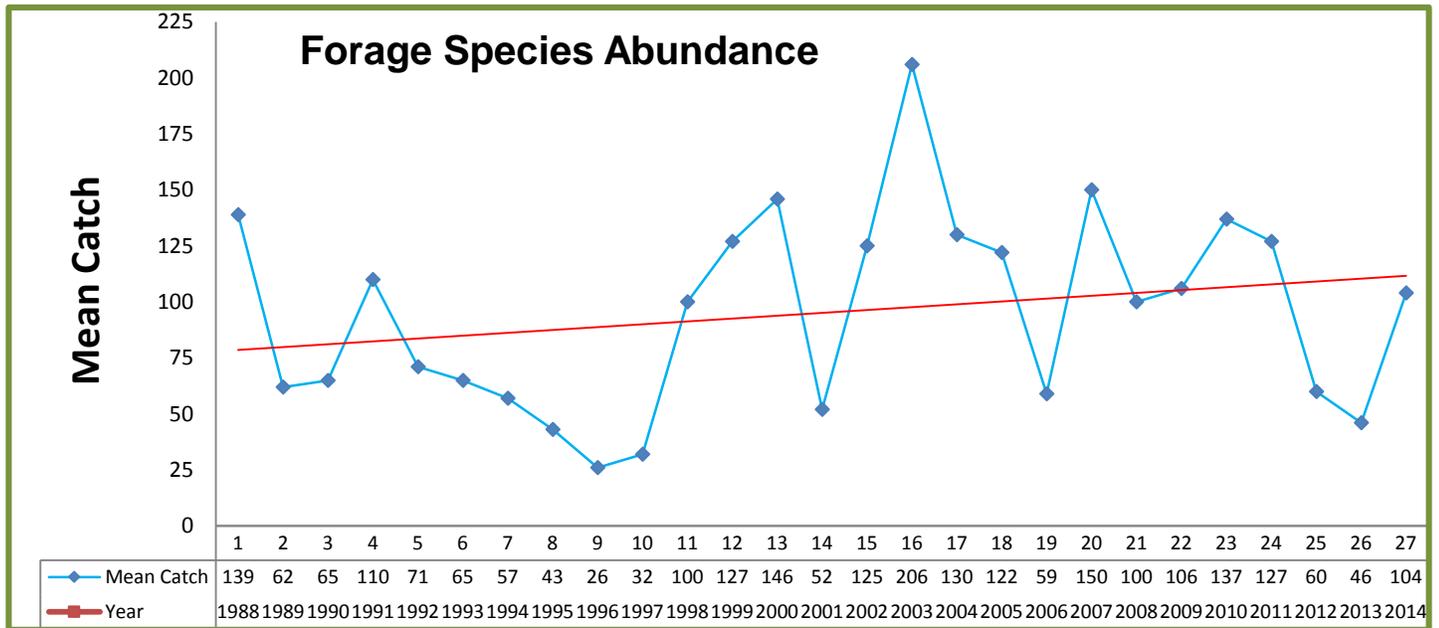


Figure 8.6: Total Catch of Four