

## 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 2012 annual index of recruitment for young-of-year winter flounder (0.3 fish/haul) ranked the lowest out of 25 annual indices.

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

Mean catch of all finfish (153 fish/haul) ranked ninth highest out of 25 annual indices and was slightly above the series average of 147 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 2012 (60 forage fish/haul) was the eighth lowest of the 25-year series, and well below 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.

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 (Collette and Klein-MacPhee 2002, Murdy et al. 1997). Criteria used to assign species into a cold temperate group, warm temperate group, or subtropical group are listed in Job 2.1.

## RESULTS

A total of 48 seine hauls were taken in 2012 at eight sites, yielding a total catch of 7,323 fish of 29 species and 4,318 invertebrates of eleven species. Mean catch of all finfish (153 fish/tow) was the eighth lowest in the 25 year time series (Figure 2.2). This catch is slightly above the long-term mean of 147 fish/tow which can be attributed to above average catches of black sea bass, as well as scup. Atlantic silversides were caught in average abundance. All other forage fish abundances (except sheepshead minnow) were below average.

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 black sea bass (75%), striped killifish (65%), tautog (60%), northern pipefish (60%), scup (42%), northern puffer (42%) and mummichog (35%). 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, scup, tautog and puffer occurrence. Nine of the 22 species monitored decreased in abundance in 2012, fifteen other fish species increased and six were unchanged. Tautog abundance and occurrence rate increased significantly in 1998-99, returned to the series average in 2005, 2010 and 2011 after a record year in 2007. Previous to 2005, tautog relative abundance significantly increased to all-time abundance levels in 2002-04 and 2012 (Figure 2.4). The abundance of cunner the other labridae species commonly seen in the survey fell in 2011 but rebounded above the time series averages in 2012 after declining in abundance since 2007.

In 2012, three of the four forage species monitored decreased in abundance from the previous year (Atlantic silverside, especially mummichog and striped killifish). Only the forage fish sheepshead minnow increased slightly in abundance in 2012. Forage fish species Atlantic silverside was slightly below the 25-year time-series average in 2012. Scup occurrence and abundance decreased to the 25 year time series average in 2011, but increased to its largest abundance in 3 years in 2012, which is the second largest abundance overall. Snapper bluefish occurred in the time series in 2011 and again in 2012 after a 2007 absence. Striped bass and weakfish were not observed in the survey in 2012. Weakfish young-of-year were absent and only occurred in 2003. All other species occurred in less than 10% of all samples, with occurrence rates similar to previous years.

Spot (*Leiostomus xanthurus*) a mid-Atlantic species, occurred for the first time in the time series. Two other new species of finfish, juvenile and adult feather blenny (southern species) (*Hypsoblennius hentzi*) was captured in 2012, at three sites (WTF, CLT and GRW). Also, skillettfish (*Gobiesox strumosus*) another southern species were captured at the Greenwich site. Six juvenile summer flounder were captured in 2012. Summer flounder (juvenile) have occurred in 2006-08 and 2010 of the 25 year time series. Windowpane flounder re-occurred at low abundance in 2011 after being absent in 2009-10 and once again in 2012. Other notable catches: at the Waterford site; lined seahorses, spot, and feather blenny along with inshore lizardfish. The Cinton site saw large numbers of yoy black sea bass, shorthorn sculpin, spot, feather blenny and American eel. The Greenwich site saw two new species...feather blenny and skillettfish. The New Haven site saw many yoy scup and snapper bluefish. Summer flounder, northern kingfish and large numbers of forage species were captured at the Old Lyme site. Bridgeport was dominated by smallmouth flounder and the Groton (Bluff Point) site saw large numbers of yoy black sea bass.

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

The 2012 index of YOY winter flounder (0.3fish/haul) ranked lowest out of the 25 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 2012 index of YOY tautog (1.3 fish/haul) was the fourth highest (tie, 1999) ranking out of 25 annual indices (Table 2.1, Figure 2.4), well above the series average of 0.7 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 and 2012. The 2006 and 2009-11 mean was below the long-term average. ( $P \leq 0.03$ ,  $t=2.3$ ,  $df=24$ ), (Table 2.1, Figure 2.4).

### **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 2012, the species was especially abundant, a reflection of strong recruitment and survival in recent years (Table 2.3, Figure 2.7). Juvenile striped bass first occurred in the survey in 1999 with one individual captured. In 2003 six more YOY striped bass were taken (Table 2.3, Figure 2.8). One large individual (369mm) was captured in 2008. YOY summer flounder have occurred in ten years (more recently) in the 25-year time series (1993, 1994, 1996, and 1998, 2006 – 2010, 2012). The 2006 summer flounder abundances were the highest of the time series, followed by 2007, 2008, 2010 and 2012. 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 2012, (Figure 2.7). Snapper bluefish occurred in 19 out of 25 years of the time series, reaching peak abundance in

1999. Juvenile tautogs occurred every year in the seine survey except 1989. White perch appeared in record numbers in 2008 and only once prior (2005) were present in 2011, and absent in 2012. Atlantic tomcod, a threatened species re-appeared in 2008 and 2011, none were present in 2009, 2010 and 2012. Inshore lizardfish were captured at average abundances for the time series in 2012. Fourspine stickleback were absent in 2012, and appear to be dropping out of the survey, occurring only 4 times in the past decade.

### **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 2.5, Figure 2.6). The index for 2012 was the eighth lowest in the 25 year time series. Only one of the four forage fish species (sheepshead minnow) increased slightly in abundance and occurrence in 2012. Atlantic silverside abundance declined in 2012 (45 fish /haul) and was below the series mean of 64 fish/haul for the time series (Table 2.1). 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 striped killifish, and mummichog abundance in 2012. A decrease in these species' abundance in 2012 reversed a five-year trend of increasing abundance from 2007-2011. Striped killifish decreased substantially in abundance in 2012, to the ninth lowest in the time series. This species of killifish abundance and occurrence (5.3fish/tow, 65% occurrence) was well below the series mean of 10.3. In 2012, mummichog abundance (1.6 fish/haul) was also well below the long-term average of 2.4 in 2012. Sheepshead minnow had a record abundance (3.35) in 2007 and decreased in 2008 through 2010. Sheepshead increased slightly in 2011 and again in 2012, the index of abundance of this forage fish (0.8fish/haul) was substantially higher, ranking third in the time series. Collectively, forage fish abundance has declined since 2003 (Figure 2.5).

Forage fish abundance show a general increase since 1997 (Figure 2.5) after a period of lower abundance (decreasing trend) from 1991-1996. In 2012, forage fish abundance was below the series mean of 98 fish/haul, with a mean catch of 60 fish per haul (large decline from 2007). 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, 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, 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 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 2002-04 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 and 2012, the sheepshead

minnow catch rebounded and was slightly above the series average (0.5 – 0.8 fish/tow).

