

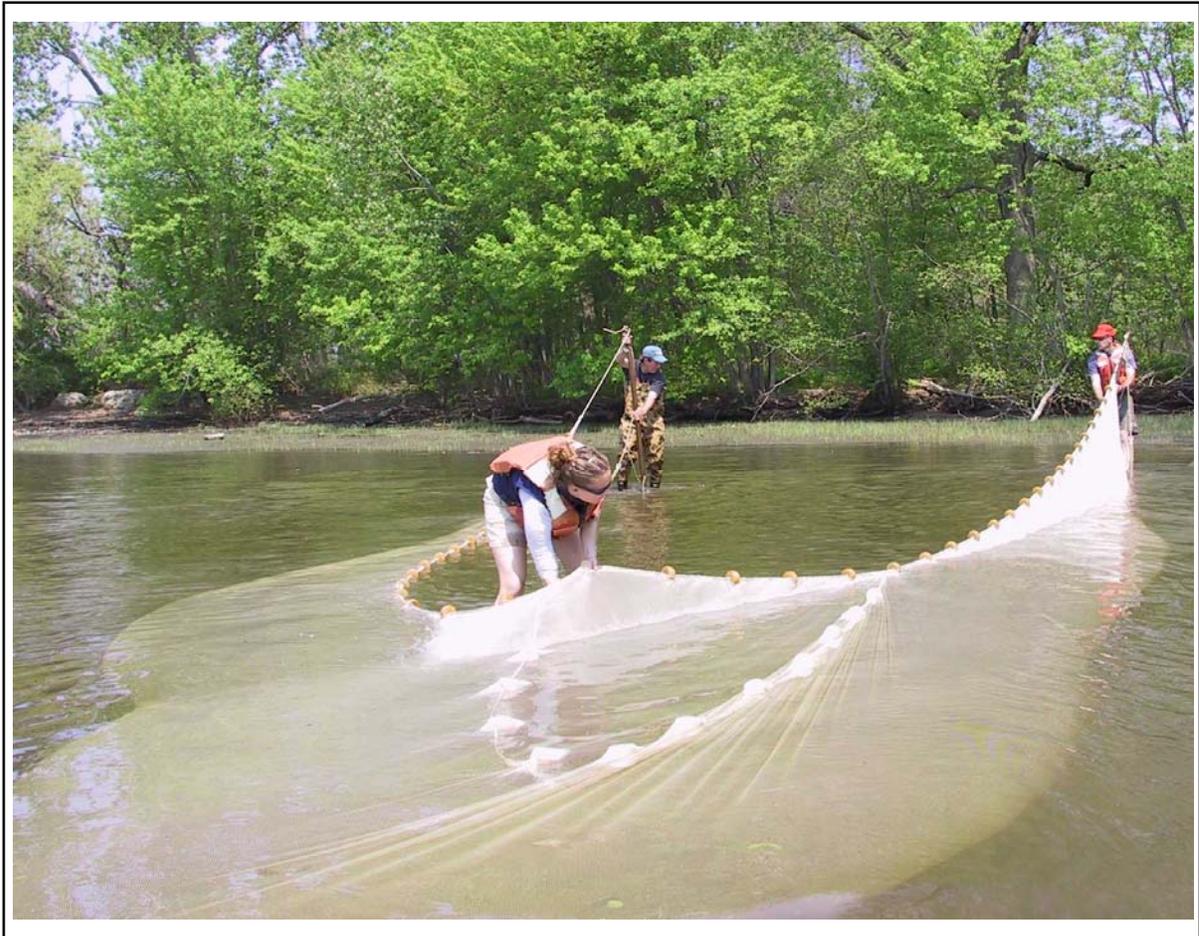


**STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION**

Daniel C. Esty
Commissioner

Bureau of Natural Resources
Marine Fisheries Division
www.ct.gov/dep/fishing

**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

State of Connecticut
Department of Environmental Protection
79 Elm Street
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Federal Aid in Sport Fish Restoration
F-54-R-30
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.

PART 2: ESTUARINE SEINE SURVEY

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JOB 2 PART 2: 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 2010 annual index of recruitment for young-of-year winter flounder (1.0 fish/haul) ranked the second lowest (22nd) out of 23 annual indices.

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

Mean catch of all finfish (194 fish/haul) ranked fifth highest out of 23 annual indices and was above the series average of 143 fish/haul (Figure 2.2). Geometric means were calculated for 22 species commonly captured since the survey began in 1988 (Table 2.1).

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 2010 (137 forage fish/haul) was the fourth highest of the 23-year series, and slightly above the time series average of 98 forage fish/haul.

METHODS

Eight sites (Figure 2.1) 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.

Finfish, crabs, and other invertebrates taken in each sample are identified to species or lowest practical taxon (full listing given in Appendix 2.1, 2.2) 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.

RESULTS

A total of 48 seine hauls were taken in 2010 at eight sites, yielding a total catch of 9,312 fish of 30 species and 5,813 invertebrates of fourteen species. Mean catch of all finfish (194 fish/tow) was the fifth highest in the time series (Figure 2.2). This catch is above the long-term mean of 143 fish/tow which can be attributed to above average catches of Atlantic silversides, as well as northern kingfish, striped killifish, northern puffer, white mullet and American sandlance. Geometric means were calculated for 22 species commonly captured since the survey began in 1988 (Table 2.1). The most frequently caught species was Atlantic silversides, which occurred in all samples, followed by striped killifish (90%), yoy winter flounder (60%), mummichog (40%), northern pipefish (39%), tautog (31%), northern kingfish (23%), and northern puffer (21%). This rank order has changed from the previous years, with a notable decrease in winter flounder (age 0 and age 1+), mummichog, sheepshead minnow and windowpane flounder occurrence rates along with an increase in pipefish, kingfish and puffer occurrence. Only seven of the 22 species monitored increased in abundance in 2010, while thirteen other fish species decreased and three (weakfish, striped bass and age 1 winter flounder) were unchanged. Tautog abundance and occurrence rate increased significantly in 1998-99, returned to the series average in 2005, and 2010 after a record year in 2007. Previous to 2005, tautog relative abundance had significantly increased to all-time abundance levels in 2002-04 (Figure 2.4). In 2010, two forage species increased slightly in abundance from the previous year (Atlantic silverside and striped killifish). Forage fish species striped killifish and sheepshead minnow were slightly below the 23-year time-series average in 2010. Scup occurrence and abundance fell to the 23 year time series average in 2010. Cunner abundance fell again in 2010 dropped to 1997 levels after being the third highest in the 23 year time-series in 2007. Snapper bluefish occurred at the time series average in 2010 after a 2007 absence. Striped bass, weakfish and four-spine stickleback were not observed in the survey in 2010. Weakfish young-of-year were absent and have only occurred in 2003. All other species occurred in less than 10% of all samples, with occurrence rates similar to previous years. One new species of finfish, banded rudderfish (*Seriola zonata*) was captured in 2010, at the Waterford site. Six juvenile summer flounder were captured at the Greenwich site. Summer flounder (juvenile) have occurred in the past five years of the 23 year time series. Other notable catches were two seahorses captured at the Waterford site, seven American sandlance (Old Lyme), one yellow jack and one jack crevalle (Waterford). Seventy-five white mullet were captured at the Bridgeport and Greenwich seines sites in 2010.

Relative Abundance of Juvenile Winter Flounder and Tautog

The 2010 index of YOY winter flounder (1.0 fish/haul) ranked second to last out of 23 annual indices (Table 2.2, Figure 2.3 and 2.7). Overall, the time series indicates that relatively strong year classes were only produced many years ago in 1988, 1992, 1994, and 1996 (Figure 2.3).

The 2010 index of YOY tautog (0.4 fish/haul) was the seventh lowest ranking out of 23 annual indices (Table 2.1, Figure 2.3 and 2.7), well below the series average of 0.8 tautog

/ haul. Overall, the time series indicates a significant increasing trend in abundance of young-of-year tautog from 1988 to 2008, with good year classes produced in 1998-99, 2002-04 and 2007, even though the 2006 and 2009 mean was below the long-term average. ($P \leq 0.03$, $t=2.3$, $df=22$), (Table 2.1, Figure 2.4).

