Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

2015 Annual Performance Reports
F-61-R-22
Grant Number: F14AF00182

Jobs 1-14

Note: Jobs 5 and 7 have been completed

PERIOD: January 1, 2015 – December 31, 2015

Rhode Island Division of Fish and Wildlife

ASSESSMENT OF RECREATIONALLY IMPORTANT FINFISH STOCKS IN RHODE ISLAND WATERS

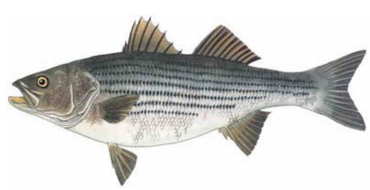
COASTAL FISHERY RESOURCE ASSESSMENT
TRAWL SURVEY
2015

PERFORMANCE REPORT
F-61-R SEGMENT __
JOBS 1 AND 2

Scott D. Olszewski
Principle Marine Fisheries Biologist

Rhode Island Department of Environmental Management
Division of Fish and Wildlife
Marine Fisheries

March 2016



Annual Performance Report

STATE: Rhode Island PROJECT NUMBER: F-61-R
SEGMENT NUMBER: 22

PROJECT TITLE: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

JOB NUMBER: 1
TITLE: Narragansett Bay Monthly Fishery Resource Assessment

JOB OBJECTIVE: To collect, summarize and analyze bottom trawl data for biological and fisheries management purposes.

PERIOD COVERED: January 1, 2015 – December 31, 2015.

PROJECT SUMMARY: Job 1, summary accomplished:
A: 140, twenty minute bottom trawl were successfully completed.
B: Data on weight, length, sex and numbers were gathered on 65 species. Hydrographic data were gathered as well. Additionally, anecdotal notations were made on other plant and animal species. Although not previously discussed, these notations are in keeping with past practice.

TARGET DATE: December 2015

SCHEDULE OF PROGRESS: On schedule.

SIGNIFICANT DEVIATIONS: None
.
JOB NUMBER: 2
TITLE: Seasonal Fishery Resource Assessment of Narragansett Bay, Rhode Island Sound and Block Island Sound

JOB OBJECTIVE: To collect, summarize and analyze bottom trawl data for biological and fisheries management purposes.

PERIOD COVERED: Spring(April – May)/ Fall (September – October) 2015

PROJECT SUMMARY: Job 2, summary accomplished:
A: 43, twenty minute tows were successfully completed during the Spring 2015 survey (25 NB. – 6 RIS – 12 BIS).
B: 43, twenty minute tow were successfully completed during the Fall 2015 survey (25 NB. – 6 RIS – 12 BIS)

TARGET DATE: DECEMBER 2015.

SCHEDULE OF PROGRESS: On schedule.

SIGNIFICANT DEVIATIONS: None

JOBS 1 & 2

RECOMMENDATIONS: Continuation of both the Monthly and Seasonal Trawl surveys into 2016, Data provided by these surveys is used extensively in the Atlantic States Marine Fisheries Commission Fishery Management process and Fishery Management Plans.

RESULTS AND DISCUSSION: 140 tows were completed during 2015 Job 1 (Monthly survey). 65 species accounted for a combined weight of 6,995.1 kgs. and 362,733 length measurements being added to the existing Narragansett Bay monthly trawl data set
By contrast, 86 tows were completed during 2015 Job 2 (Seasonal survey) 64 species accounted for a combined weight of 4,295.6 kgs. and 291,362 length measurements added to the existing seasonal data set.

With the completion of the 2015 surveys, combined survey(s) Jobs (1&2) data now reflects the completion of 6,170 tows with data collected on 132 species.
.

PREPARED BY: ______________________ ______________________
Scott D. Olszewski Date
Supervising Marine Fisheries Biologist
Principal Investigator

APPROVED BY: ______________________ ______________________
Jason McNamee Date
Chief, Marine Resources
RIDFW – Marine Fisheries

Coastal Fishery Resource Assessment – Trawl Survey

Introduction:

The Rhode Island Division of Fish and Wildlife - Marine Fisheries Section, began monitoring finfish populations in Narragansett Bay in 1968, continuing through 1977. These data provided monthly identification of finfish and crustacean assemblages. As management strategies changed and focus turned to the near inshore waters, outside of Narragansett Bay, a comprehensive fishery resource assessment program was instituted in 1979. (Lynch T. R. Coastal Fishery Resource Assessment, 2007)