### **Finfish Species Richness**

Over the time series, the mean number of cold temperate species captured per seine haul varied from 1.6 to 2.8 without trend (Figure 2.10, Table 2.4), while the mean number of warm temperate species increased significantly ( $F=29.2$ ,  $p<0.001$ ,  $r^2=0.54$ ). The mean number of warm temperate species rose from 1.6 to 4.4, more than doubling over the 25-year time series. Subtropical species richness showed no trend, averaging one species per haul almost every year.

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

A total of 4,318 invertebrates of eleven species were captured in 2012 (Table 2.3), (Appendix 2.2). Eight crab species were present in the seine hauls, along with three shrimp species (including mantis shrimp) and one gastropod. Mud snail, sand shrimp, shore shrimp, green crab, and hermit crab were the most abundant. Mud snails, shore shrimp, sand shrimp, and hermit crab had greater than 50% occurrence in 2012 (Table 2.3). Blue crab abundance continued to remain low in 2012 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. Both sand and shore shrimp decreased substantially in abundance in 2012 from the previous year (Table 2.3). Mud snail abundance was at the time series average. Mud crabs dropped significantly in 2011 and 2012 from an all-time high in 2010. Spider crab abundance was at a time-series high in 2011 and decreased too slightly above the time series average in 2012.

## **MODIFICATIONS**

In 2013 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.

## **LITERATURE CITED**

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- 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.
- Murdy, E., R. Birdsong and J. Musick, 1997, editors. *Fishes of Chesapeake Bay*. Smithsonian Institution Press, Washington DC.

**Table 2.1: Geometric mean catch of species commonly taken in seine samples, 1988-2012.** *See Appendix 3.1 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 2.1: Geometric mean catch of species commonly taken in seine samples, 1988-2012.** *See Appendix 3.1 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>
alewife	0.0	0.1	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	<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	<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	<b>0.03</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	<b>44.9</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	<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	<b>5.2</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	<b>0.01</b>
bluefish	0.1	0.0	0.2	0.2	0.1	0.2	0.0	0.0	0.3	0.0	0.2	<b>0.4</b>
cunner	0.2	0.3	0.2	0.5	0.3	0.1	0.5	0.1	0.2	0.1	0.0	<b>0.4</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	<b>0.0</b>
grubby	0.2	0.3	0.5	1.3	0.8	0.3	0.3	0.2	0.5	0.3	0.7	<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	<b>0.2</b>
mummichog	1.4	3.4	2.9	2.3	1.5	2.5	7.3	2.9	3.8	1.7	3.1	<b>1.6</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	<b>0.06</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	<b>0.5</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	<b>1.4</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	<b>0.9</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	<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	<b>2.1</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	<b>0.8</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	<b>0.4</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	<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	<b>5.3</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	<b>0.08</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	<b>0.08</b>
tautog	0.6	1.5	1.1	1.4	0.7	0.4	2.4	1.0	0.4	0.4	0.3	<b>1.3</b>
weakfish	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<b>0.0</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	<b>0.0</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	<b>0.02</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	<b>0.3</b>

**Table 2.1 cont.: Percent occurrence of species commonly taken in seine samples, 1988-2012.** See Appendix 3.1 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 2.1 cont.: Percent occurrence of species commonly taken in seine samples, 1988-2012.** See Appendix 3.1 for species names.

<u>Species</u>	<u>2001</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>
alewife	0.00	0.04	0.02	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	<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	<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	<b>0.04</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	<b>0.98</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	<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	<b>0.75</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	<b>0.02</b>
bluefish	0.13	0.02	0.10	0.15	0.04	0.08	0.00	0.02	0.15	0.02	0.10	<b>0.21</b>
cunner	0.15	0.13	0.17	0.29	0.21	0.13	0.25	0.10	0.17	0.08	0.04	<b>0.23</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	<b>0.00</b>
grubby	0.17	0.21	0.29	0.50	0.46	0.27	0.15	0.19	0.27	0.21	0.42	<b>0.23</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	<b>0.15</b>
mummichog	0.42	0.54	0.44	0.35	0.27	0.48	0.65	0.48	0.50	0.40	0.42	<b>0.35</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	<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	<b>0.29</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	<b>0.60</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	<b>0.42</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	<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	<b>0.42</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	<b>0.25</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	<b>0.17</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	<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	<b>0.65</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	<b>0.08</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	<b>0.08</b>
tautog	0.40	0.54	0.50	0.54	0.42	0.17	0.54	0.42	0.35	0.31	0.23	<b>0.60</b>
weakfish	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	<b>0.00</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	<b>0.00</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	<b>0.04</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	<b>0.27</b>

**Table 2.2: Mean catch of young-of-year winter flounder at eight sites sampled by seine, 1988-2012.**

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

\*record high for a site/year.

\*\* record low for time-series

**Table 2.3: Total catch 1988-2012.** 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>
alewife					1								28	1
American eel					1				5					
American sand lance			1		10									
American shad	1													
American shad (1+)									151					
Anchovy, spp (YOY)														
Atlantic menhaden	2	4	1,074	3	9	2		11	2,003	377	1,236	1	1,284	5,098
Atlantic needlefish														
Atlantic silverside	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
Atlantic tomcod				3					1					
banded gunnel									2	3				
banded rudderfish														
bay anchovy						4	69		27			1	11	
black sea bass		10			41	43			27	14	2	687	63	27
blue spotted coronet fish										1				
blueback herring	3	194	10		5	2			3	24	1		13	5
<i>bluecrab</i>														
bluefish		15	2		1			1	9	142	3	8	2	17
<i>boreal squid</i>														
<i>brown shrimp</i>														
burrfish, striped										1				
butterfish						1								
<i>channeled whelk</i>														
<i>common slipper shell</i>														
crevalle jack														
cunner	2	5	19		42	24	63	1	23	142	26	15	110	15
<i>flat claw hermit crab</i>														
flying gurnard														
fourspine stickleback		183	11	21	1		3		24	3	1	7		
gizzard shad														
<i>green crab</i>														
grey snapper	1													
grubby	2	7	61	6	38	19	21	28	17	55	15	73	33	95
hogchoker							2							