Presence of Other Important Recreational Finfish

YOY scup is another recent addition to the seine survey, first occurring in 1999, with the highest relative abundance in the last nine years of the time series, a reflection of strong recruitment and survival in recent years (Table 2.4, Figure 2.8). Juvenile striped bass first occurred in the survey in 1999 with one individual captured. In 2003 six more YOY stripers were taken (Table 2.4, Figure 2.8). One large individual (369mm) was captured in 2008. YOY summer flounder have occurred in nine years (more recently) of the 23-year time series (1993, 1994, 1996, 1998, 2006 - 2010). The 2010 summer flounder abundance was the third highest of the time series. YOY black sea bass first appeared in 1991 and every year since 1997, reaching their highest abundance in 2009, (Figure 2.7). Snapper bluefish have occurred in 17 out of 23 years of the time series, reaching peak abundance in 1999. Juvenile tautog has occurred every year in the seine survey except 1989. White perch appeared in record numbers in 2008 and only once prior (2005). Atlantic tomcod, a threatened species, re-appeared in 2008, none were present in 2009 and 2010.

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 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 2.5, Figure 2.6). The index for 2010 was the fourth highest in the 23 year time series. Two of the four forage fish species (sheepshead minnow and mummichog) decreased in occurrence in 2010. Atlantic silverside abundance remained at historical highs for the time series. Atlantic silversides were the most abundant, and the only species present at all sites in all samples (Table 2.1). There was a substantial decrease in mummichog and sheepshead minnow abundance in 2010. An increase in this species' abundance in 2002 and 2007 reversed a three-year decrease from 2002-2005. Striped killifish, increased in abundance in 2010. Mummichog abundance (1.7) was below the long-term average of 2.5 in 2010. Sheepshead minnow had a record abundance (3.35) in 2007 and has decreased since. In 2010, the index of abundance ranked tenth in the time series. Striped killifish abundance and occurrence increased but remained slightly above the series mean levels in 2010 (15.9 fish/tow, 90% occurrence). Collectively, killifish abundance has not been high in 2002-2005 and 2008 and was the only forage fish species to remain at high levels in 2008.

Forage fish abundance has generally been increasing since 1997 (Figure 2.5) after a period of lower abundance (decreasing trend) since 1991. In 2010, forage fish abundance rose above the series mean of 98 fish/haul, with a mean catch of 137 fish per haul. Forage fish abundance is driven numerically by the occurrence of adult Atlantic silverside (Figure 2.6) and more recently striped killifish, mummichog and sheepshead minnow, the second and third most abundant forage species. Striped killifish are more suited to marine habitats, than other 'Fundulus' species captured in the estuarine seine survey. Both Atlantic silverside and striped killifish were captured in slightly above average numbers in 2010, suggesting relatively good year class production 2 –3 years ago, since the survey captures adults more effectively. Mummichog, the third most abundant forage fish (Table 2.3) in the survey, peaked in abundance in 2007. The lowest time series abundance occurred in 1997, mummichog appear to be stable with an above average catches since 1999. Sheepshead minnow the least abundant of the four forage fish species monitored has recently shown elevated abundances in 2002-2007, with a record year in 2007 (3.35 fish/tow) and above average catches in 2008 (1.2 fish/tow) followed by slight decrease in 2009 and 2010.

Relative Abundance of Invertebrate Species

A total of 5,813 invertebrates of fourteen species were captured in 2010 (Table 2.3), (Appendix 2.2). Seven crab species were present in the seine hauls, along with two shrimp species, two gastropods and one echinoderm. Mud snail, sand shrimp, shore shrimp, green crab, and hermit crab were the most abundant, and only mud snails, shore shrimp, sand shrimp, and hermit crab had greater than 50% occurrence in 2010 (Table 2.3). Moon jelly fish were common in abundance in 2010.

MODIFICATIONS

None.

LITERATURE CITED

Northeast Utilities Service Company (NUSCo), 2002. Monitoring the marine environment of Long Island Sound at Millstone Nuclear Power Station, Waterford, CT. Winter flounder studies, Table 6, page 34.

Table 2.1: Mean catch of species commonly taken in seine samples, 1988-2010. *Geometric mean catch per haul is given with percent occurrence in parentheses. See Appendix 3.1 for complete species names.*

Species	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Atlantic Silverside	60.7 (95)	32.6 (95)	45.0 (81)	88.5 (100)	53.2 (100)	42.7 (94)	37.7 (100)	27.0 (96)	17.7 (94)	23.1 (92)	81.6 (100)	102.5 (94)
Black Sea Bass	0.0 (0)	0.0 (0)	0.0 (0)	0.1 (4)	0.0 (0)	0.0 (0)	0.2 (15)	0.1 (4)	0.0 (0)	0.0 (0)	0.1 (6)	0.1 (8)
Bluefish (Snapper)	0.0 (0)	0.0 (0)	0.02 (2)	0.1 (10)	0.02 (2)	0.0 (0)	0.01 (2)	0.1 (4)	0.0 (0)	0.01 (2)	0.1 (15)	0.9 (46)
Cunner	0.2 (17)	0.2 (14)	0.03 (4)	0.1 (11)	0.2 (15)	0.0 (0)	0.4 (23)	0.2 (15)	0.4 (13)	0.01 (2)	0.03 (23)	0.5 (23)
Fluke	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.03 (4)	0.08 (10)	0.0 (0)	0.02 (2)	0.0 (0)	0.1 (2)	0.0 (0)
Four-Spine Stickleback	0.3 (17)	0.4 (19)	0.0 (0)	0.7 (22)	0.1 (5)	0.1 (4)	0.01 (2)	0.0 (0)	0.04 (4)	0.0 (0)	0.1 (8)	0.04 (4)
Grubby	0.8 (33)	0.0 (0)	0.03 (4)	0.1 (11)	0.5 (31)	0.1 (8)	0.4 (33)	0.3 (25)	0.2 (19)	0.3 (29)	0.2 (17)	0.5 (27)
Menhaden	0.05 (5)	0.0 (0)	0.03 (4)	0.05 (4)	0.54 (19)	0.04 (6)	0.10 (10)	0.03 (4)	0.0 (0)	0.08 (6)	0.4 (6)	0.4 (15)
Mummichog	2.8 (47)	1.7 (50)	1.1 (35)	1.9 (40)	1.6 (38)	3.7 (50)	3.5 (42)	0.7 (35)	1.2 (44)	0.5 (15)	2.0 (42)	0.8 (29)
Northern Kingfish	0.0 (0)	0.0 (0)	0.0 (0)	0.04 (6)	0.1 (8)	0.2 (10)	0.03 (4)	0.1 (15)	0.04 (4)	0.1 (13)	0.02 (10)	0.1 (8)
Northern Pipefish	0.7 (39)	0.3 (29)	0.5 (41)	1.1 (57)	0.9 (35)	0.9 (50)	1.1 (58)	0.5 (33)	1.0 (44)	0.4 (33)	1.8 (71)	1.0 (48)
Northern Puffer	0.1 (8)	0.2 (19)	0.1 (10)	0.4 (25)	0.1 (8)	0.4 (23)	0.2 (17)	0.5 (40)	0.2 (15)	0.1 (6)	0.1 (10)	0.2 (19)
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 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Sheepshead Minnow	0.7 (27)	1.0 (33)	0.1 (9)	0.6 (21)	0.04 (4)	0.01 (2)	0.02 (2)	0.1 (4)	0.0 (0)	0.1 (4)	0.1 (4)	0.1 (6)
Striped Killifish	9.6 (72)	11.0 (76)	6.0 (65)	4.2 (73)	3.1 (58)	5.1 (63)	5.3 (63)	4.0 (69)	2.0 (54)	1.5 (40)	7.2 (75)	4.5 (67)
Smallmouth Flounder	0.02 (3)	0.0 (0)	0.0 (0)	0.02 (2)	0.0 (0)	0.1 (13)	0.1 (10)	0.1 (6)	0.03 (4)	0.1 (4)	0.0 (0)	0.3 (21)
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 (0)	0.0 (0)	0.0 (0)	0.02 (2)
Striped Searobin	0.2 (11)	0.0 (0)	0.1 (13)	0.2 (10)	0.1 (8)	0.9 (46)	0.1 (10)	0.01 (2)	0.1 (10)	0.4 (35)	1.9 (60)	0.6 (38)
Tautog	0.3 (22)	0.0 (0)	0.3 (22)	0.7 (42)	0.4 (31)	0.2 (19)	0.8 (33)	0.7 (33)	0.3 (13)	0.2 (19)	1.0 (44)	1.3 (46)
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 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Winter Flounder (young-of-year)	15.5 (97)	1.9 (74)	2.9 (74)	5.2 (92)	11.9 (98)	5.6 (88)	14.2 (98)	10.1 (94)	19.2 (100)	7.5 (94)	9.3 (92)	8.7 (88)
Winter Flounder (age 1 + older)	0.1 (14)	0.1 (10)	0.0 (0)	0.1 (15)	0.1 (8)	0.2 (21)	0.2 (17)	0.2 (19)	0.2 (10)	0.1 (15)	0.1 (10)	0.1 (6)
Windowpane Flounder	0.6 (31)	0.0 (0)	0.2 (13)	0.2 (13)	0.2 (23)	0.3 (23)	0.3 (17)	0.1 (17)	0.7 (35)	0.4 (23)	0.1 (13)	0.1 (13)

