Harbor Watch, a Program of Earthplace
Report on Norwalk Harbor Juvenile Benthic Marine Fish
May through October 2015

Wilton High School Marine Biology Club advisor holds up an angelwing found in the trawl net

Authors:
Sarah Crosby, Ph.D., Principal Investigator, Director of Harbor Watch, Earthplace, Westport CT
Phone: (203) 557-4403, Email: s.crosby@earthplace.org
Peter Fraboni, Associate Director of Harbor Watch, Earthplace Westport CT
Nicole Cantatore, Laboratory Director, Harbor Watch, Earthplace, Westport CT
Joshua Cooper, Laboratory Director, Harbor Watch, Earthplace, Westport CT

Introduction:
Harbor Watch is a program within a larger non-profit called Earthplace, The Nature Discovery and Environmental Learning Center. The mission of Earthplace is to build passion in the community for nature and the environment through education, experience and action. Harbor Watch was founded in 1986 as a citizen science organization dedicated to improving the health of Connecticut's waterways and has established a strong reputation for successful partnerships in our community. Our program goal is to provide the people of Connecticut with the data, knowledge, and field expertise necessary to safeguard our waterways, educate our communities about watershed issues, and train volunteers and student interns through hands-on research. We accomplish this goal through (1) basic and applied water quality research, (2) high school and college student internship programs, (3) a public outreach and volunteer program, and (4) partnering with local municipalities to restore degraded ecosystems.

Harbor Watch has been trawling in the Norwalk River Estuary for over 25 years, with support from a dedicated network of volunteers including the Wilton High School Marine Biology Club. The program began in 1990 under the guidance of the State of Connecticut's Department of Environmental Protection (now known as the CT Department of Energy and Environmental Protection, or CT DEEP) Fisheries Bureau. A trawling program was devised using a one meter beam trawl and a grid system which divides the harbor into 300m^2 sampling quadrants (Figure 1). The survey targeted the sample collection of juvenile benthic marine fish that live on the harbor floor or spend many months on the harbor floor before heading out to sea. The abundance and diversity of juvenile benthic fish can be used to assess the health of the harbor.

Full trawling history:
1990-1994: The early '90s show a harbor floor rich in species diversity with an extensive population of winter flounder. Large numbers of juvenile flounder were caught from the I-95 Bridge down to the Maritime Center where it was not unusual to find up to 50 flounder in a single tow.

1995-1997: The HW vessel RV Annie was laid up for extensive repairs.

1998-2001: Trawling was conducted on the apron outside the harbor from Norwalk west to Scott's Cove based on a CT DEEP request. Results were minimal numbers of benthic fish caught.

2002: HW returned to trawling inside Norwalk Harbor, although only a few trips resulted due to engine problems. The catch per unit of effort (CPU) was very small.

2003-2005: Benthic fish begin a strong recovery both in number of species and population. Recruitment of juveniles was doing well in 2005 especially in the "other" category with good numbers of Tom Cod, *Microgadus tomcod*, and Grubby, *Myoxocephalus aeneus*, recovered.

In mid-August of 2005 a large (one million+) fish kill occurred in the upper harbor when blue fish, *Pomatomus saltatrix*, chased a very large school of menhaden, *Brevoortia tyrannus*, upstream into a zone depleted of dissolved oxygen (<3 ppm, HW records) between the I-95 Bridge and Wall Street. The mass of dead fish sank and did not refloat. Previous fish kills were observed to refloat due to gas generated inside the decomposing fish and were subsequently moved out of the harbor on ebb tide (author's observations).

Extensive dredging began in the upper harbor which was protracted into early spring 2006. This in conjunction with masses of dead fish on the harbor floor curtailed juvenile benthic recruitment in 2006. Recovery was further hampered by another, although smaller, menhaden kill in July of 2006 of approximately 10,000 fish.

2007: The benthic fish population began to recover again with a CPU of 3.65.

2008-2009: The recovery stalled for reasons unknown. Possible rising water temperatures on the bottom were retarding the winter flounder spawning.

2010: Dredging occurred in the outer harbor. A blue crab, *Callinectes sapidus*, invasion by the thousands was found on the harbor floor which possibly helped consume available benthic fish. Only 27 winter flounder were recovered during the monitoring season.