Table 2.3 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>Grand Total</u>
<b>alewife</b>										<b>30</b>
<b>American eel</b>									<b>1</b>	<b>11</b>
<b>American sand lance</b>							<b>13</b>			<b>24</b>
<b>American shad</b>										<b>1</b>
<b>American shad (1+)</b>										<b>169</b>
<b>Anchovy, spp (YOY)</b>					<b>15</b>					<b>15</b>
<b>Atlantic menhaden</b>	<b>1,117</b>	<b>75</b>	<b>117</b>	<b>144</b>	<b>21</b>	<b>54</b>	<b>3</b>	<b>43</b>	<b>2</b>	<b>12,685</b>
<b>Atlantic needlefish</b>					<b>2</b>					<b>2</b>
<b>Atlantic silverside</b>	<b>5,122</b>	<b>5,089</b>	<b>3,267</b>	<b>5,087</b>	<b>3,245</b>	<b>4,156</b>	<b>7,063</b>	<b>4,657</b>	<b>4,142</b>	<b>134,846</b>
<b>Atlantic tomcod</b>	<b>1</b>	<b>3</b>			<b>1</b>			<b>8</b>		<b>17</b>
<b>banded gunnel</b>	<b>4</b>	<b>2</b>	<b>3</b>	<b>1</b>	<b>3</b>			<b>1</b>		<b>19</b>
<b>banded rudderfish</b>							<b>1</b>			<b>1</b>
<b>bay anchovy</b>	<b>1</b>	<b>12</b>					<b>1</b>			<b>126</b>
<b>black sea bass</b>	<b>110</b>	<b>15</b>	<b>82</b>	<b>109</b>	<b>33</b>	<b>304</b>	<b>86</b>	<b>489</b>	<b>783</b>	<b>2,925</b>
<b>blue spotted coronet fish</b>										<b>1</b>
<b>blueback herring</b>				<b>9</b>			<b>3</b>		<b>1</b>	<b>299</b>
<b>bluecrab</b>	<b>1</b>	<b>2</b>	<b>84</b>	<b>31</b>	<b>4</b>	<b>333</b>	<b>35</b>	<b>23</b>	<b>27</b>	<b>540</b>
<b>bluefish</b>	<b>23</b>	<b>8</b>	<b>30</b>		<b>7</b>	<b>53</b>	<b>1</b>	<b>26</b>	<b>54</b>	<b>402</b>
<b>boreal squid</b>				<b>1</b>						<b>1</b>
<b>brown shrimp</b>			<b>11</b>							<b>11</b>
<b>burrfish, striped</b>								<b>10</b>		<b>11</b>
<b>butterfish</b>										<b>1</b>
<b>channeled whelk</b>							<b>1</b>			<b>1</b>
<b>common slipper shell</b>			<b>13</b>							<b>13</b>
<b>crevalle jack</b>							<b>1</b>			<b>7</b>
<b>cunner</b>	<b>54</b>	<b>35</b>	<b>18</b>	<b>58</b>	<b>8</b>	<b>28</b>	<b>15</b>	<b>2</b>	<b>42</b>	<b>789</b>
<b>feather blenny</b>									<b>36</b>	<b>36</b>
<b>flat claw hermit crab</b>	<b>761</b>	<b>532</b>	<b>703</b>	<b>153</b>	<b>244</b>	<b>539</b>	<b>558</b>	<b>441</b>	<b>283</b>	<b>4,214</b>
<b>flying gurnard</b>				<b>1</b>						<b>1</b>
<b>fourspine stickleback</b>	<b>9</b>		<b>2</b>			<b>8</b>		<b>2</b>		<b>384</b>
<b>gizzard shad</b>								<b>4</b>		<b>4</b>
<b>green crab</b>	<b>234</b>	<b>266</b>	<b>341</b>	<b>147</b>	<b>644</b>	<b>176</b>	<b>308</b>	<b>228</b>	<b>175</b>	<b>2,519</b>
<b>grey snapper</b>										<b>1</b>
<b>grubby</b>	<b>143</b>	<b>76</b>	<b>31</b>	<b>32</b>	<b>16</b>	<b>51</b>	<b>25</b>	<b>55</b>	<b>18</b>	<b>1,031</b>
<b>hogchoker</b>						<b>1</b>				<b>3</b>

**Table 2.3: 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>
<i>inshore lizardfish</i>	5		2			4	6			46	6	16	15	103	2
<i>Japanese shore crab</i>															
<i>Jonah crab</i>															
<i>lady crab</i>															
<i>lined seahorse</i>							4			1			2		
<i>little skate</i>										1					1
<i>mantis shrimp</i>															
<i>mole crab</i>															
<i>moon jelly</i>															
<i>mud crabs</i>															
<i>mud snail</i>															
<i>mummichog</i>	1,031	197	171	765	573	1,256	1,943	78	149	190	396	115	1,008	246	811
<i>naked goby</i>			1	4				1			1	1		4	2
<i>northern comb jelly</i>															
<i>northern kingfish</i>				3	4	23	2	9	3	10	7	6	5	17	5
<i>northern pipefish</i>	65	23	33	106	120	82	117	52	241	38	295	141	96	189	87
<i>northern puffer</i>	4	22	13	34	4	37	15	40	25	5	5	13	63	14	79
<i>northern searobin</i>		2	1				1	1					3	40	24
<i>northern sennet</i>															
<i>northern star gazer</i>		5													
<i>oyster drill</i>															
<i>oyster toadfish</i>	5			1						1	1			1	
<i>pumpkinseed</i>				2											
<i>rainbow smelt</i>						5	2								
<i>rainwater killifish</i>									3	4			2		6
<i>rock crab</i>															
<i>rock gunnel</i>			1		1	1	1			3					
<i>sand shrimp</i>															
<i>scup</i>												1		58	172
<i>sheepshead minnow</i>	174	815	5	345	4	1	2	30		14	19	12	267	59	402
<i>shore shrimp</i>															
<i>smallmouth flounder</i>	1			1		8	14	7	2	5		40	3	12	
<i>smooth dogfish</i>			1												
<i>spider crab</i>															
<i>starfish spp.</i>															
<i>striped anchovy</i>															
<i>striped bass</i>												1			

Table 2.3: 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>Grand Total</u>
inshore lizardfish		3		169	18	26	22	10	16	23	492
<i>Japanese shore crab</i>		1		1	1				6	1	10
<i>Jonah crab</i>							2				2
<i>lady crab</i>		298	119	66	195	92	42	19	24	18	873
lined seahorse					2	7	2	1	2		21
little skate											2
<i>mantis shrimp</i>										1	1
<i>mole crab</i>		1	5								6
<i>moon jelly</i>								319			319
<i>mud crabs</i>		60	55	74	30	85	67	308	80	80	759
<i>mud snail</i>		948	2,071	4,478	3,569	3,810	3,128	2,699	2,683	3072	26,458
mummichog	702	637	543	398	1,203	498	857	299	775	329	15,170
naked goby	2	2		13		2			2	4	39
<i>northern comb jelly</i>							346	36			382
northern kingfish	21	38	11	1	1	23	42	76	30	54	391
northern pipefish	25	72	92	82	75	156	307	49	248	152	2,943
northern puffer	101	75	93	34	241	19	41	51	28	98	1,154
northern searobin	5	4	13	2	10			1	9		116
northern sennet				1							1
northern star gazer											5
<i>oyster drill</i>				38							38
oyster toadfish	1	2	1	1	1	2	1				18
pumpkinseed		3									5
rainbow smelt		34									41
rainwater killifish	35	53	19	3							125
<i>rock crab</i>		2						1			3
rock gunnel		1				1					9
<i>sand shrimp</i>		278	373	1,027	525	2,625	762	902	1,507	246	8,245
scup	131	50	154	6	170	14	413	21	30	375	1,595
sheepshead minnow	276	205	28	104	1,439	304	203	82	219	238	5,247
<i>shore shrimp</i>		990	404	1,149	707	1,390	535	619	762	402	6,958
smallmouth flounder				1		14	21	5	114	63	311
smooth dogfish											1
<i>spider crab</i>		4	5	6	1	3	1	7	33	13	73
starfish spp.								1			1
striped anchovy							3				3
striped bass	6					1					8