Table 2.1 cont.: Mean catch of species commonly taken in seine samples, 1988-2010.*Geometric mean catch/haul is given with percent occurrence in parentheses. See Appendix 3.1 for species names.*

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Atlantic Silverside	99.7 (100)	36.1 (92)	80.1 (100)	113.6 (96)	85.1 (100)	81.3 (100)	37.7 (100)	74.9 (100)	57.5 (100)	66.8 (100)	96.9 (100)
Black Sea Bass	0.02 (2)	0.98 (25)	0.39 (17)	0.18 (13)	0.44 (25)	0.14 (8)	0.5 (23)	0.6 (23)	0.3 (15)	1.1 (27)	0.4 (13)
Bluefish (Snapper)	0.04 (4)	0.1 (13)	0.02 (2)	0.15 (10)	0.20 (15)	0.06 (4)	0.17 (8)	0 (0)	0.04 (2)	0.34 (15)	0.01 (2)
Cunner	0.3 (19)	0.16 (15)	0.33 (13)	0.18 (17)	0.48 (29)	0.30 (21)	0.14 (13)	0.47 (25)	0.1 (10)	0.2 (17)	0.1 (8)
Fluke	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0 (0)	0.20 (19)	0.08 (6)	0.12 (15)	0.15 (2)	0.06 (4)
Four-Spine Stickleback	0.01 (2)	0.05 (4)	0.0 (0)	0.0 (0)	0.5 (2)	0 (0)	0.02 (2)	0 (0)	0 (0)	0.5 (2)	0.0 (0)
Grubby	0.1 (10)	0.24 (17)	0.31 (21)	0.53 (29)	1.26 (50)	0.84 (46)	0.35 (27)	0.27 (15)	0.20 (19)	0.46 (27)	0.28 (21)
Menhaden	0.4 (10)	0.01 (2)	1.0 (27)	8.1 (58)	0.42 (8)	0.21 (6)	0.40 (13)	0.59 (17)	0.07 (2)	0.30 (15)	0.03 (2)
Mummichog	3.2 (44)	1.4 (42)	3.4 (54)	2.9 (44)	2.8 (35)	1.5 (27)	2.5 (48)	7.3 (65)	2.9 (48)	3.8 (50)	1.7 (40)
Northern Kingfish	0.05 (4)	0.17 (13)	0.05 (4)	0.21 (15)	0.32 (17)	0.11 (10)	0.01 (8)	0.02 (2)	0.25 (19)	0.29 (17)	0.54 (23)
Northern Pipefish	1.0 (54)	1.4 (48)	0.46 (19)	0.30 (25)	0.74 (48)	0.53 (25)	0.62 (29)	0.82 (42)	0.75 (23)	1.86 (52)	0.59 (39)
Northern Puffer	0.6 (35)	0.17 (17)	0.70 (35)	0.70 (31)	0.67 (40)	0.54 (31)	0.37 (29)	1.24 (44)	0.25 (23)	0.34 (23)	0.40 (21)
Scup	0.0 (0)	0.46 (23)	0.99 (35)	0.56 (25)	0.24 (13)	0.88 (29)	0.06 (4)	0.99 (29)	0.06 (2)	1.9 (38)	0.11 (4)
Sheepshead Minnow	0.4 (17)	0.24 (10)	0.58 (15)	0.66 (19)	0.51 (15)	0.23 (15)	0.23 (6)	3.35 (40)	1.2 (27)	0.5 (13)	0.31 (10)
Striped Killifish	8.6 (63)	7.5 (71)	14.5 (85)	14.9 (81)	12.9 (73)	19.4 (96)	7.1 (65)	21.2 (88)	21.7 (94)	12.3 (75)	15.9 (90)
Smallmouth Flounder	0.4 (6)	0.13 (13)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.01 (2)	0 (0)	0.14 (13)	0.21 (15)	0.06 (6)
Striped Bass	0.0 (0)	0.0 (0)	0.0 (0)	0.06 (6)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.01 (2)	0.0 (0)	0.0 (0)
Striped Searobin	0.1 (10)	0.38 (29)	0.35 (25)	0.66 (40)	0.49 (38)	0.18 (13)	0.09 (13)	0.32 (27)	0.27 (19)	0.78 (40)	0.18 (17)
Tautog	0.5 (23)	0.61 (40)	1.5 (54)	1.1 (50)	1.4 (54)	0.7 (42)	0.38 (17)	2.42 (54)	1.04 (42)	0.36 (35)	0.40 (31)
Weakfish	0.0 (0)	0.0 (0)	0.0 (0)	0.15 (13)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Winter Flounder (young-of-year)	4.3 (77)	1.3 (58)	3.1 (79)	8.1 (85)	11.0 (98)	5.6 (94)	0.92 (46)	4.73 (92)	1.97 (71)	0.78 (52)	0.96 (60)
Winter Flounder (age 1 + older)	0.1 (15)	0.03 (4)	0.03 (2)	0.0 (0)	0.13 (17)	0.17 (21)	0.10 (15)	0.08 (8)	0.15 (15)	0.03 (4)	0.03 (4)
Windowpane Flounder	0.05 (6)	0.0 (0)	0.01 (2)	0.7 (10)	0.2 (21)	0.17 (15)	0.04 (6)	0.03 (4)	0.15 (10)	0.0 (0)	0.03 (4)

Table 2.2: Mean catch of young-of-year winter flounder at eight sites sampled by seine, 1988-2010.

The 95% confidence interval, rounded to the nearest whole number, for each geometric mean per haul is given in parentheses. Sites are listed west to east, left to right.