2011: A modest recovery began in winter flounder with 95 juveniles caught during the year. This is attributed to cold water supplied by the winter of 2010/2011. A few more species begin to appear, i.e. Inshore Lizardfish (2), *Synodus foetens*, Tom Cod (1), *Microgadus tomcod*, and Black Fish (4), *Tautoga onitis*. The CPU for 2011 was 1.84 fish. The cold water also reduced the blue crab population to normal levels which may have eliminated a possible level of high predation by these crustaceans.

2012: Although no great improvement to the harbor was seen, there appeared to be no loss in CPU from 2011 to 2012, 1.8 for both years. Black Fish, a species under pressure, had returned for a second year which is a promising sign for the estuary. Many experts expected a blue crab invasion due to the warm winter of 2011-2012, but the crabs did not appear in any large numbers to damage to the fisheries.

2013: The monitoring season started off strong by way of fish recovered, especially winter flounder. 462 winter flounder were recovered during the monitoring season, with a fish total of 521, the largest CPU since 2007 (Table 3). A decline in catch was recorded again from August through October due to unknown reasons.

2014: Out of a 156 total fish caught, 60 were Winter Flounder, and the CPU was 1.97. Low water temperatures from a cold winter and poor oxygen conditions throughout the summer are speculation as to why the observed CPU returned to levels seen from 2008-2012.