**Table 2.3: continued.**

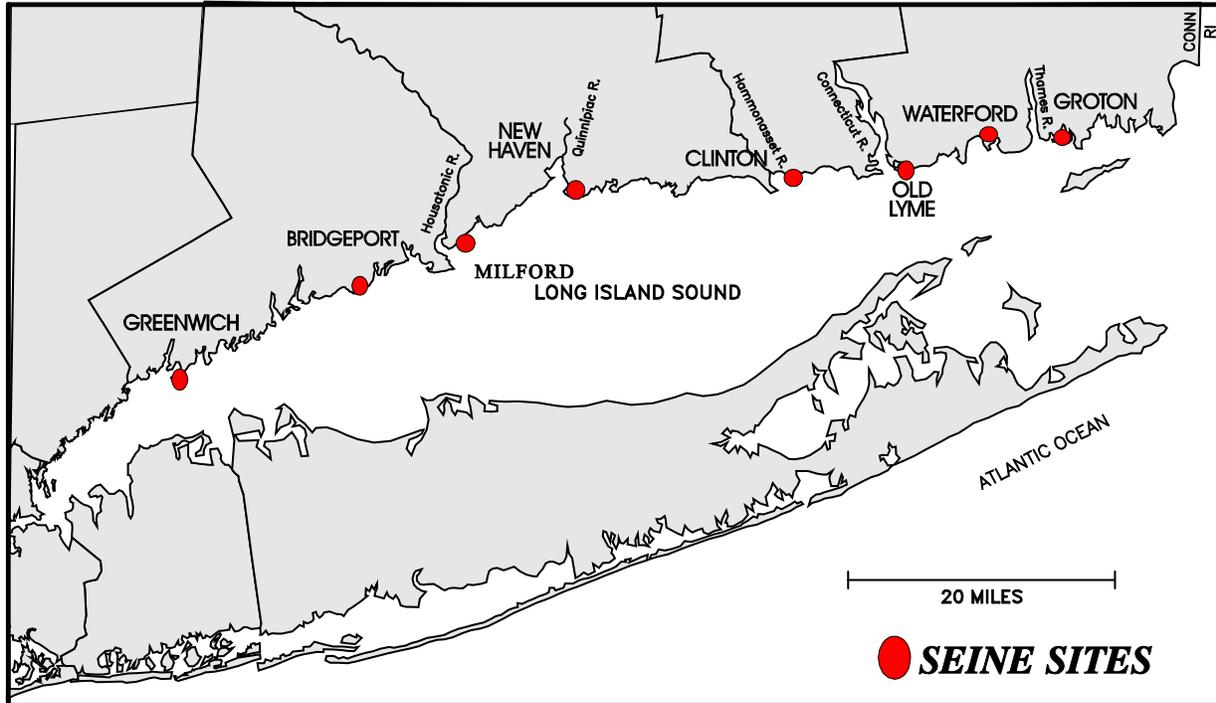
<u>Species</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>
striped killifish	1,511	1,383	748	659	465	773	1,923	520	269	289	1,066	539	1,797	1,494
striped searobin	22	12	5	94	5	71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

<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>Grand Total</u>
striped killifish	1,698	3,410	1,548	1,470	1,063	1,994	1,874	1,508	1,300	1,964	720	<b>31,985</b>
striped searobin	33	62	38	19	6	32	36	82	14	4	7	<b>866</b>
summer flounder					16	8	8	1	6		6	<b>55</b>
tautog	153	140	145	64	93	321	131	25	33	27	123	<b>2,114</b>
threespine stickleback												<b>11</b>
weakfish		15										<b>15</b>
web burrfish					1				1			<b>2</b>
white mullet	1				7	7	11		75	68	0	<b>182</b>
white perch				3			11			6	0	<b>20</b>
windowpane flounder	1	5	15	15	3	2	17		2	4	0	<b>392</b>
winter flounder	3		9	11	7	6	13	2	2	2	2	<b>452</b>
winter flounder YOY	302	1,310	914	470	110	365	190	72	71	86	22	<b>15,172</b>
<u>yellow jack</u>									1			<b>1</b>
Grand Total	<b>11,056</b>	<b>24,783</b>	<b>14,010</b>	<b>12,153</b>	<b>13,662</b>	<b>16,696</b>	<b>15,606</b>	<b>14,188</b>	<b>15,125</b>	<b>14,718</b>	<b>11,641</b>	<b>284,340</b>

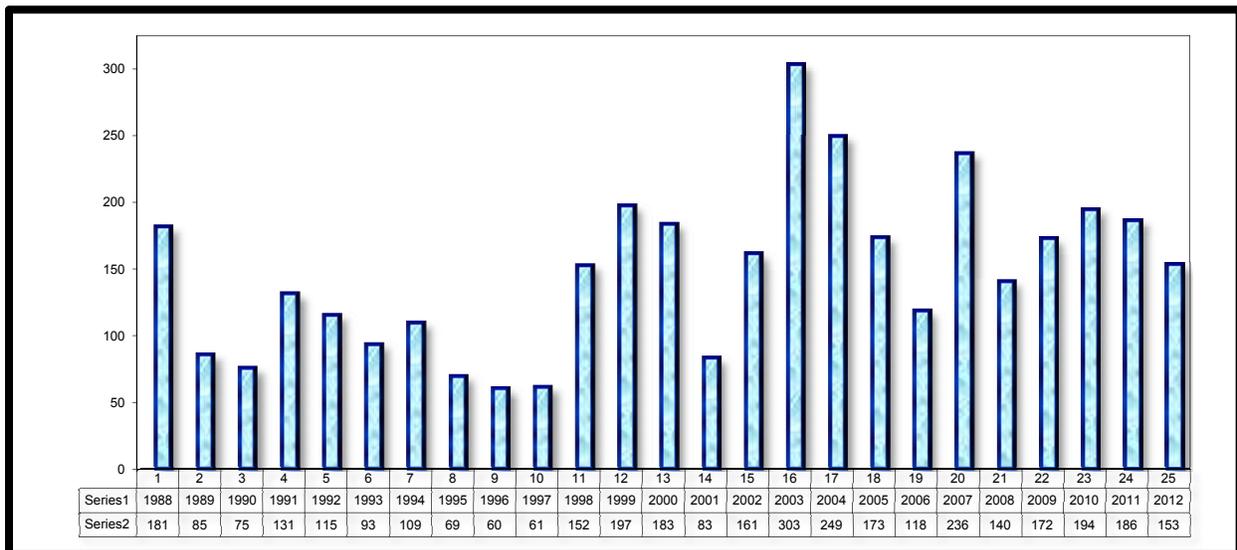
**Table 2.4: Cold and warm temperate species captured in the Estuarine Seine Survey.**