Year	Greenwich	Bridgeport	Milford	New Haven	Clinton	Old Lyme	Waterford	Groton	All Sites
1988	9.7 (3-29)	*19.0 (1-23)	not sampled	38.7 (23-65)	2.7 (1-7)	58.4 (27-126)	29.6 (19-46)	11.4 (8-16)	15.5 (10-23)
1989	0.6 (0-2)	1.7 (1-10)	not sampled	4.7 (2-11)	1.1 (1-2)	1.6 (0-5)	3.5 (2-7)	1.5 (0-4)	1.9 (1-3)
1990	0.5 (0-1)	4.0 (0-5)	1.6 (0-4)	5.7 (2-14)	0.2 (0-1)	16.8 (10-21)	2.6 (0-4)	2.2 (0-8)	2.9 (2-4)
1991	2.0 (1-2)	1.8 (0-5)	2.7 (1-6)	6.4 (3-13)	4.1 (2-7)	15.3 (7-31)	18.2 (8-39)	5.6 (3-9)	5.2 (3-6)
1992	6.2 (4-19)	3.3 (1-8)	4.3 (1-16)	40.2 (17-94)	5.5 (3-10)	48.0 (32-134)	32.5 (18-59)	6.3 (4-10)	11.9 (7-18)
1993	4.3 (1-21)	1.2 (0-3)	3.6 (2-5)	11.5 (6-20)	1.4 (0-4)	13.3 (4-38)	16.7 (13-22)	8.6 (5-15)	5.6 (4-8)
1994	4.3 (1-20)	4.5 (2-7)	4.6 (1-12)	35.3 (21-59)	8.1 (2-31)	61.7 (37-103)	21.0 (8-52)	38.4 (9-144)	14.2 (9-21)
1995	7.2 (4-13)	1.9 (0-5)	1.8 (0-7)	19.0 (14-26)	3.2 (1-9)	34.2 (17-70)	36.6 (23-58)	30.3 (23-40)	10.1 (7-15)
1996	*12.6 (6-24)	7.7 (4-14)	*6.6 (5-9)	*49.3 (31-79)	11.8 (7-18)	91.3 (64-130)	30.5 (14-63)	15.7 (9-26)	*19.2 (14-26)
1997	3.4 (1-12)	2.9 (0-14)	1.6 (0-4)	3.8 (2-9)	6.6 (1-14)	52.0 (33-80)	11.3 (9-15)	23.7 (4-134)	7.5 (5-11)
1998	9.0 (5-17)	1.2 (0-3)	0.9 (0-2)	22.4 (14-35)	4.0 (3-5)	57.2 (38-86)	21.9 (12-40)	17.6 (4-67)	9.3 (6-14)
1999	8.0 (4-15)	1.0 (0-4)	3.5 (1-10)	0.9 (0-2)	2.6 (1-7)	*137.1 (75-249)	36.1 (24-55)	25.7 (12-55)	8.7 (5-14)
2000	6.7 (2-17)	2.1 (0-6)	0.8 (0-3)	1.7 (1-4)	0.5 (0-1)	48.3 (29-81)	*41.6 (31-55)	0.8 (0-3)	4.3 (2-7)
2001	1.2 (.1-3.4)	0.2 (.2-.9)	0.6 (.1-1.3)	0.0 (0)	1.1 (.1-3.1)	0.9 (.8-2.4)	9.1 (4.9-16.2)	4.1 (.7-14.5)	1.3 (.8-2.1)
2002	5.1 (1.6-13.3)	0.9 (0-2.7)	0.3 (0-0.8)	1.1 (.2-2.5)	2.66 (0.7-7)	15.6 (8.7-27.3)	9.0 (5.9-13.5)	3.1 (0-17.3)	3.1 (2-4.6)
2003	5.9 (1.2-20.4)	1.9 (0.4-4.8)	0.9 (0-4.1)	1.7 (0.2-4.9)	4.6 (2.1-9.0)	51.1 (19.7-130.1)	32.3 (15.2-67.6)	*45.8 (8.0-243.3)	8.1 (4.7-13.4)
2004	11.3 (6.4-19.4)	1.0 (0.3-2.1)	3.4 (0.9-8.5)	33.1 (12.3-86)	*18.4 (9.2-35.7)	11.1 (4.2-27.4)	13.0 (5.7-28.5)	33.8 (20.2-56.1)	11.0 (7.6-15.6)
2005	7.7 (2.7-19.6)	1.9 (1.4-2.7)	5.1 (1-18.3)	1.6 (0.4-4.1)	11.1 (5-23.6)	4.1 (0.3-18.8)	7.3 (2-21.9)	16.7 (6.5-40.7)	5.6 (3.9-8.0)
2006	0.1 (0-0.5)	0.1 (0-0.5)	0 (0-0)	0 (0-0)	1.4 (0.4-3.1)	3.3 (2.1-5.0)	1.3 (0.1-3.8)	5.5 (0.8-23)	0.9 (0.5-1.5)
2007	4.4 (1.2-12.3)	0.8 (0-2.5)	0.8 (0.3-1.4)	6.4 (2.4-15)	5.6 (3.2-9.5)	7.9 (3.7-13.1)	7.1 (0.1-3.8)	17.9 (8.8-35.4)	4.7 (3.3-6.6)
2008	0.5 (0-1.4)	0.5 (0-1.4)	0.0 (0-0)	1.6 (0.3-4.1)	2.4 (0.9-5.3)	2.6 (0.4-8.1)	5.9 (2.9-11.3)	10.8 (4.4-25)	2.0 (1.3-2.9)
2009	0.1 (0.1-0.5)	0.9 (0.3-1.7)	0.5 (0.1-1.4)	0.1 (0.1-0.5)	1.6 (0.5-3.7)	0.1 (0.1-0.5)	1.8 (1.1-2.6)	2.3 (1.0-12.2)	0.8** (0.5-1.2)
2010	1.3 (0.1-3.8)	0.4 (0.2-1.5)	0.1 (0.1-0.5)	0.4 (0.2-1.5)	1.1 (0.1-4.1)	1.9 (1.1-2.9)	1.6 (0.9-2.5)	1.7 (0.1-5.6)	0.965 (0.6-1.4)

*record high for a site.

** record low for time-series

Table 2.3: Total catch of 17 invertebrate species at eight sites sampled by seine, 2010 and total catch for all sites combined, 2004-2010. Seine sites are listed west to east.

Species	Greenwich	Bridgeport	Milford	New Haven	Clinton	Old Lyme	Waterford	Groton	All Sites
Blue Crab	0	0	0	0	19	3	9	0	35
Comb Jelly	0	0	0	0	36	0	0	0	36
Moon Jelly	0	0		300	19	0	0	0	319
Green Crab	1	5	4	0	15	7	5	271	308
Hermit Crab	24	89	5	101	292	9	26	12	558
Asian Crab	0	0	0	0	0	0	0	0	0
Lady Crab	12	2	2	0	1	0	1	0	19
Mud Crab	35	1	3	4	1	14	2	252	308
Mole Crab	0	0	0	0	0	0	0	0	0
Mud Snail	326	757	420	141	561	75	419	0	2,699
Rock Crab	0	0	1	0	0	0	0	0	1
Sand Shrimp	140	6	14	13	77	150	47	395	902
Spider Crab	1	1	3	0	1	0	1	0	7
Shore Shrimp	0	0	1	69	26	17	506	22	619
Shortfin Squid	0	0	0	0	0	0	0	0	0
Channeled Whelk	0	0	0	1	0	0	0	0	1
Starfish	0	0	1	0	0	0	0	0	1

Species	2004	2005	2006	2007	2008	2009	2010
Blue Crab	1	2	84	31	4	333	35
Comb Jelly	0	0	0	0	0	346	36
Moon Jelly	0	0	0	0	0	0	319
Green Crab	234	269	1,024	147	644	176	308
Hermit Crab	760	567	703	153	244	539	558
Asian Crab	1	0	1	1	0	2	0
Lady Crab	298	119	66	195	92	42	19
Mud Crab	60	52	74	30	85	67	308
Mole Crab	1	5	0	0	0	0	0
Mud Snail	948	2,071	4,478	3,569	3,810	3,128	2,699
Rock Crab	2	0	0	0	0	0	1
Sand Shrimp	278	373	1,027	525	2,625	762	902
Spider Crab	4	2	12	1	3	1	7
Shore Shrimp	990	404	1,149	707	1,390	535	619
Shortfin Squid	0	0	0	1	0	0	0

Table 2.4: Total Catch by Species, 1988-2010.

SPECIES	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Alewife			1				1								28	1				
American Eel	1	3	1	1			1				5									
American Shad			1																	
American Sand Lance			1				10													
Atlantic Needlefish																				
Atlantic Silverside	4,750	3,319	10,977	8,765	5,545	5,263	6,311	2,352	1,942	3,249	6,532	10,120	8,738	4,417	5,730	13,278	5,122	5,089	3,267	5,087
Atlantic Tomcod			13			3											1	3		
Banded Gunnel											2	3					4	2	3	1
Banded Rudderfish																				
Bay Anchovy	18	67	24								27			1			1	12		
Black-Spot Stickleback			11																	
Black Sea Bass				10			41	43			27	14	2	687	63	27	110	15	82	109
Blueback Herring			202	194	10		5	2			3	24	1		13	5				9
Bluefish (snapper)			26	23	2		1			1	11	152	3	8	2	17	23	8		
Bluespotted Coronetfish												1								
Crevalle Jack	5		1																	
Cunner	15	13	14	7	19		42	24	63	1	24	142	26	15	110	15	54	35	18	58
Flying Gurnard																				1
4-Spine Stickleback	33	76	83	225	11	21	1		3		6	3	1	7			9		2	
Gray Snapper			1																	
Grubby	111		54	10	61	7	38	19	21	28	17	55	15	73	33	95	143	76	31	32
Hogchoker			3	1																
Inshore Lizardfish	5		2			2	6			46	6	16	15	103	2		3		169	18
Little Skate										1					1					
Menhaden	3		4	5	1,074	3	9	2		11	2,003	377	1,236	1	1,284	5,098	1,117	75	117	144
Mummichog	1,031	198	710	1,150	573	1,256	2,343	78	151	190	396	115	1,008	246	811	702	637	543	398	1,203
Naked Goby			1	5				1			1	1		4	2	2	2		13	
Nine-Spine Stickleback			132																	
Northern Kingfish			2	5	4	23	2	9	3	10	7	6	5	17	5	21	38	11	1	1
Northern Pipefish	64	19	216	142	120	82	117	52	241	38	191	141	96	189	87	25	72	92	82	75
Northern Puffer	4	14	59	37	4	37	15	40	25	5	5	13	63	14	79	101	75	93	34	241

Table 2.4 Cont.: Total Catch by Species, 1988-2010.