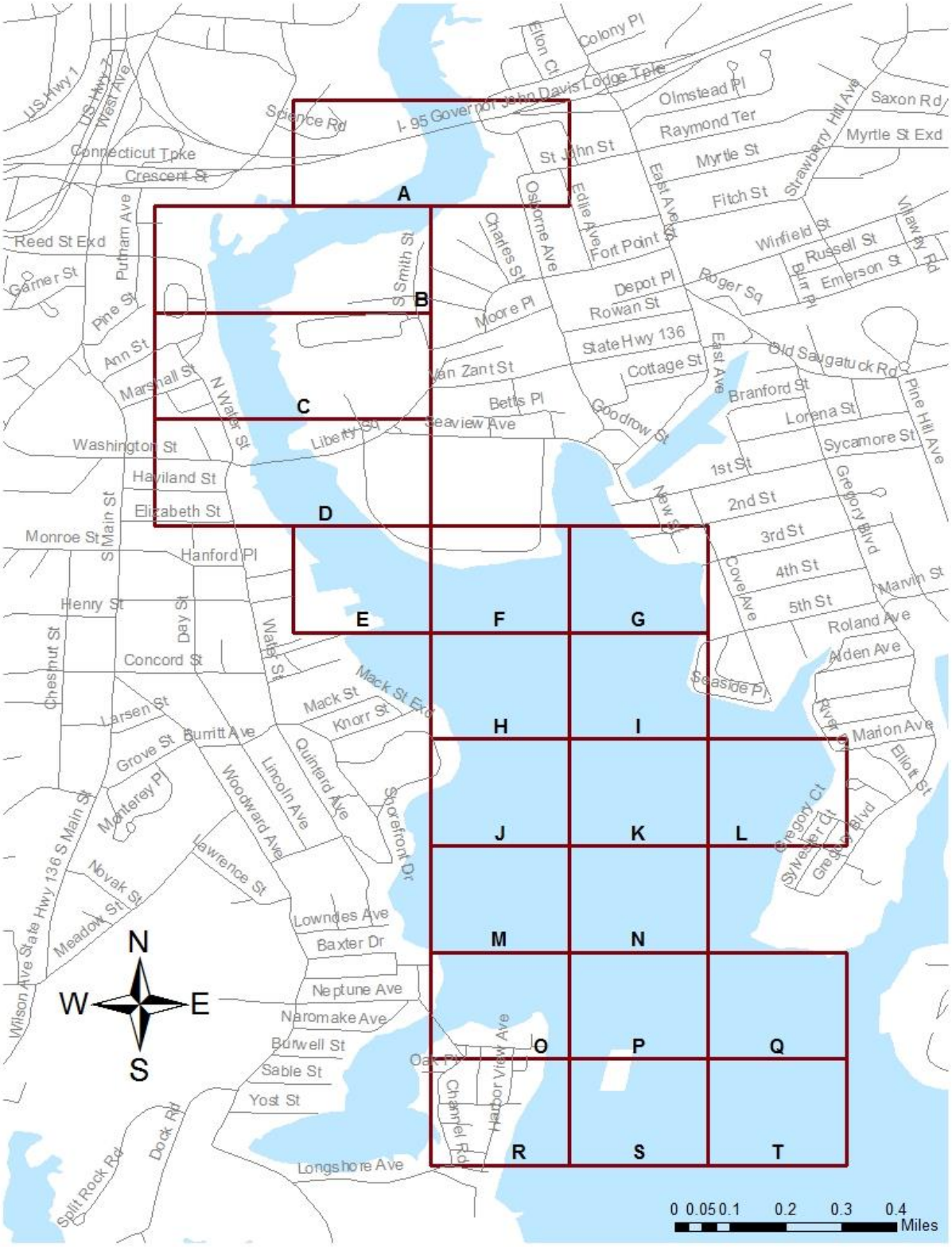

Figure 1. Location of trawl boxes within Norwalk Harbor. Each box was trawled multiple times during the study season (see Table 2).

Methods:
Trawling is conducted from the R.V. Annie, a 26' converted oyster scow equipped with a winch and pulley for trawl retrieval. The crew is comprised of 2 Harbor Watch staff members that fulfil roles as pilot and deck hand and possess Connecticut boating licenses. They are joined by up to 6 additional trained volunteers to assist the deck hand. A grid system which divides the harbor into twenty $300m^2$ sampling quadrants (Figure 1) was devised by the CT DEEP. During each trawling session, 3 boxes are selected to trawl, 1 in the upper harbor (box A-F), one in the middle harbor (box G-N), and one in the outer harbor (box O-T). When in proper position within a box, the 1m beam trawl is launched off the starboard stern. The trawl, which is connected to the winch by approximately 13 meters of line, is equipped with a tapered 0.25-in mesh net, tickler chain, and rescue buoy. Each box is trawled for 3 minutes at 3 miles per hour. Coordinates are recorded for where the trawl was launched and where it was retrieved. At the end of 3 minutes, the trawl is pulled back onto the boat via the winch. The net is removed from the trawl and emptied into a sorting bin. The catch is recorded by species and the number of individuals caught.

Over the years there has been slight variance in data collection due to weather patterns, fish kills, boat repairs, and a request from the CT DEEP to trawl outside of Norwalk Harbor which disrupted trawling activity. In order to maintain some comparison from year to year all catches are reported as catch per unit of effort (CPU) or the total number of fish caught in a period of time divided by the total number of trawls conducted during that same time period.

Results and Discussion:
The harbor has seen a rise and fall in CPU over the length of the study. In the early 1990s, we observed CPUs between 5 and 17, whereas since the early 2000s CPUs below 5 have often been observed with the exception of 2005, 2013, and 2015. The causes of these increases in catch are unknown. Our hypotheses include reduction in predators in the harbor (the water being too cold for blue crabs), or the water temperature in a given year being favorable for recruitment of *Pseudopleuronectes americanus* (winter flounder) and other benthic species.

In 2015, 17 species of fish were caught in Norwalk Harbor. In total, 499 fish were recovered over 75 trawls. Winter Flounder were the most abundant fish caught, totaling 216 individuals caught (Figure 2, Figure 3, Table 3). The CPU was 6.65 in 2015, the highest recorded in our study since 2005 (Figure 5, Table 3). Winter Flounder, *Pseudopleuronectes americanus*, was the most abundant species followed by Northern Searobin, *Prionotus carolinus*, and Black Sea Bass, *Centropristis striata*. Winter flounder were observed in 18 of the 19 boxes trawled, with Box L being the most abundant with 65 individuals caught (Figure 3). However, a seasonal pattern was also observed as Winter Flounder were not observed in September or October. Twelve different species of crab were caught in Norwalk Harbor along with 3 species of shrimp. The most abundant crabs were Black Fingered Mud Crab*, Panopeus herbstii*, with 611 individuals caught (Figure 4). Schools of bunker, *Brevoortia tyrannus*, were observed swimming near the surface, especially in September and October during the trawling trips. On occasion, there were reports of dead Bunker, but never in large numbers. Overall, Norwalk Harbor supports a diverse assemblage of fish and crustaceans with complex spatiotemporal patterns in abundance and community composition.