Species of Forage Fish, 1998-2014

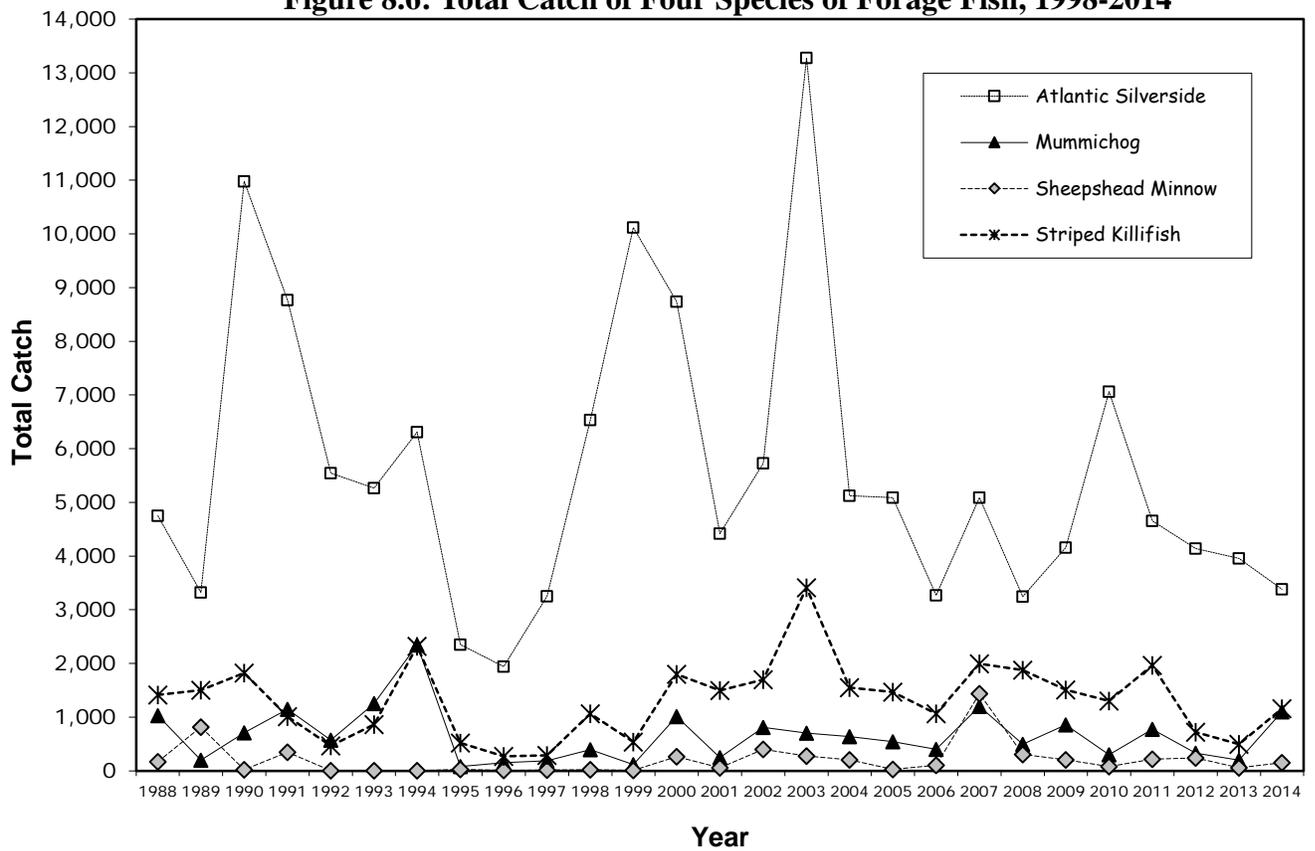