SPECIES	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Northern Searobin			7										3	40	24	5	4	13	2	10
Northern Sennet																			1	
Northern Stargazer		5																		
Oyster Toadfish	3	-	-	1	-	-	-	-	-	1	1			1		1	2	1	1	1
Pumpkinseed				2													3			
Rainbow Smelt						5	2										34			
Rainwater Killifish			4							4			2		6	35	53	19	3	
Rock Gunnel			1		1	1				3							1			
Seahorse (Northern)			1				4			1			2		1					2
Scup (Porgy)												1		58	172	131	50	154	6	170
Sheepshead Minnow	168	816	20	345	4	1	2	30	7	14	19	12	267	59	402	276	205	28	104	1,439
Smallmouth Flounder	1			1		8	14	7	2	5		40	3	12						1
Smooth Dogfish			1																	
Spotted Hake			1																	
Striped Anchovy																				
Striped Bass												1				6				
Striped Burrfish												1								
Striped Killifish	1,416	1,504	1,824	1,009	465	863	2,323	520	269	289	1,066	539	1,797	1,494	1,698	3,410	1,548	1,470	1,063	1,994
Striped Searobin	22		20	125	5	71	5	1	9	40							38	19	6	32
Summer Flounder						2	6		1		1								16	8
Tautog (Blackfish)	23	17	53	135	32	16	104	88	42	20	133	174	67	59	153	140	145	64	93	321
Three-Spine Stickleback			64											11						
Weakfish																15				
Web Burrfish																			1	
White Perch																		3		
White Mullet			8		3										1				7	7
Windowpane Flounder	49		64	19	35	30	9	13	71	50	12	10	4		1	5	15	15	3	2
Winter Flounder (age 0)	904	139	276	483	1,055	481	1,401	916	1,486	874	1,015	1,497	708	138	302	1,310	914	470	110	365
Winter Flounder (age 1)	7	5	16	9	6	14	13	12	21	8	9	4	7	2	3		9	11	7	6
Yellow Jack			1																	

Table 2.4 Cont.: Total Catch by Species, 1988-2010.

SPECIES	<u>2008</u>	<u>2009</u>	<u>2010</u>
Alewife			
American Eel			
American Shad			
American Sand Lance			13
Atlantic Needlefish	2		
Atlantic Silverside	3,245	4,156	7,063
Atlantic Tomcod	1		
Banded Gunnel	3		
Banded Rudderfish			1
Bay Anchovy	15		1
Black-Spot Stickleback			
Black Sea Bass	33	304	
Blueback Herring			3
Bluefish (snapper)	7	53	1
Bluespotted Coronetfish			
Crevalle Jack			1
Cunner	8	28	15
Flying Gurnard			
4-Spine Stickleback		8	
Gray Snapper			
Grubby	16	51	25
Hogchoker		1	
Inshore Lizardfish	26	22	10
Little Skate			
Menhaden	21	54	3
Mummichog	498	857	299
Naked Goby	2		
Nine-Spine Stickleback			
Northern Kingfish	23	42	76
Northern Pipefish	156	307	49

Table 2.4 Cont.: Total Catch by Species, 1988-2010.

SPECIES	2008	2009	2010
Northern Puffer	19	41	51
Northern Searobin			1
Northern Sennet			
Northern Stargazer			
Oyster Toadfish	2	1	
Pumpkinseed			
Rainbow Smelt			
Rainwater Killifish			
Rock Gunnel	1		
Seahorse (Northern)	7	2	1
Scup (Porgy)	14	413	21
Sheepshead Minnow	304	203	82
Smallmouth Flounder	14	21	5
Smooth Dogfish			
Spotted Hake			
Striped Anchovy	3		
Striped Bass	1		
Striped Burrfish			
Striped Killifish	1,874	1,508	1,300
Striped Searobin	36	82	14
Summer Flounder	8	1	6
Tautog (Blackfish)	131	25	33
Three-Spine Stickleback			
Weakfish			
Web Burrfish			1
White Perch	11		
White Mullet	11		75
Windowpane Flounder	17		2
Winter Flounder (age 0)	190	72	71
Winter Flounder (age 1)	13	2	2
Yellow Jack			1

Figure 2.1: Sampling locations of the seine survey along the coast of Connecticut.

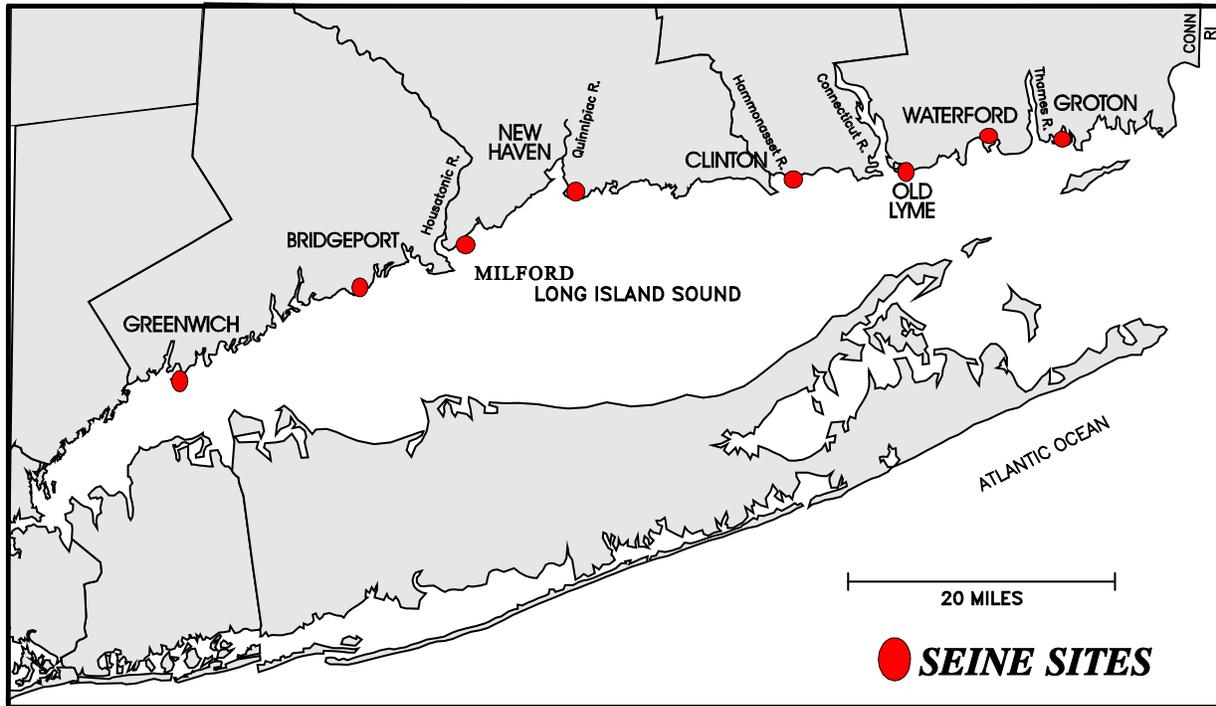


Figure 2.2: Mean catch (numbers) of all finfish taken in seine samples, 1988-2010. Mean catch per haul includes samples at all sites. Note that sampling at the Milford site began in 1990.