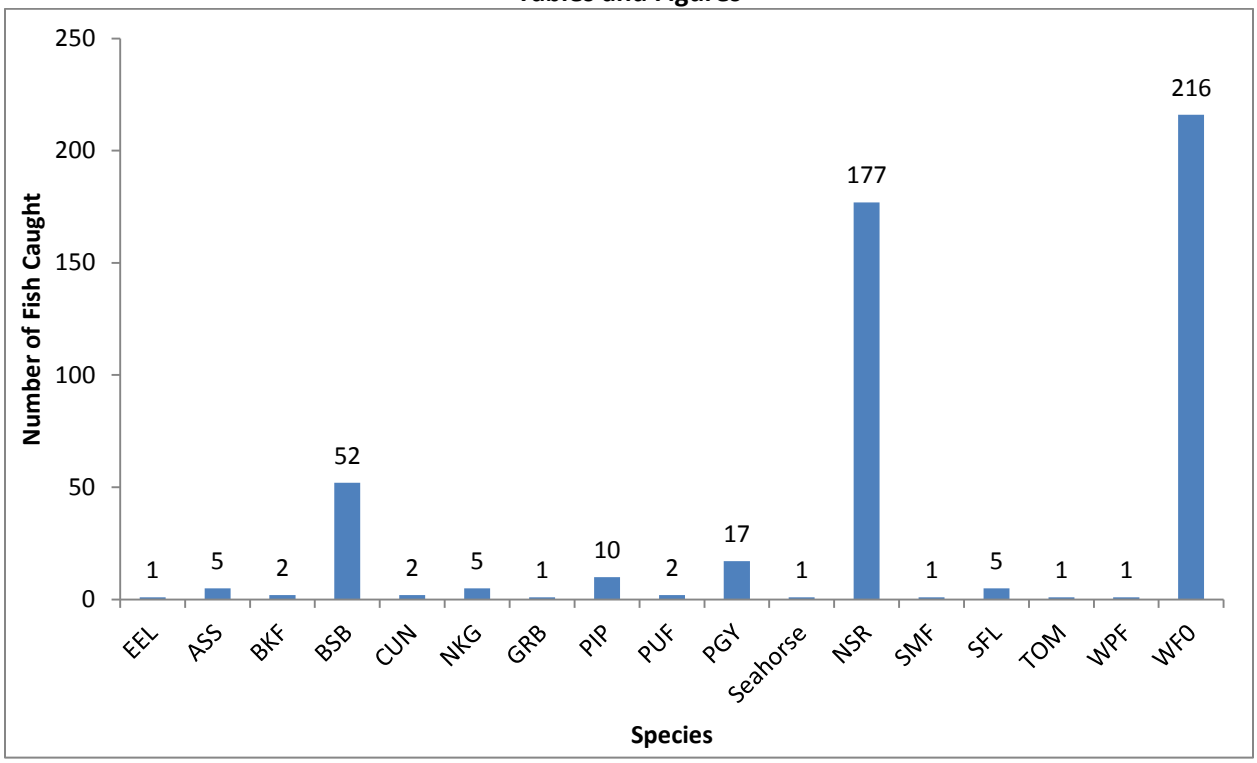

Figure 2. Total number of fish caught by species in Norwalk Harbor, May through October 2015.