<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>

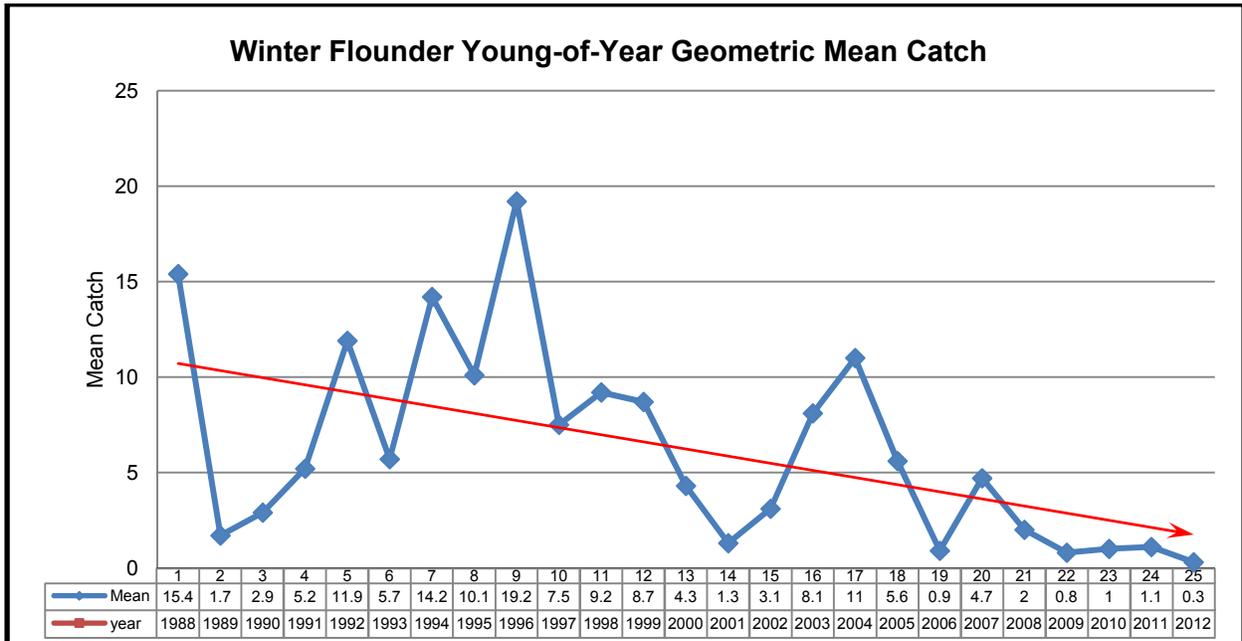
**Figure 2.1:** Sampling locations of the seine survey along the coast of Connecticut.



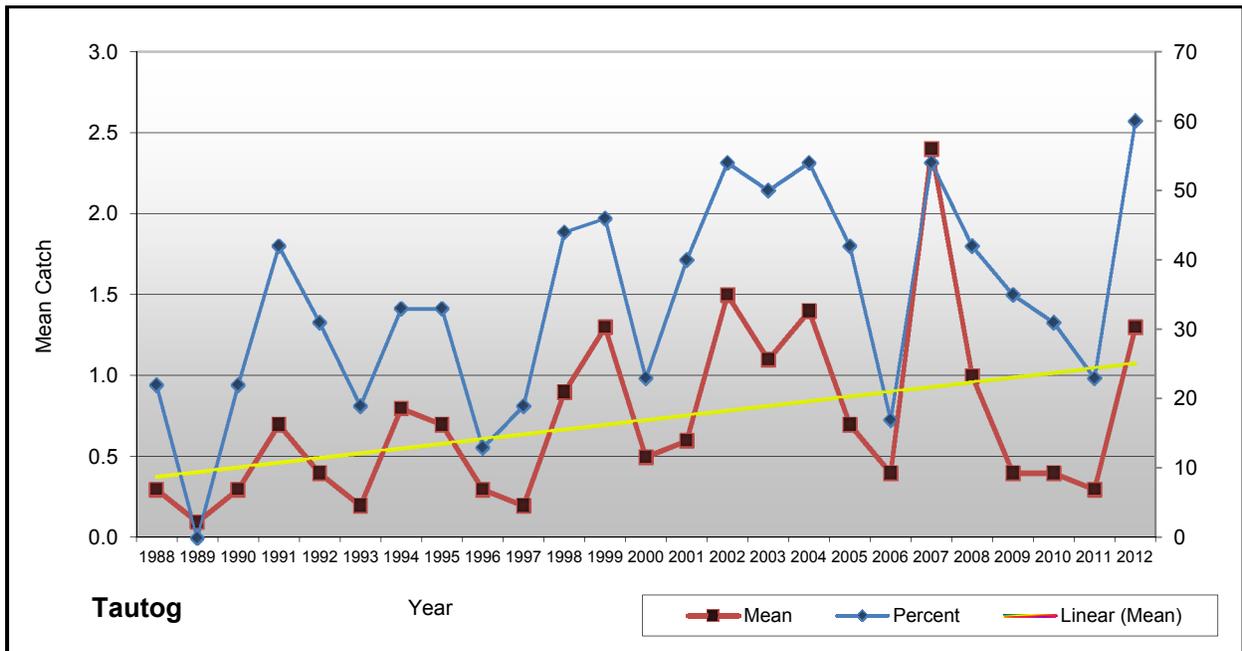
**Figure 2.2:** Mean catch (numbers) of all finfish taken in seine samples, 1988-2012. Mean catch per haul includes samples at all sites. Note that sampling at the Milford site began in 1990.



**Figure 2.3: Mean catch of young-of-year winter flounder, 1988-2012.** 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, 1988-2012.** 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.