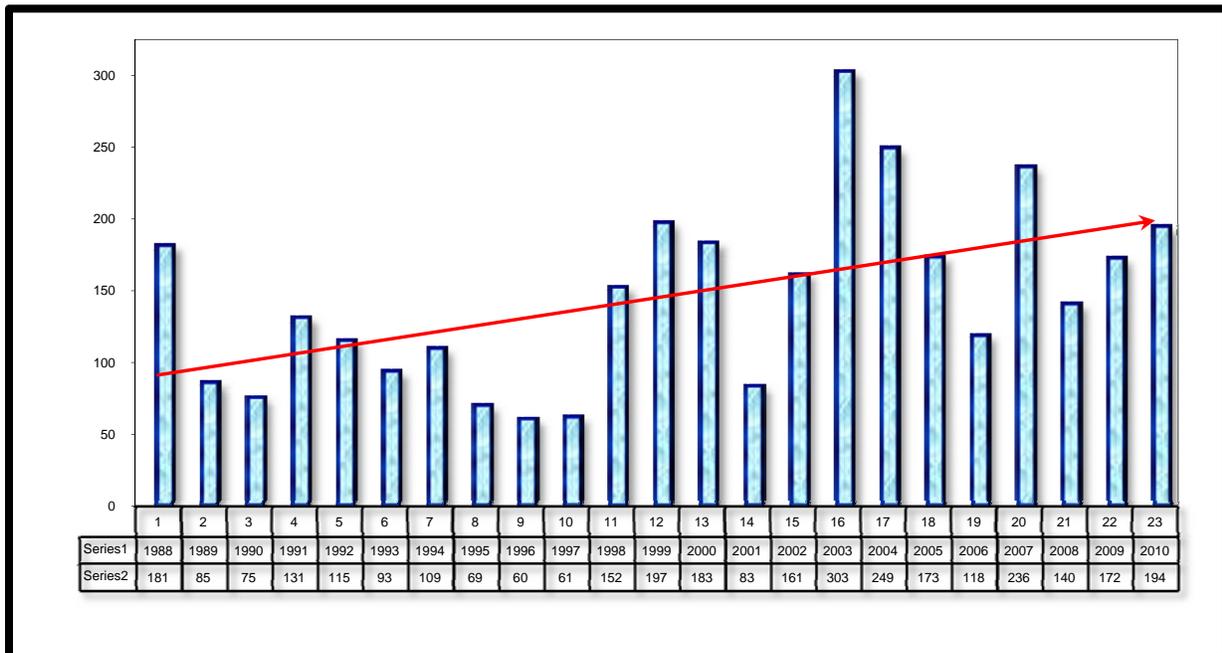


Figure 2.3: Mean catch of young-of-year winter flounder, 1988-2010. The trend line is shown as a horizontal line with an arrow. Note that all sites are included with sampling at the Milford site beginning in 1990.

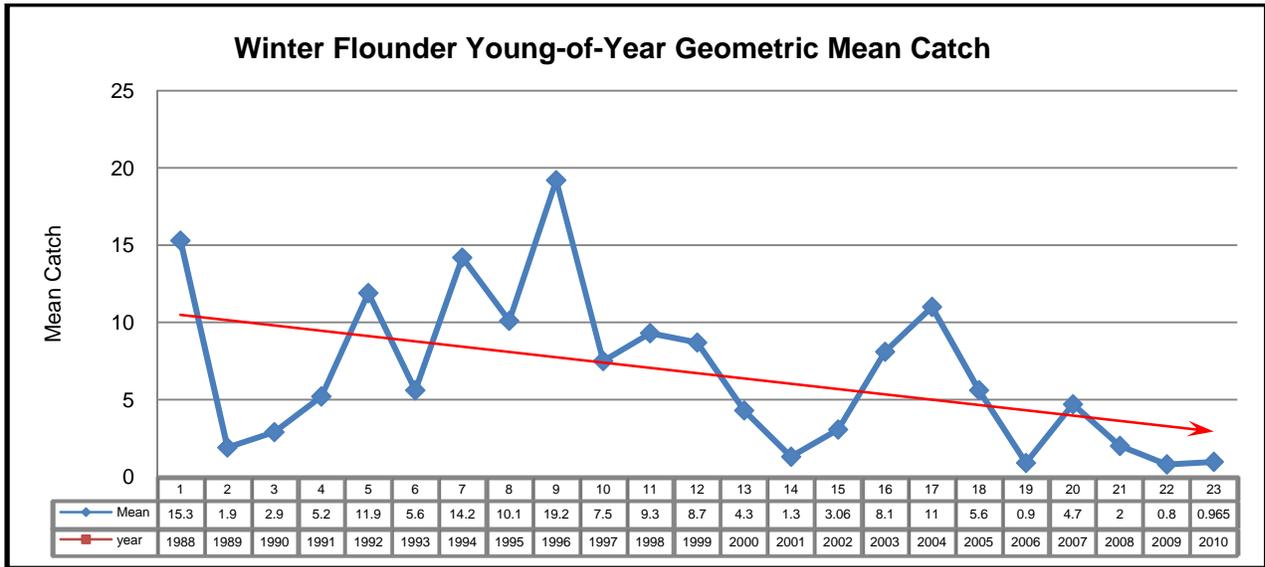


Figure 2.4: Mean catch of young-of-year tautog taken in seine samples, 1988-2010. Geometric mean catch per haul (numbers) and occurrence (percent) includes samples at all sites. The time series trend line is shown by the yellow line. Note that sampling at the Milford site began in 1990.

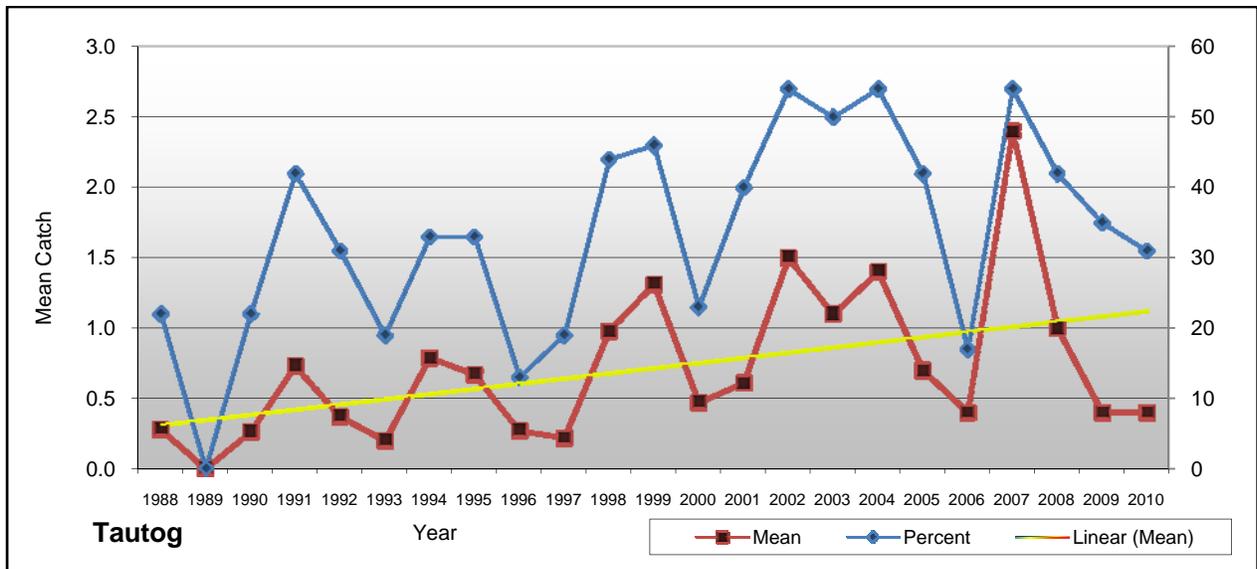


Figure 2.5: Mean catch of forage fish at eight sites sampled by seine, 1988-2010.
 Forage species include Atlantic silversides, mummichog, sheepshead minnow, and striped killifish.
 The 95% confidence interval (CI) for each mean is also listed. See Appendix 2.1 for complete species names.