Since the inception of the Rhode Island Seasonal Trawl Survey (April 1979) and the Narragansett Bay Monthly Trawl Survey (January 1990), 6,170 tows have been conducted within Rhode Island territorial waters with data collected on 132 species. This performance report reflects the efforts of the 2015 survey year as it relates to the past 35 years. (Lynch T. R. Coastal Fishery Resource Assessment, 2007), (Olszewski S.D. Coastal Fishery Resource Assessment 2014)

Methods:

The methodology used in the allocation of sampling stations employs both random and fixed station allocation. Fixed station allocation began in 1988 in Rhode Island Sound and Block Island Sound. This was based on the frequency of replicate stations selected by depth stratum since 1979. With the addition of the Narragansett Bay monthly portion of the survey in 1990, an allocation system of fixed and randomly selected stations has been employed depending on the segment (Monthly vs. Seasonal) of the annual surveys.

Sampling stations were established by dividing Narragansett Bay into a grid of cells. The seasonal trawl survey is conducted in the spring and fall of each year. Usually 44 stations are sampled each season; however this number has ranged from 26 to 72 over the survey time series due to mechanical and weather conditions. The stations sampled in Narragansett Bay are a combination of fixed and random sites. 13 fixed during the monthly portion and 26, (14 of which are randomly selected) during the seasonal portion. The random sites are randomly selected from a predefined grid. All stations sampled in Rhode Island and Block Island Sounds are fixed.

Depth Stratum Identification

Area	**Stratum**	**Area nm2**	**Depth Range (m)**
Narragansett Bay	1	15.50	<=6.09
	2	51.00	>=6.09
Rhode Island Sound	3	0.25	<=9.14
	4	2.25	9.14 – 18.28
	5	13.5	18.28 – 27.43
	6	9.75	>=27.43
Block Island Sound	7	3.50	<=9.14
	8	10.50	9.14 – 18.28
	9	11.50	18.28 – 27.43
	10	12.25	27.43 – 36.57
	11	4.00	>=36.57

At each station, an otter trawl equipped with a ¼ mesh inch liner is towed for twenty minutes. The Coastal Trawl survey net is 210 x 4.5”, 2 seam (40’ / 55’), the mesh size is 4.5” and the sweep is 5/16” chain, hung 12” spacing, 13 links per space. Figure 1 depicts the RI Coastal Trawl survey net plan.

The research vessel used in the Coastal Trawl Survey is the R/V John H. Chafee. Built in 2002, the Research Vessel is a 50’ Wesmac hull, powered by a 3406 Caterpillar engine generating 700 hp.

Data on wind direction and speed, sea condition, air temperature and cloud cover as well as surface and bottom water temperatures, are recorded at each station. Catch is sorted by species. Length (cm/mm) is recorded for all finfish, skates, squid, scallops, Whelk lobster, blue crabs and horseshoe crabs. Similarly, weights (gm/kg) and number are recorded as well. Anecdotal information is also recorded for incidental plant and animal species.