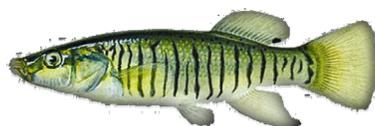
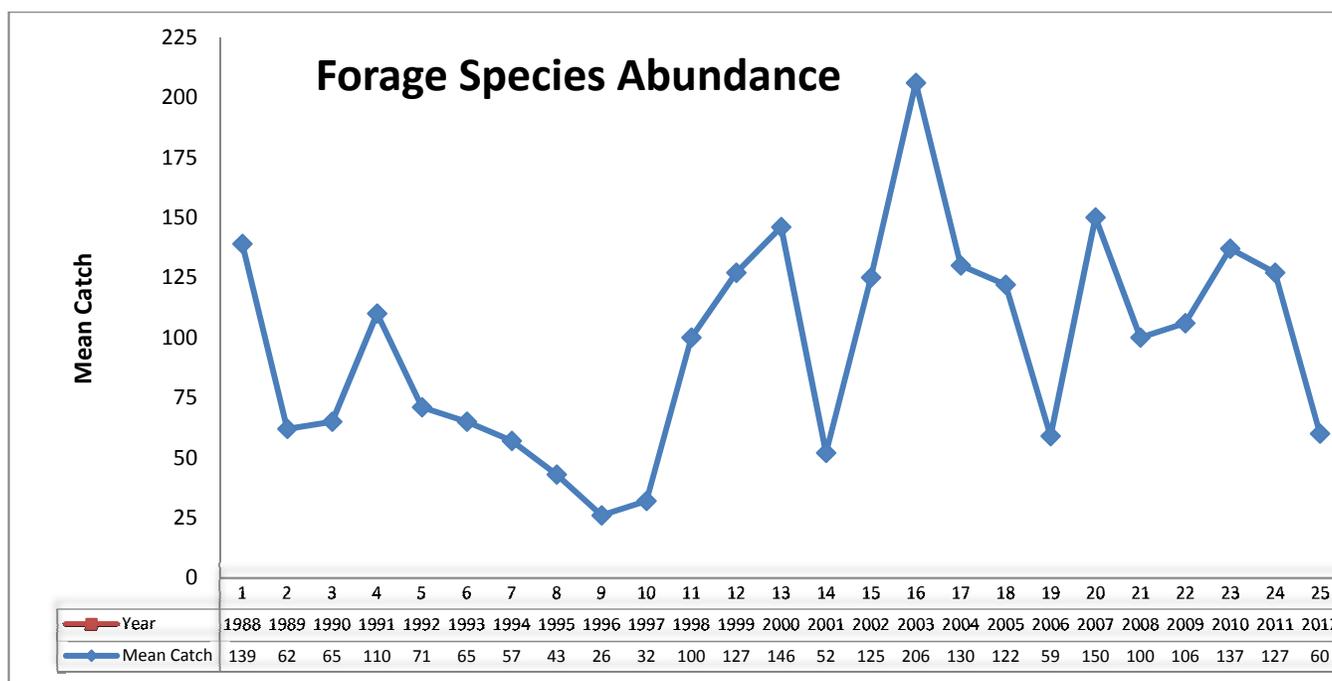


**Figure 2.5: Mean catch of forage fish at eight sites sampled by seine, 1988-2012.**  
*Forage species include Atlantic silversides, mummichog, sheepshead minnow, and striped killifish.*  
*The 95% confidence interval (CI) for each mean is also listed. See Appendix 2.1 for complete species names.*

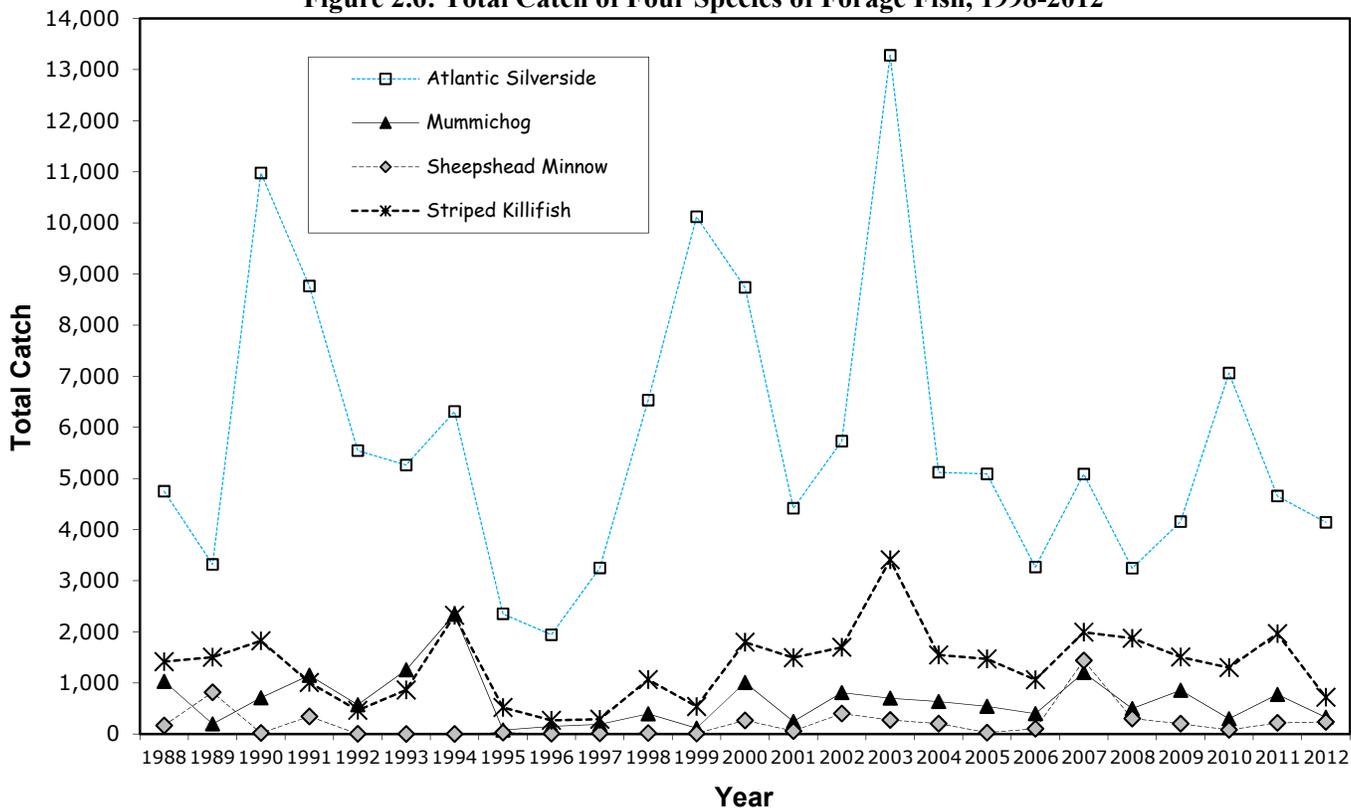
**MEAN CATCH PER STANDARD HAUL**

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
MEAN	139	62	65	110	71	65	57	43	26	32	100	127
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