MEAN CATCH PER STANDARD HAUL

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
MEAN	136.3	76.1	65.0	111.7	74.2	65.6	58.0	42.5	25.9	32.2	110.0	126.9
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

YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
MEAN	146.3	52.4	125.3	206.4	129.7	121.7	59.4	149.5	99.6	106.1	137
95% CI	108-197	32-86	97-162	152-281	108-155	101-147	43-82	119-187	82-121	86-131	112-167

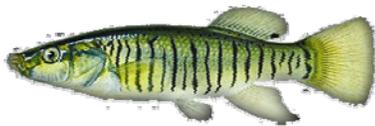
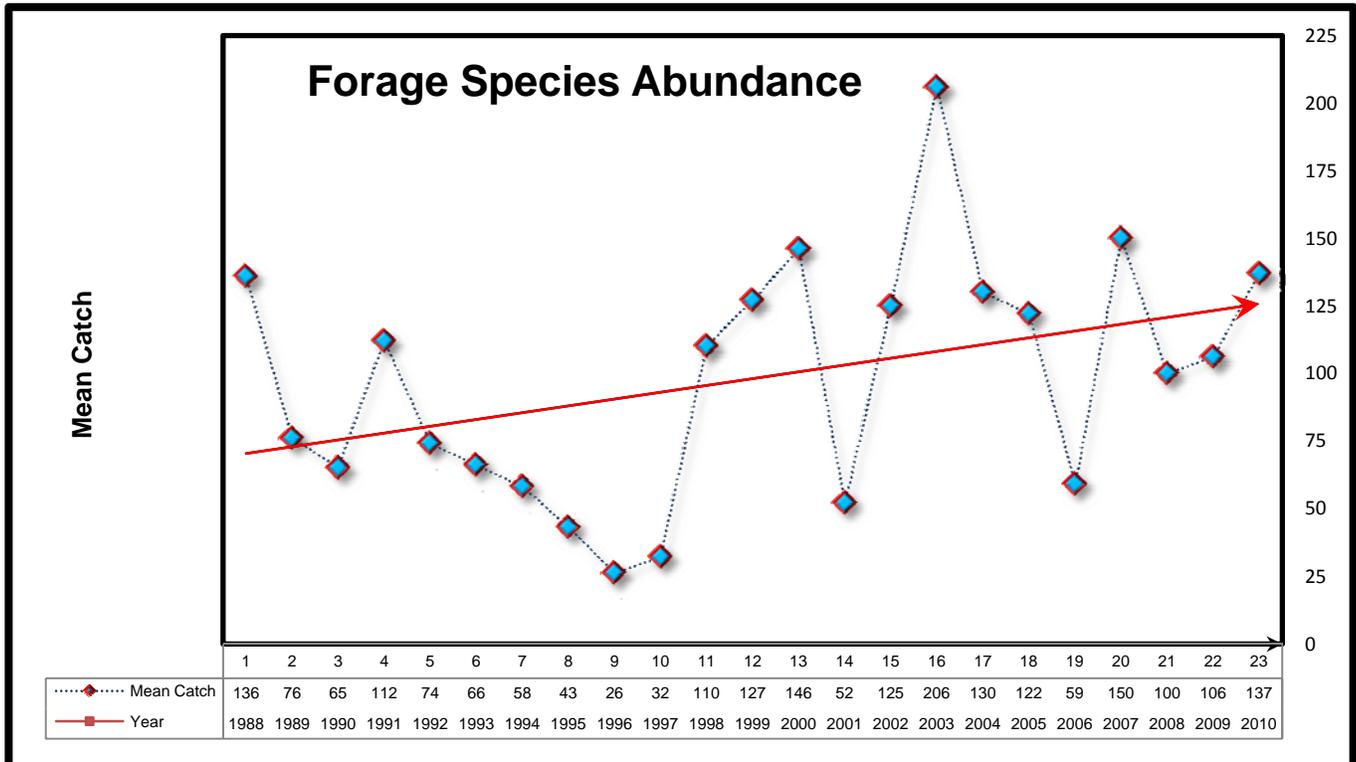


Figure 2.6: Total Catch of Four Species of Forage Fish, 1998-2010

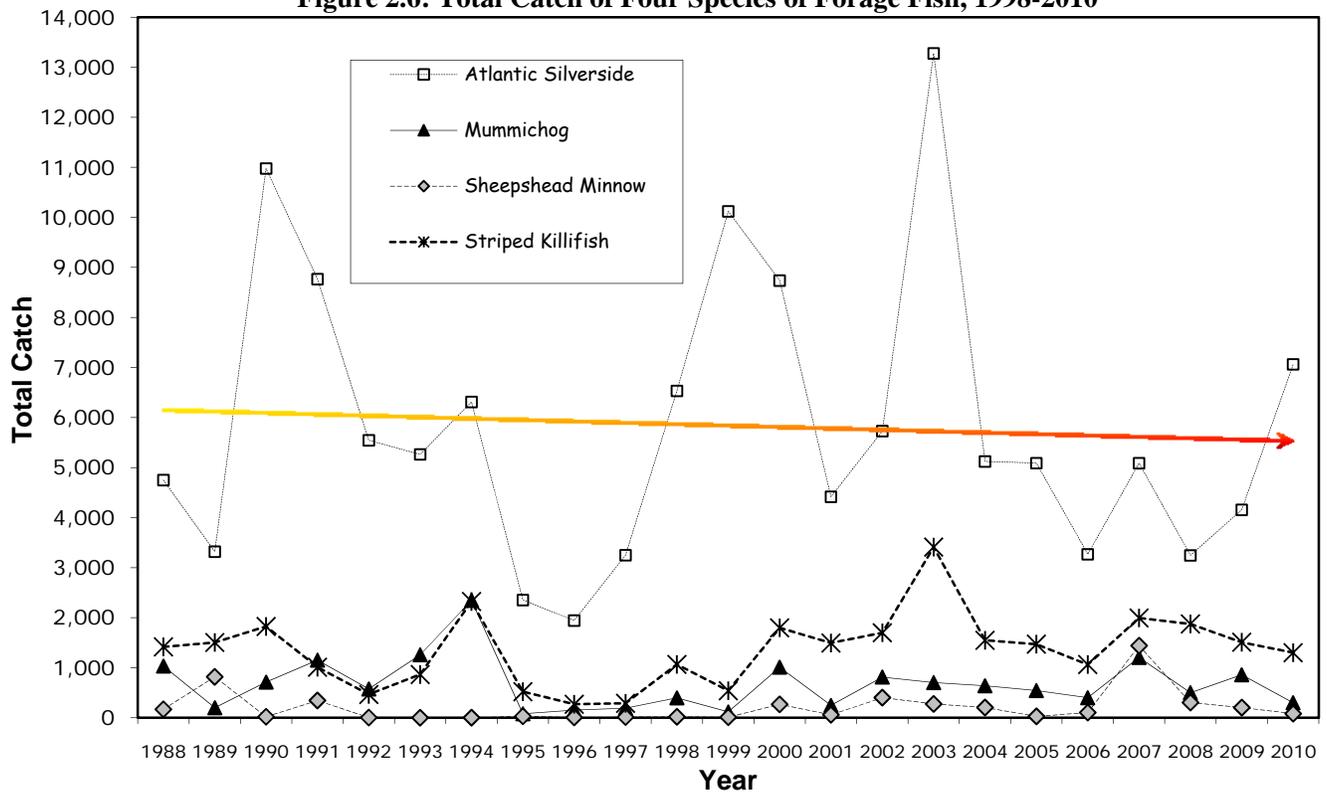


Figure 2.7: Total Catch of Juvenile Black Sea Bass and Scup, Recreational Important Finfish, 1988-2010