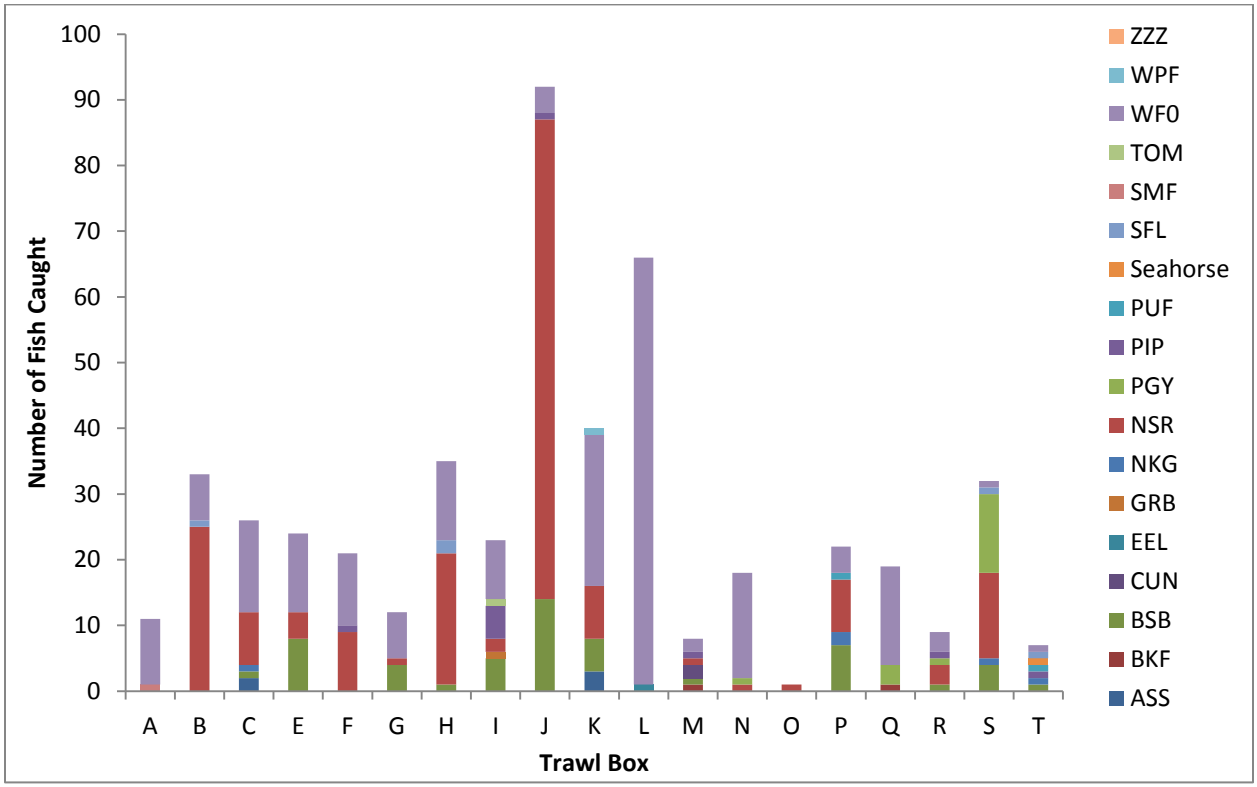

Figure 3. Breakdown of number of each species caught in each box in Norwalk Harbor, May through October 2015.

Table 1 Legend for Figure 2 and 3 with ommon names for each coded color

Code	Common Name	Code	Common Name
ASS	Atlantic Silverside	PIP	Northern Pipefish
BKF	Blackfish	PUF	Northern Puffer
BSB	Black Sea Bass	Seahorse	Seahorse
CUN	Cunner	SFL	Summer Flounder
EEL	Eel	SMF	Smallmouth Flounder
GRB	Grubby	TOM	Tomcod
NKG	Naked Goby	WF0	Winter Flounder
NSR	Northern Searobin	WPF	Windowpane Flounder
PGY	Porgy	ZZZ	No fish caught