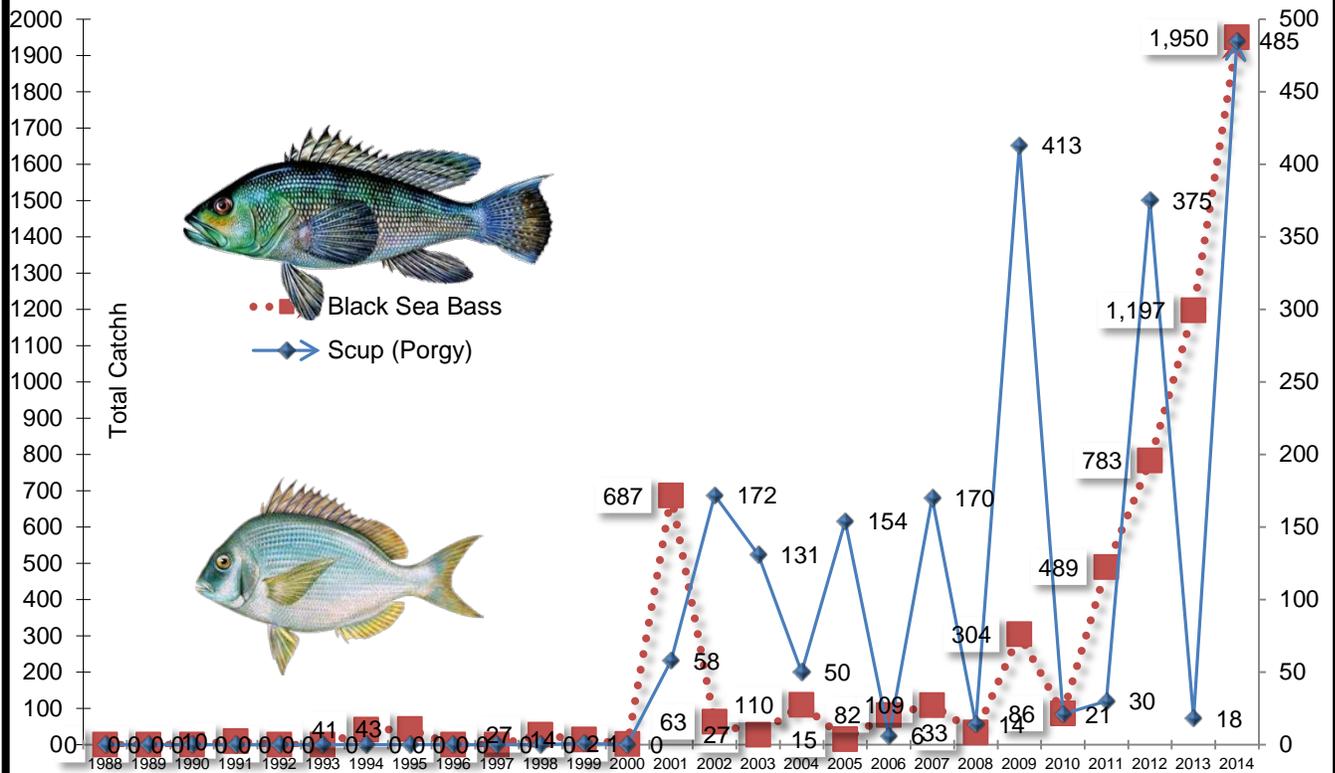
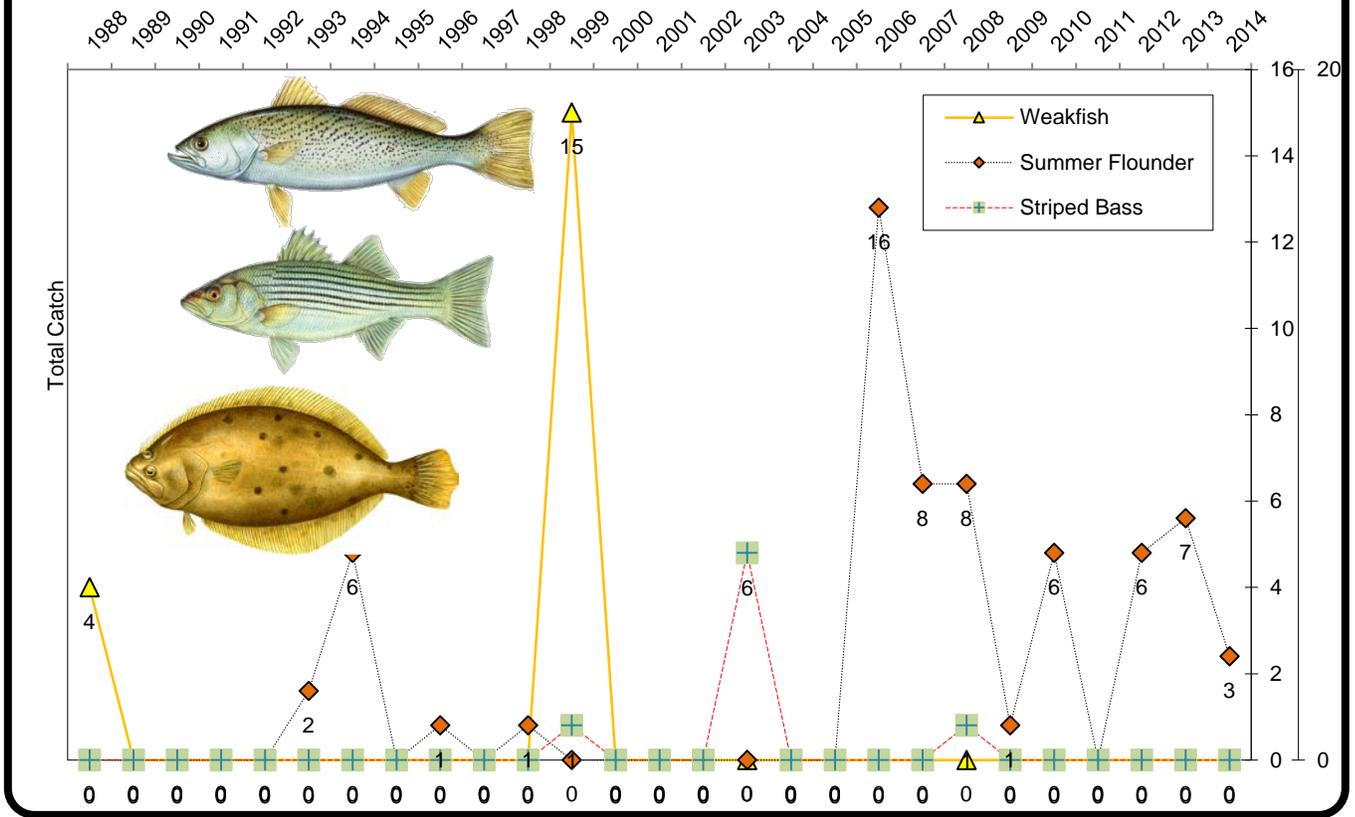