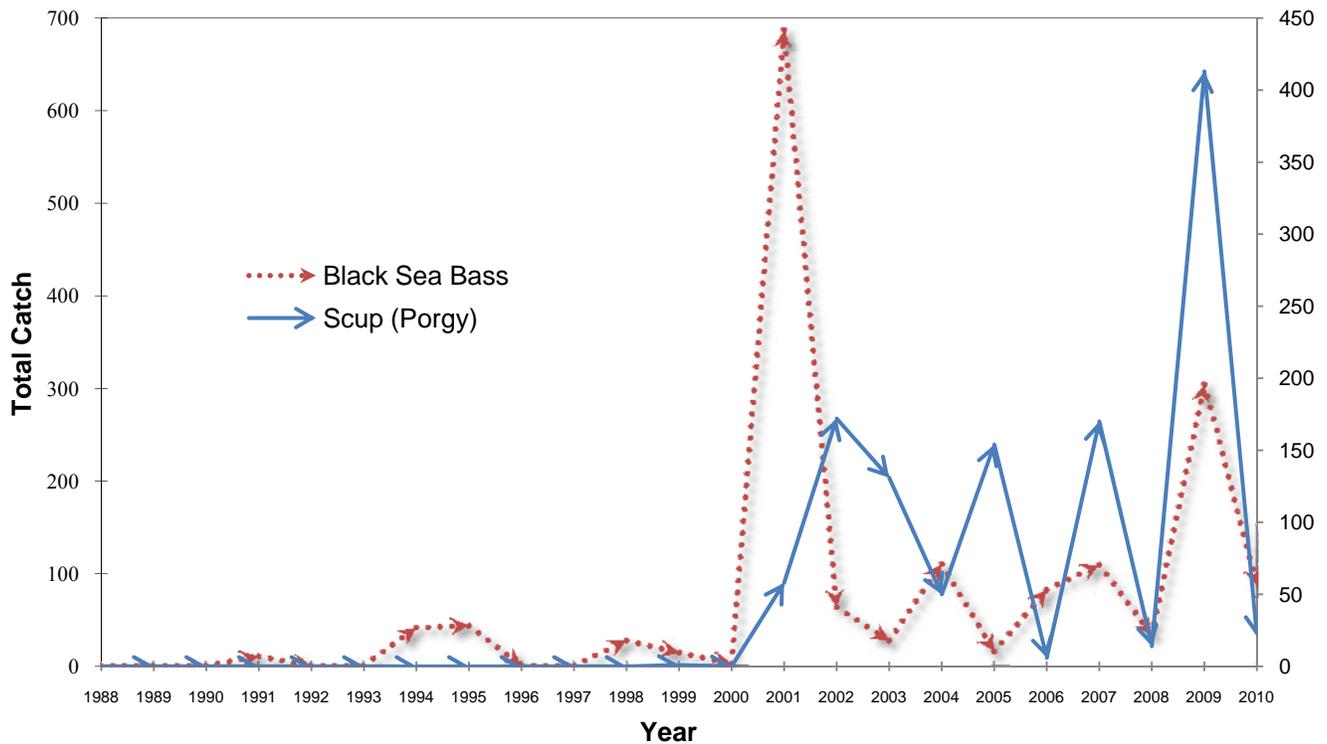


Figure 2.8: Total Catch of Juvenile Striped Bass, Summer Flounder and Weakfish, Recreational Important Finfish, 1988-2010

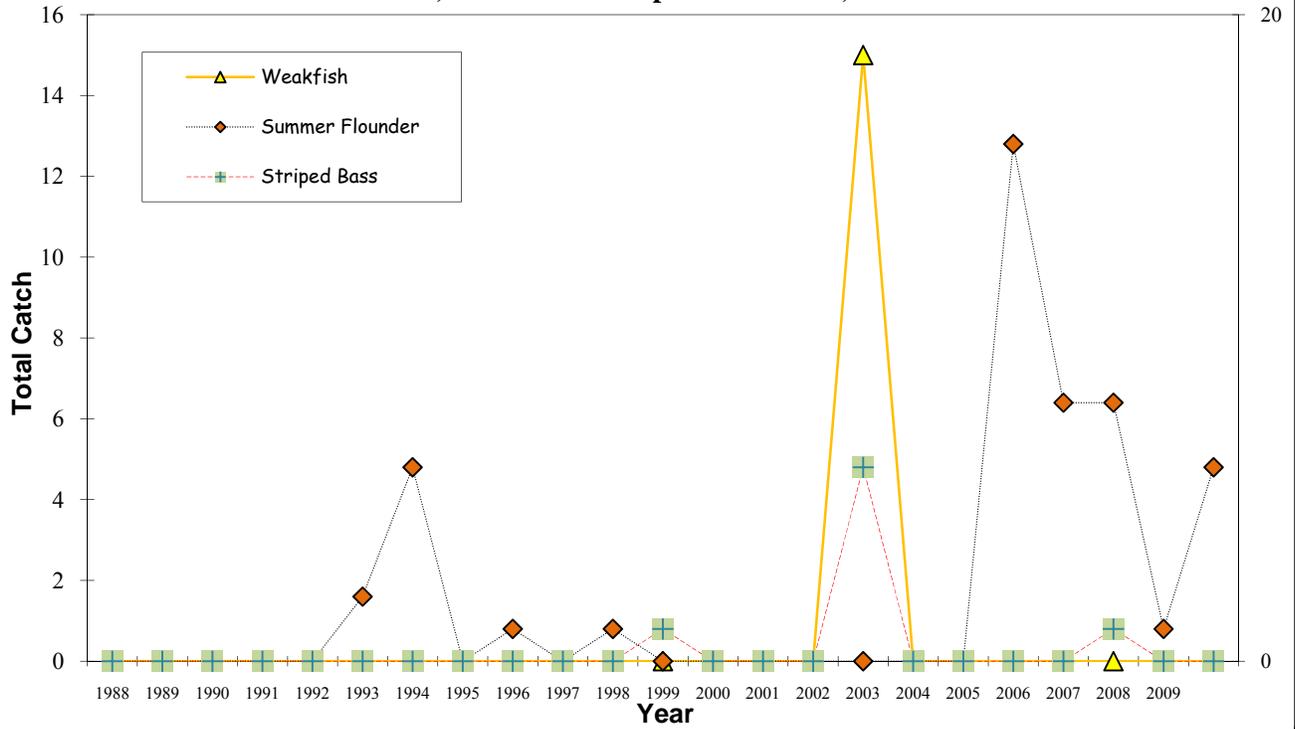
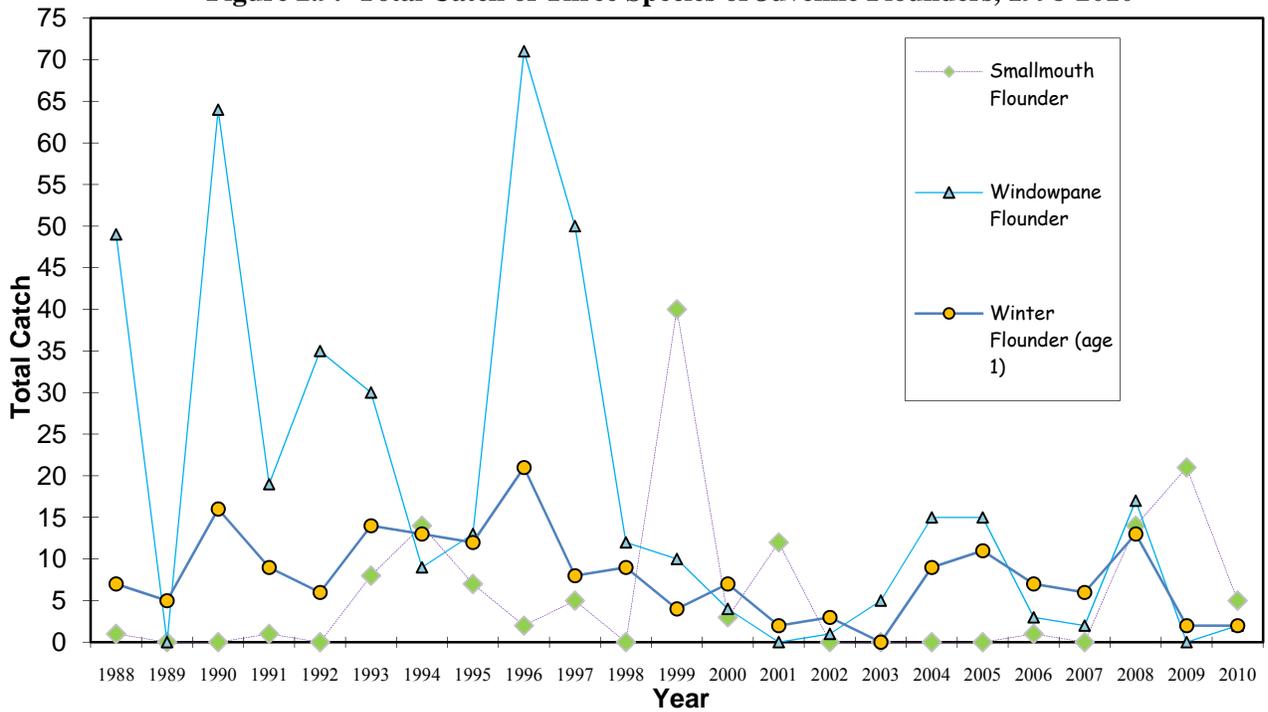


Figure 2.9: Total Catch of Three Species of Juvenile Flounders, 1998-2010



Appendix 2.1: Finfish species taken in the Estuarine Seine Survey, 1988-2010.

<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>
Flying Gurnard	FGD	<i>Dactylopterus volitans</i>
Four-spine stickleback	FSS	<i>Apeltes quadracus</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>Sphyræna borealis</i>
Scup	PGY	<i>Stenotomus chrysops</i>
Sheepshead minnow	SHM	<i>Cyprinodon variegatus</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>
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 2.2: Invertebrate species taken in the Estuarine Seine Survey, 1988-2010.

<u>COMMON NAME</u>	<u>SPECIES CODE</u>	<u>SCIENTIFIC NAME</u>
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>
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 2.10: Haul Seining in 2010.