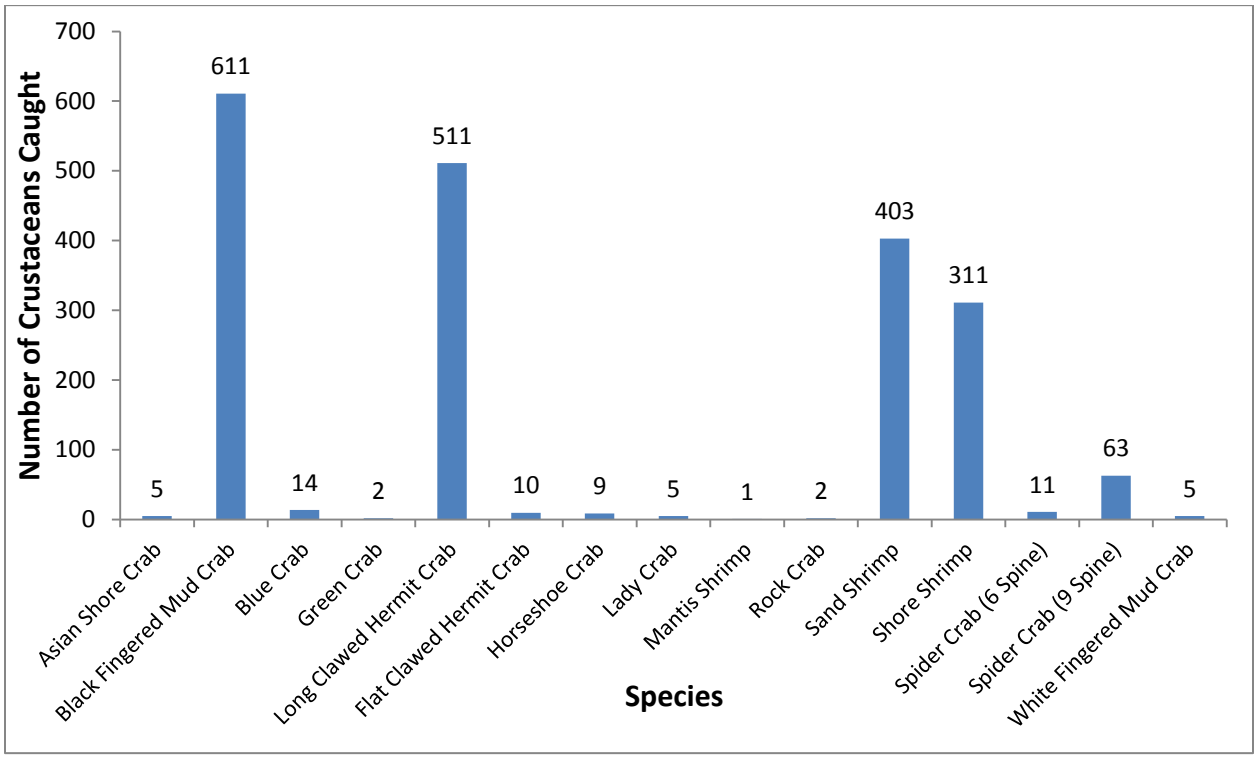

Figure 4. Total number of crustaceans caught by species in Norwalk Harbor, May through October 2015.

Table 2. Total number of trawls in Norwalk Harbor broken down by box, May through September 2014

Box	Trawls	Box	Trawls
A	4	K	4
B	5	L	3
C	5	M	4
D	0	N	3
E	5	O	4
F	4	P	4
G	4	Q	4
H	3	R	3
I	4	S	4
J	4	T	4
		Total	**75**

Table 3. Catch per unit of effort of primary species caught for each trawling season over the last 25 years in Norwalk Harbor

	1990	1991	1992	1993	1994	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Winter Flounder	3.44	5.38	11.97	4.42	15.14	0.00	1.39	3.05	5.33	0.51	1.78	0.38	0.79	0.41	0.97	0.87	5.37	0.76	2.88
Windowpane Flounder	0.00	0.03	0.05	0.23	0.00	0.00	0.00	0.05	0.00	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.03	0.05	0.01
Cunner	0.14	0.12	0.70	0.07	0.55	0.67	0.09	0.03	0.48	0.12	0.22	0.44	0.03	0.00	0.05	0.13	0.02	0.01	0.03
Pipefish	0.58	0.48	0.93	0.96	0.76	0.17	0.17	0.03	0.56	0.20	0.39	0.26	0.29	0.16	0.38	0.22	0.16	0.47	0.13
Searobin	0.35	0.36	1.47	0.26	0.52	0.17	1.15	1.48	0.85	0.03	0.70	0.10	0.66	0.12	0.18	0.28	0.12	0.32	2.36
Blackfish	0.30	0.12	0.10	0.01	0.00	0.33	0.02	0.00	0.04	0.00	0.04	0.06	0.00	0.00	0.05	0.03	0.00	0.10	0.03
Other	0.37	0.33	0.58	0.12	0.62	0.33	0.50	0.34	1.85	0.25	0.52	0.54	0.12	0.07	0.20	0.29	0.35	0.27	1.21
Total	5.19	6.83	15.80	6.07	17.59	1.67	3.33	4.98	9.13	1.13	3.65	1.80	1.90	0.75	1.84	1.82	6.06	1.97	6.65