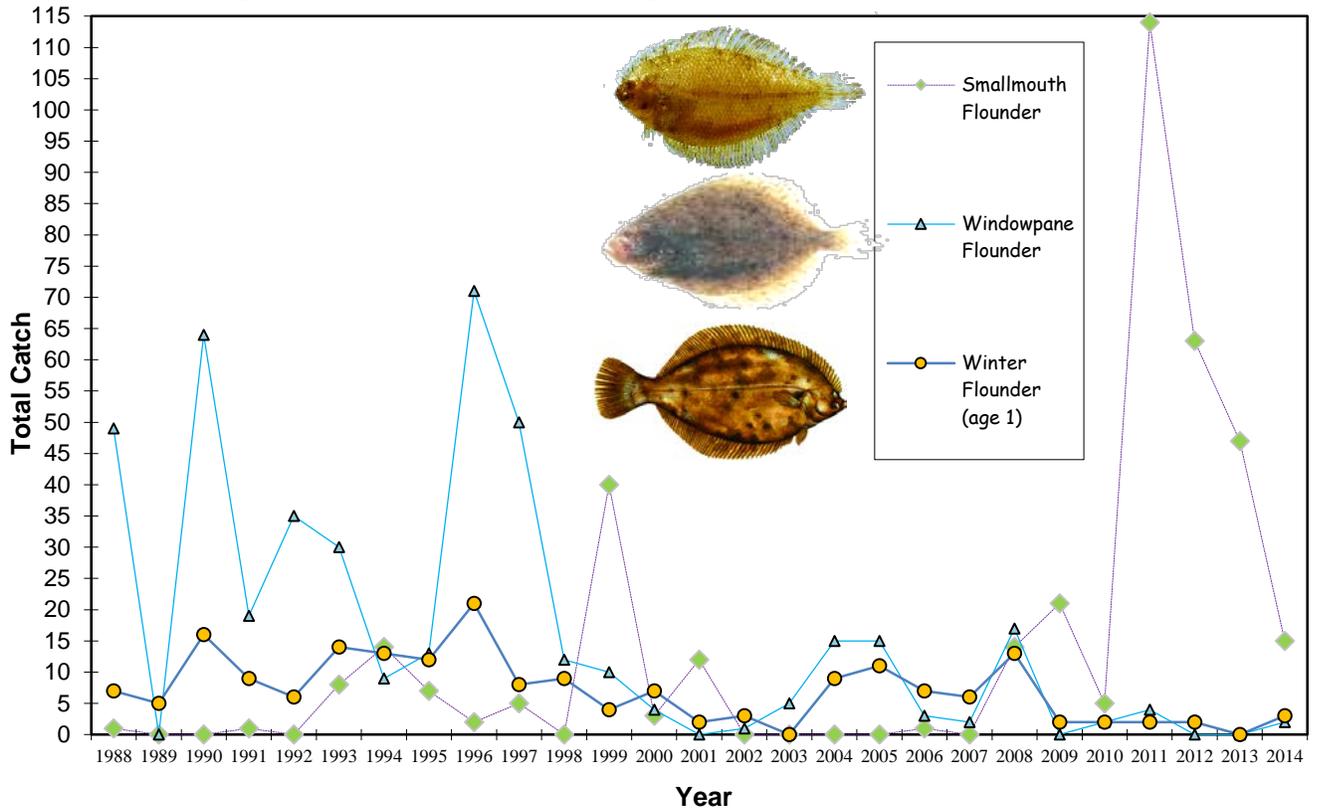
Figure 8.7: Total Catch of Juvenile Black Sea Bass and Scup, Recreational Important Finfish, 1988-2014