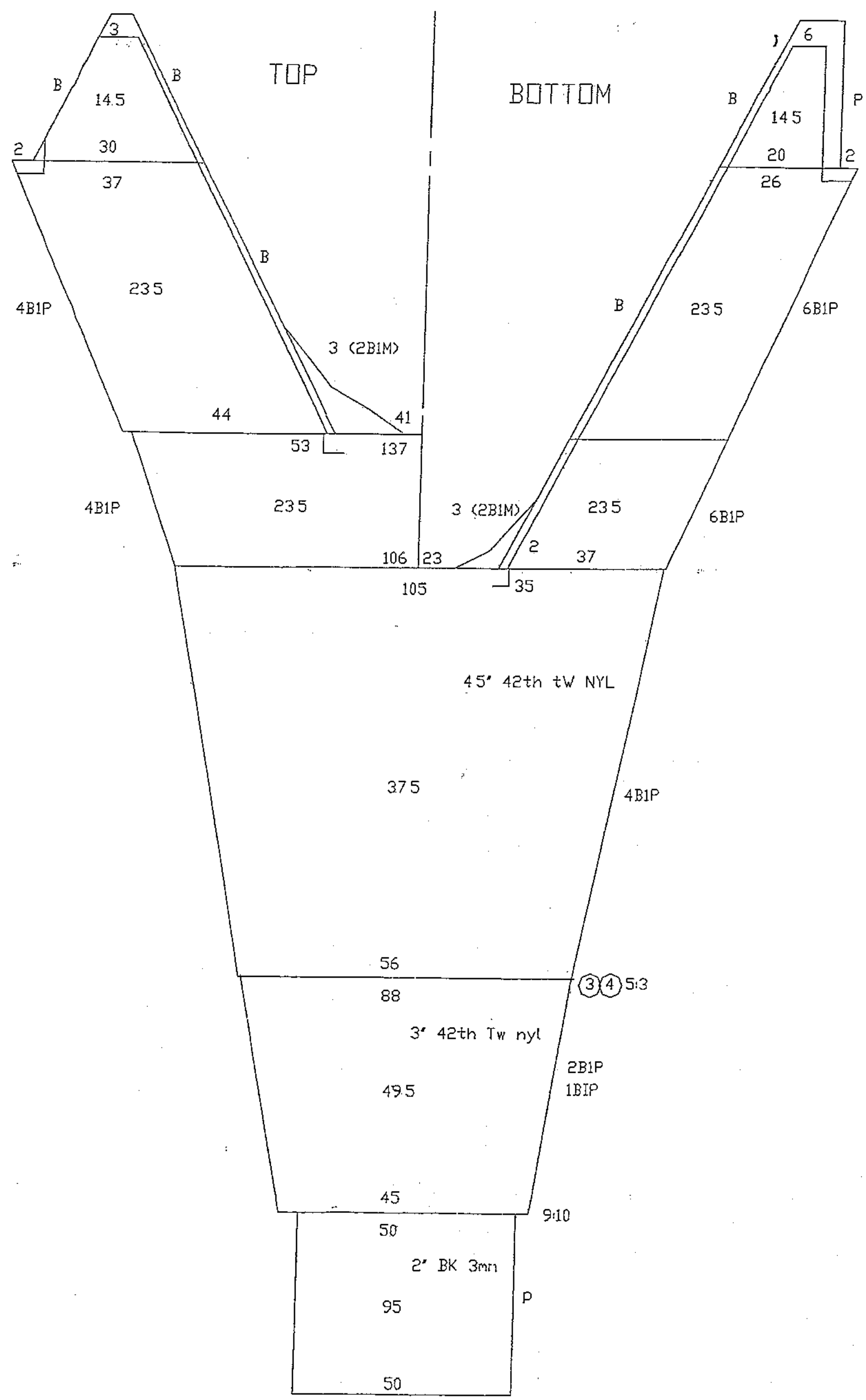
Survey changes- Beginning January 2012 the Rhode Island Coastal Trawl Survey began using an updated set of trawl doors. Throughout 2012, a comparative gear calibration study was completed to determine if a significant change to the survey catch data is exists. The analysis of this calibration study was completed in 2013 and is available upon request.

RIDEM R/V John H. Chafee

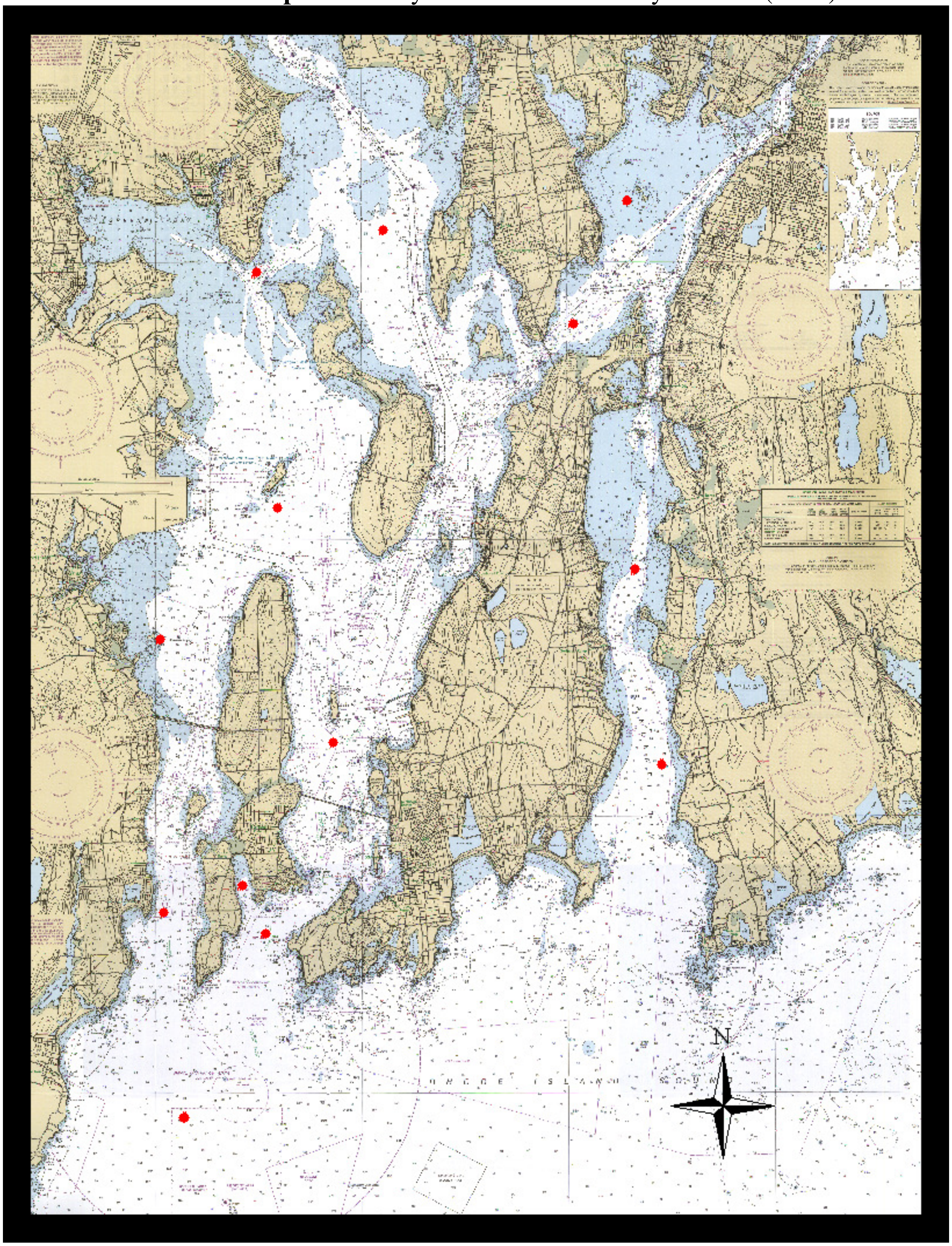
Acknowledgements:
Special thanks are again extended to Captain Richard Mello and Assistant Captain, Patrick Brown, Nichole Ares and the entire seasonal staff and volunteers. The support given over the years has been greatly appreciated.