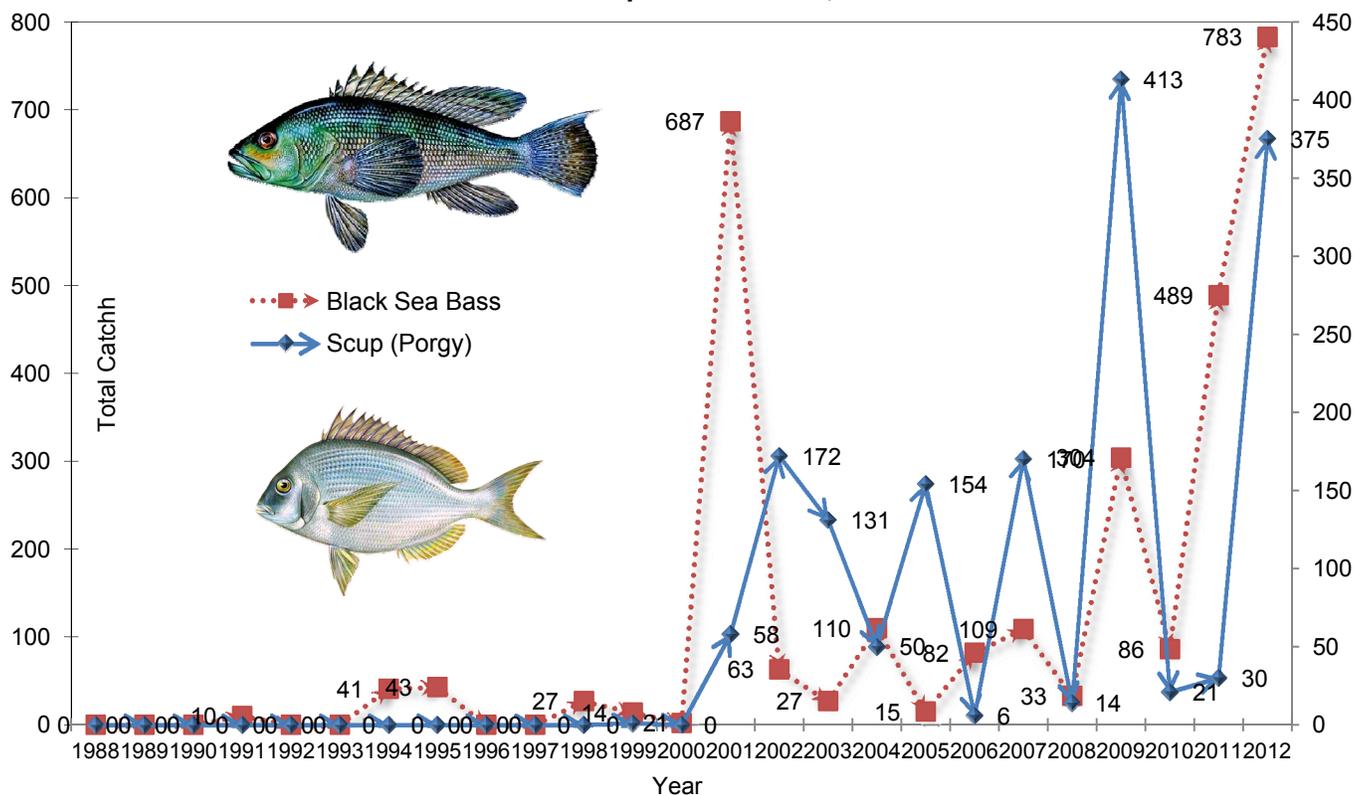
YEAR	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
MEAN	146	52	125	206	130	122	59	150	100	106	137	127	60
95% CI	108-197	32-86	97-162	152-281	108-155	101-147	43-82	119-187	82-121	86-131	112-167	105-153	41-89



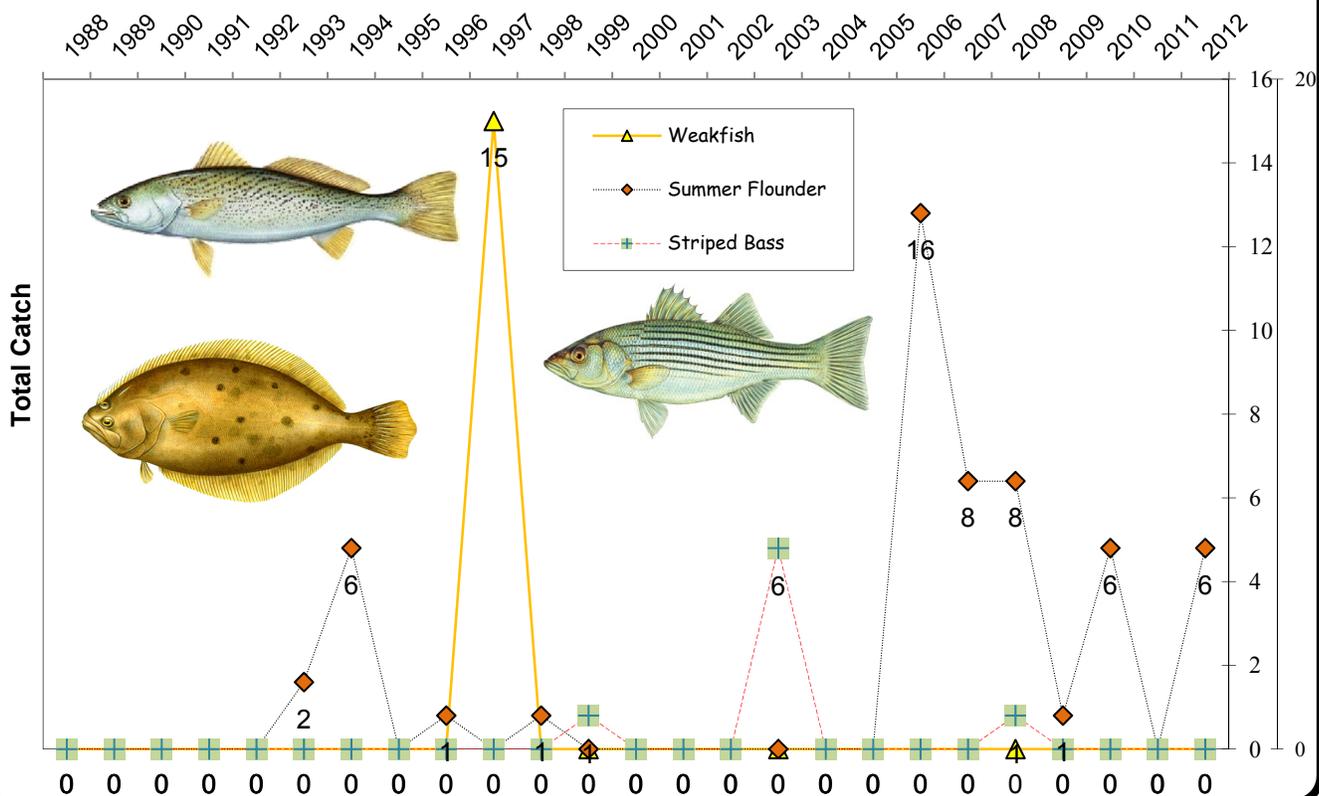
**Figure 2.6: Total Catch of Four Species of Forage Fish, 1998-2012**