**Figure 8.8: Total Catch of Juvenile Striped Bass, Summer Flounder and Weakfish, Recreational Important Finfish, 1988-2014**



**Figure 8.9: Total Catch of Three Species of Juvenile Flounders, 1998-2014**



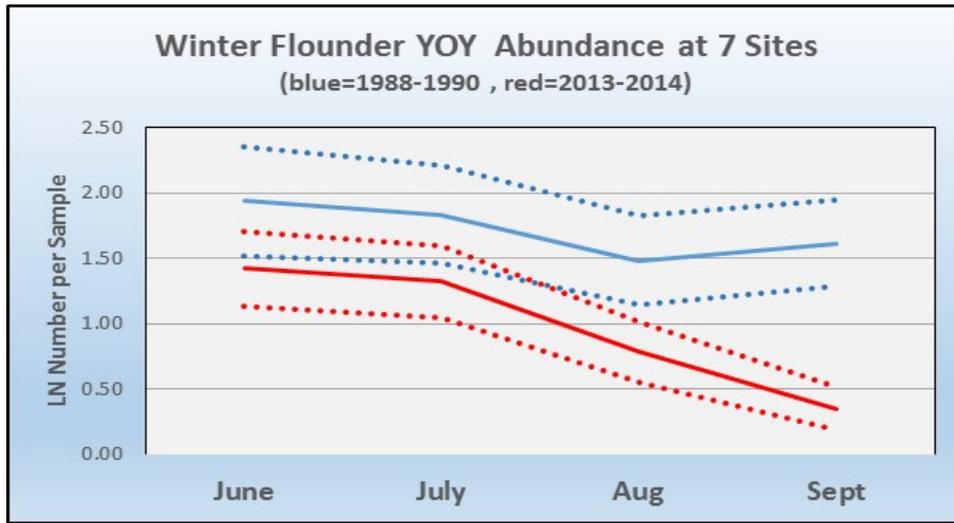


Figure 8.10 Seasonal change in winter flounder young of year (YOY) abundance, 1988-1990 and 2013-2014. Confidence intervals (95%) are shown as dotted lines.