Figure 1

210 x 4.5" 2sm (40'/55')



Map 1 Monthly Coastal Trawl Survey Stations (fixed)



Results: Job 1. Monthly Coastal Trawl Survey; 12 fixed stations in Narragansett Bay and 1 in Rhode Island Sound.

A total of 65 species were observed and recorded during the 2014 Narragansett Bay Monthly Trawl Survey totaling 362,733 individuals or 2590.9 fish per tow. In weight, the catch accounted for 6,955.1 kg. or 49.9 kg. per tow. (Figures 2 and 3) The top ten species by number and catch are represented in figures 4 and 5. The catch between demersal and pelagic species is represented in figures 6 and 7.

Figure 2 (Total Catch in Number)

Fish Name	Scientific Name	Number
Scup	STENOTOMUS CHRYSOPS	200364
Butterfish	PEPRILUS TRIACANTHUS	83139
Longfin Squid	LOLIGO PEALEI	28390
Atlantic Menhaden	BREVOORTIA TYRANNUS	11771
Atlantic Silverside	MENIDIA MENIDIA	9094
Alewife	ALOSA PSEUDOHARENGUS	7907
Bay Anchovy	ANCHOA MITCHILLI	7398
Atlantic Herring	CLUPEA HARENGUS	3684
Weakfish	CYNOSCION REGALIS	2798
Black Sea Bass	CENTROPRISTIS STRIATA	2059
Atlantic Moonfish	SELENE SETAPINNIS	1807
Rough Scad	TRACHURUS LATHAMI	735
Little Skate	LEUCORAJA ERINACEA	681
Bluefish	POMATOMUS SALTATRIX	468
Striped Searobin	PRIONOTUS EVOLANS	457
Blueback Herring	ALOSA AESTIVALIS	218
Summer Flounder	PARALICHTHYS DENTATUS	199
Winter Flounder	PLEURONECTES AMERICANUS	181
American Lobster	HOMARUS AMERICANUS	173
Rock Crab	CANCER IRRORATUS	152
Northern Kingfish	MENTICIRRHUS SAXATILIS	140
Spotted Hake	UROPHYCIS REGIA	111
Tautog	TAUTOGA ONITIS	110
American Shad	ALOSA SAPIDISSIMA	90
Smooth Dogfish	MUSTELUS CANIS	79
Atlantic Cod	GADUS MORHUA	65
Windowpane Flounder	SCOPHTHALMUS AQUOSUS	57
Silver Hake	MERLUCCIUS BILINEARIS	49
Northern Searobin	PRIONOTUS CAROLINUS	47
Channeled Whelk	BUSYCOTYPUS CANALICULATUS	45
Red Hake	UROPHYCIS CHUSS	42
Fourspot Flounder	PARALICHTHYS OBLONGUS	34
Horseshoe Crab	LIMULUS POLYPHEMUS	26