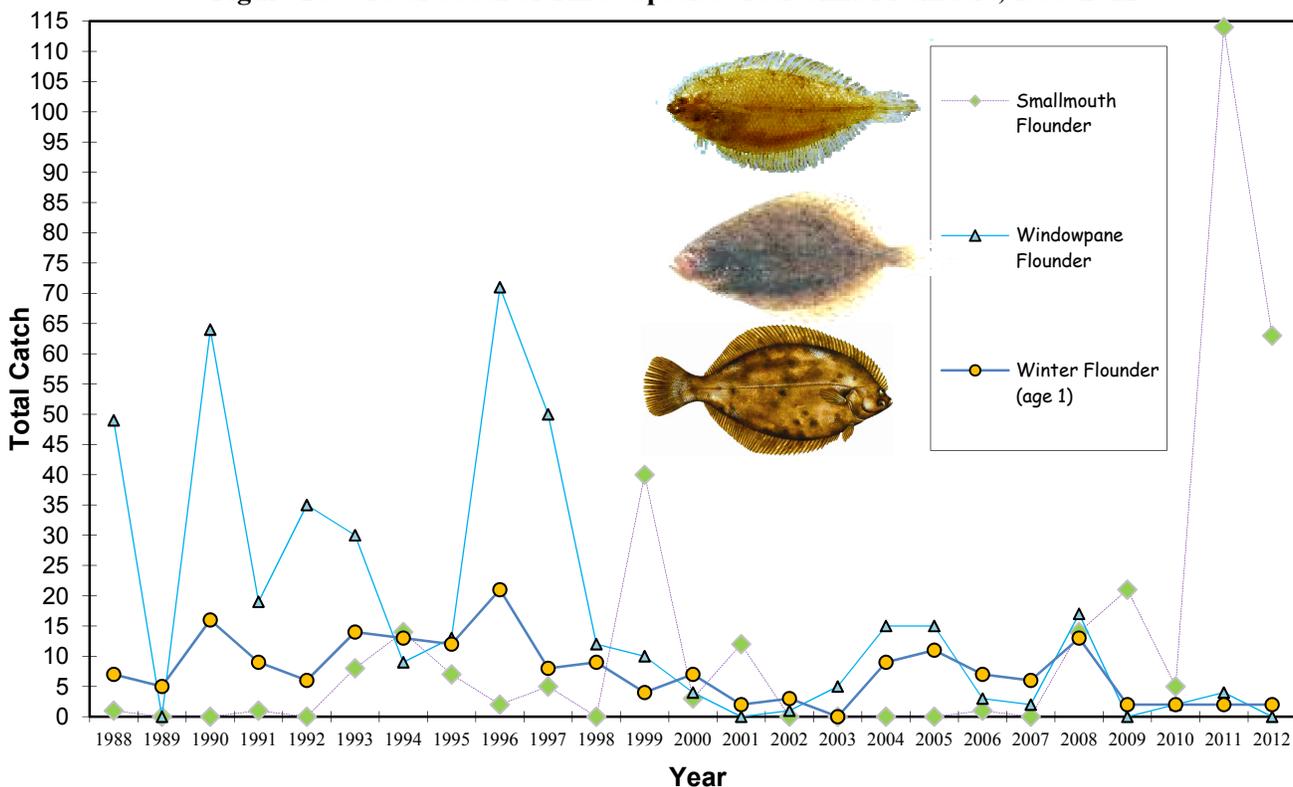
**Figure 2.7: Total Catch of Juvenile Black Sea Bass and Scup, Recreational Important Finfish, 1988-2012**

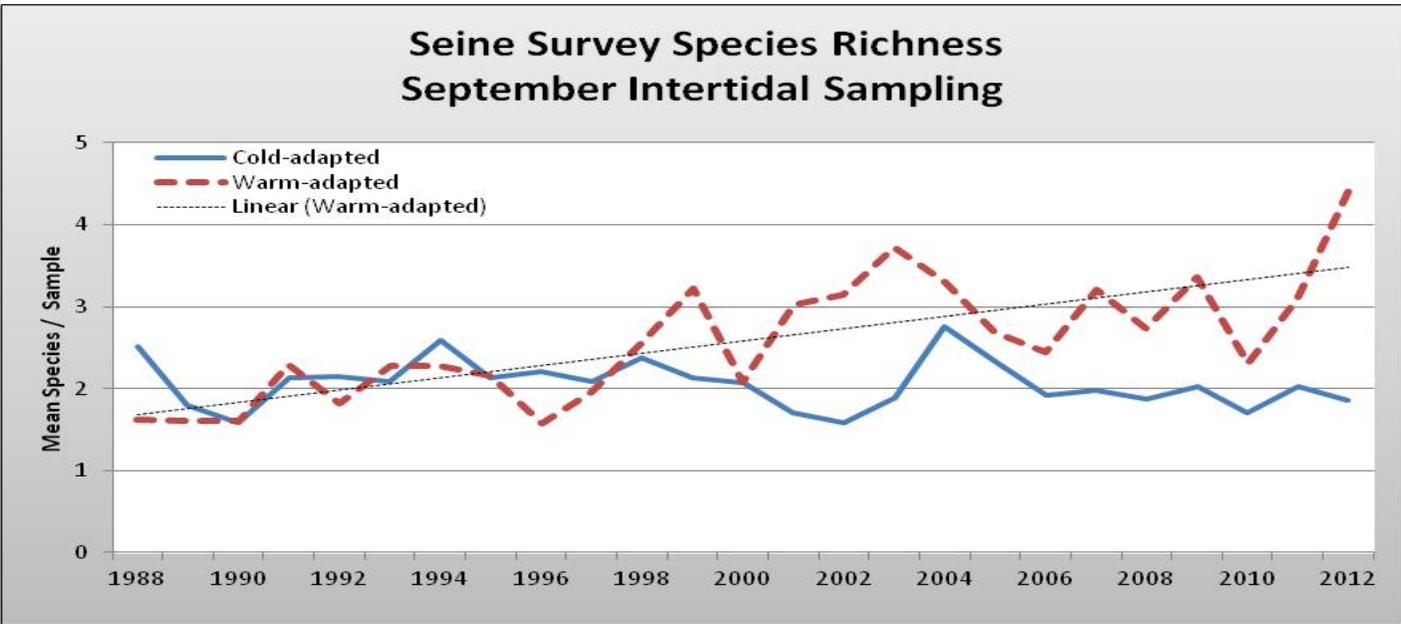


**Figure 2.8: Total Catch of Juvenile Striped Bass, Summer Flounder and Weakfish, Recreational Important Finfish, 1988-2012**



**Figure 2.9: Total Catch of Three Species of Juvenile Flounders, 1998-2012**





**Figure 2.10: Species richness trends for cold and warm adapted finfish species, 1988-2012.** *The increasing linear trend in the mean number of warm-adapted species captured per sample is statistically significant.*

## Appendix 2.1: Finfish species taken in the Estuarine Seine Survey, 1988-2012.

<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 bosci</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>Astroscopeus 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>Sphyraena 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>Scophthalmus 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, 1988-2012.

<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>
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 2.11: Haul Seining in 2012.