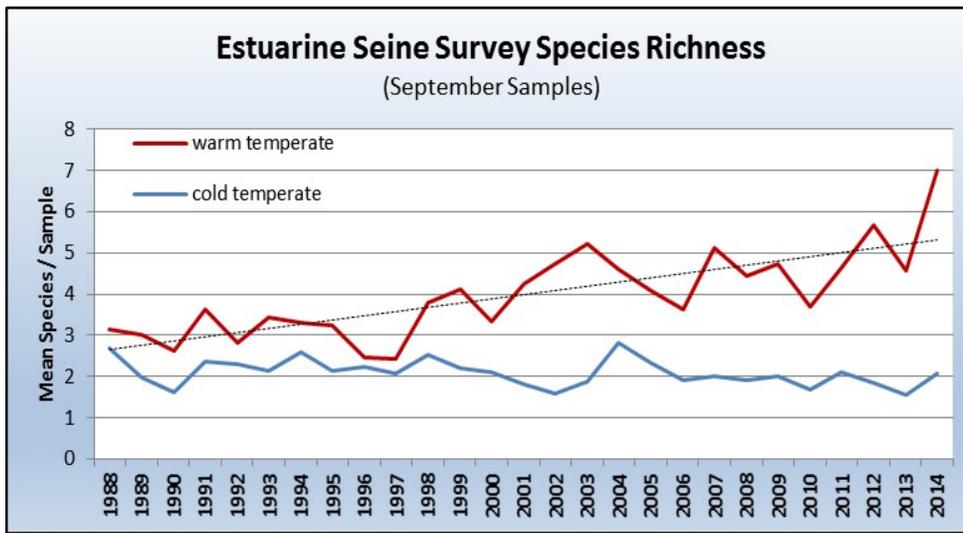


Figure 8.11: Trend in species richness for cold and warm temperate species. Mean species per sample captured in September, 1988-2014, are shown. See Table 2.4 for species listings by group.

## Appendix 8.1: Finfish species taken in the Estuarine Seine Survey, 1988-2014.

<u>COMMON NAME</u>	<u>SPECIES CODE</u>	<u>SCIENTIFIC NAME</u>
Alewife	ALW	<i>Alosa pseudoharengus</i>
American eel	EEL	<i>Anguilla rostrata</i>
American shad	ASD	<i>Alosa sapidissima</i>
American sand lance	ASL	<i>Ammodytes americanus</i>
Atlantic needlefish	ANF	<i>Strongylura marina</i>
Atlantic silversides	ASS	<i>Menidia menidia</i>
Atlantic tomcod	TOM	<i>Microgadus tomcod</i>
Banded gunnel	BGN	<i>Pholis fasciata</i>
Banded rudderfish	RUD	<i>Seriola zonata</i>
Bay anchovy	ACH	<i>Anchoa mitchilli</i>
Black-spot stickleback	BSS	<i>Gasterosteus wheatlandi</i>
Black sea bass	BSB	<i>Centropristis striata</i>
Blueback herring	BBH	<i>Alosa aestivalis</i>
Bluefish	BLF	<i>Pomatomus saltatrix</i>
Blue spotted coronetfish	BSC	<i>Fistularia tabacaria</i>
Crevalle jack	CRJ	<i>Caranx hippos</i>
Cunner	CUN	<i>Tautoglabrus adspersus</i>
Feather Blenny	FBL	<i>Hypsoblennius hentzi</i>
Flying Gurnard	FGD	<i>Dactylopterus volitans</i>
Four-spine stickleback	FSS	<i>Apeltes quadracus</i>
Gizzard Shad	GIZ	<i>Dorosoma cepedianum</i>
Gray snapper	GRA	<i>Lutjanus griseus</i>
Grubby	GRB	<i>Myoxocephalus aeneus</i>
Hogchoker	HOG	<i>Trinectes maculatus</i>
Inshore lizardfish	LIZ	<i>Synodens foetens</i>
Little skate	LSK	<i>Raja erinacea</i>
Menhaden	MEN	<i>Brevoortia tyrannus</i>
Mummichog	MUM	<i>Fundulus heteroclitus</i>
Naked goby	NKG	<i>Gobiosoma boscii</i>
Nine-spine stickleback	NSS	<i>Pungitius pungitius</i>
Northern kingfish	NKF	<i>Menticirrhus saxatilis</i>
Northern pipefish	PIP	<i>Syngnathus fuscus</i>
Northern puffer	PUF	<i>Sphaeroides maculatus</i>
Northern searobin	NSR	<i>Prionotus carolinus</i>
Northern stargazer	STR	<i>Astroscopus guttatus</i>
Pumpkinseed	PUM	<i>Lepomis gibbosus</i>
Rainbow smelt	RSM	<i>Osmerus mordax</i>
Rainwater killifish	RWK	<i>Lucania parva</i>
Rock gunnel	RGN	<i>Pholis gunnellus</i>
Northern seahorse	SEH	<i>Hippocampus erectus</i>
Northern sennet	NOS	<i>Sphyrna borealis</i>
Scup	PGY	<i>Stenotomus chrysops</i>
Sheepshead minnow	SHM	<i>Cyprinodon variegatus</i>
Shorthorn Sculpin	SHS	<i>Myoxocephalus scorpius</i>
Skilletfish	SKL	<i>Gobiosox strumosus</i>
Smallmouth flounder	SMF	<i>Etropus microstomus</i>
Smooth dogfish	SMD	<i>Mustelus canis</i>
Spotted hake	SPH	<i>Urophycis regius</i>
Striped anchovy	STA	<i>Anchoa hepsetus</i>
Striped bass	STB	<i>Morone saxatilis</i>
Striped burrfish	SBF	<i>Chilomycterus schoepfi</i>
Striped killifish	SKF	<i>Fundulus majalis</i>
Striped searobin	SSR	<i>Prionotus evolans</i>
Summer flounder	SFL	<i>Paralichthys dentatus</i>
Tautog	BKF	<i>Tautoga onitis</i>
Three-spine stickleback	TSS	<i>Gasterosteus aculeatus</i>
Toadfish	TDF	<i>Opsanus tau</i>
Weakfish	WKF	<i>Cynoscion regalis</i>
Web Burrfish	WBF	<i>Chilomycterus antillarum</i>
White mullet	WML	<i>Mugil curema</i>
Windowpane flounder	WPF	<i>Scopthalmus aquosus</i>