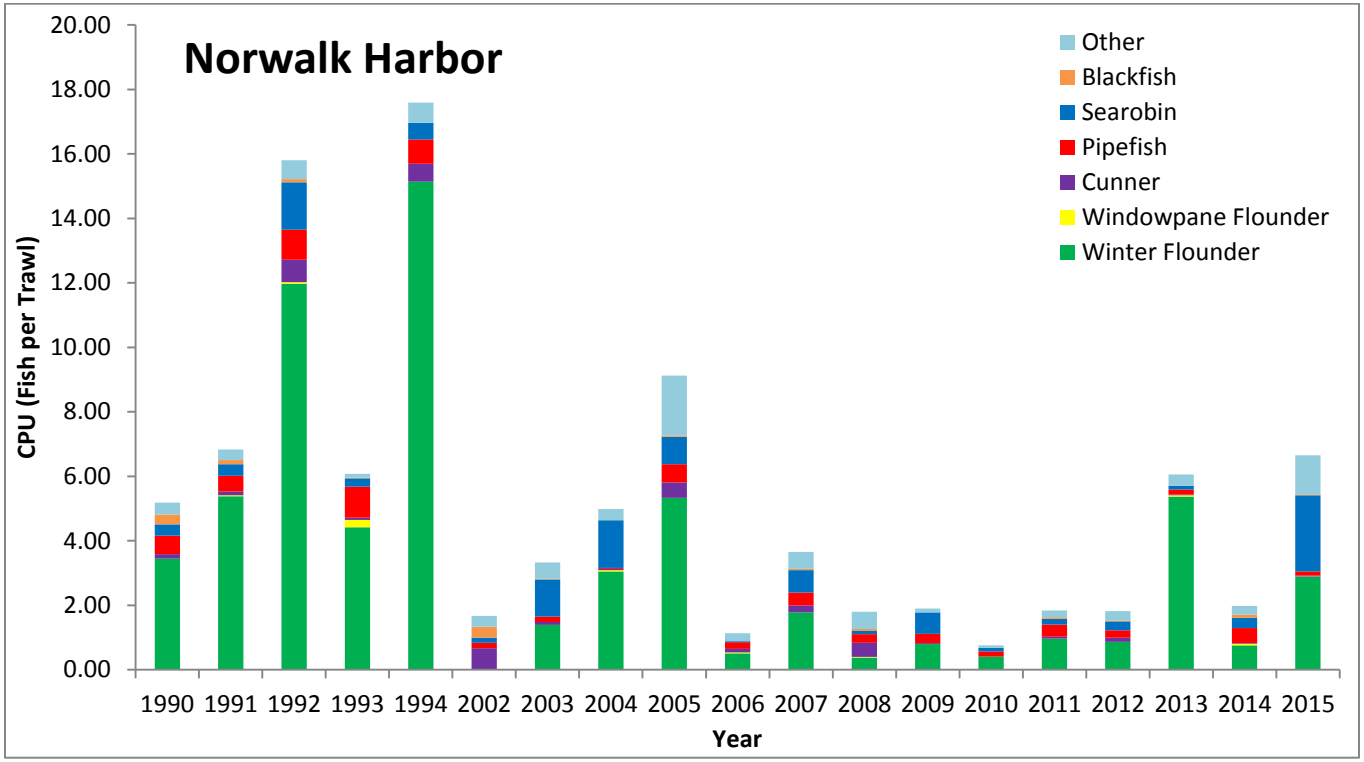

Figure 5. Catch per unit of effort from 1990 to 2015 in Norwalk Harbor.