## Appendix 8.1: Finfish species taken in the Estuarine Seine Survey, 1988-2014.

Winter flounder (YOY)	WFO	<i>Pseudopleuronectes americanus</i>
Winter flounder (AGE 1+)	WFL	<i>Pseudopleuronectes americanus</i>
Yellow jack	YJK	<i>Caranx bartholomaei</i>

## Appendix 8.2: Invertebrate species taken in the Estuarine Seine Survey, 1988-2014.

<u>COMMON NAME</u>	<u>SPECIES CODE</u>	<u>SCIENTIFIC NAME</u>
Bay Scallop	SCA	<i>Argopecten irradians</i>
Blue crab	BCR	<i>Callinectes sapidus</i>
Brown Shrimp	BNS	<i>Panaeus aztecus</i>
Channeled Whelk	CHW	<i>Busycotypus canaliculatus</i>
Northern Comb Jelly	COM	<i>Bolinopsis infundibulum</i>
Green crab	GCR	<i>Carcinus maenas</i>
Hermit crab	HER	<i>Pagurus spp.</i>
Horseshoe crab	HSC	<i>Limulus polyphemus</i>
Japanese crab	JCR	<i>Hemigrapsus sanguineus</i>
Lady crab	LCR	<i>Ovalipes ocellatus</i>
Mantis shrimp	MAN	<i>Squilla empusa</i>
Moon Jelly	MOJ	<i>Aurelia aurita</i>
Mud crab	BMC	<i>Panopeus spp.</i>
Mole crab	MLR	<i>Emerita talpoida</i>
Mud snail	MSN	<i>Nassarius obsoletus</i>
Rock crab	RCR	<i>Cancer irroratus</i>
Sand shrimp	CRG	<i>Crangon septemspinosa</i>
Sea Star	STF	<i>Asterias forbesi</i>
Shore shrimp	PAL	<i>Palaemonetes spp.</i>
Shortfin Squid	ILL	<i>Illex illecebrosus</i>



**Figure 8.12: Beach seining with 25' bag seine, 2014**