Knobbed Whelk	BUSYCON CARICA	16
Inshore Lizardfish	SYNODUS FOETENS	16
Striped Bass	MORONE SAXATILIS	14
Clearnose Skate	RAJA EGLANTERIA	14
Blue Runner	CARANX CRYSOS	13
Longhorn Sculpin	MYOXOCEPHALUS OCTODECEMSPINOS	10
Winter Skate	LEUCORAJA OCELLATA	9
Bigeye	PRIACANTHUS ARENATUS	9
Smallmouth Flounder	ETROPUS MICROSTOMUS	8
Blue Crab	CALLINECTES SAPIDUS	8
Spiny Dogfish	SQUALUS ACANTHIAS	4
Mantis Shrimp	SQUILLA EMPUSA	4
Northern Puffer	SPHOEROIDES MACULATUS	4
Jonah Crab	CANCER BOREALIS	4
Striped Anchovy	ANCHOA HEPSETUS	3
Rainbow Smelt	OSMERUS MORDAX	3
Hickory Shad	ALOSA MEDIOCRIS	2
Pollock	POLLACHIUS VIRENS	2
Northern Sennet	SPHYRAENA BOREALIS	2
Atlantic Mackerel	SCOMBER SCOMBRUS	2
Fourspine Stickleback	APELTES QUADRACUS	2
Sea Raven	HEMITRIPTERUS AMERICANUS	2
Cunner	TAUTOGOLABRUS ADSPERSUS	2
Ocean Pout	MACROZOARCES AMERICANUS	2
White Hake	UROPHYCIS TENUIS	1
Hogchoker	TRINECTES MACULATUS	1
Bobtail Squid	ROSSIA MOELLERI	1
Spot	LEIOSTOMUS XANTHURUS	1
Grubby	MYOXOCEPHALUS AENAEUS	1
Northern Stargazer	ASTROSCOPUS GUTTATUS	1
Rock Gunnel	PHOLIS GUNNELLUS	1
Northern Pipefish	SYNGNATHUS FUSCUS	1

Figure 3 (Total Catch in Kilograms)

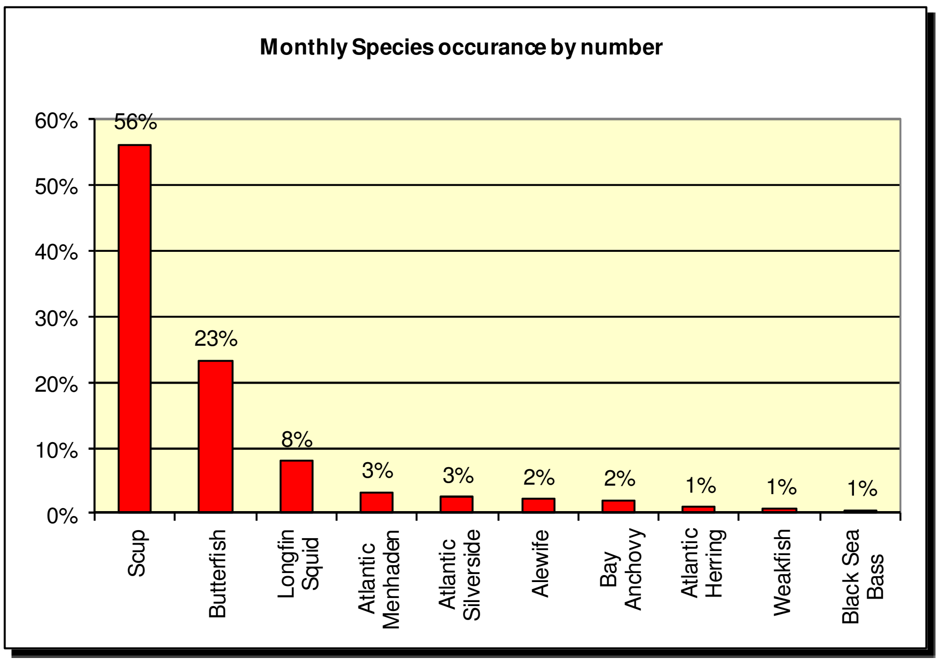
Fish Name	Scientific Name	Kg
Scup	STENOTOMUS CHRYSOPS	3285.260
Butterfish	PEPRILUS TRIACANTHUS	1198.994
Longfin Squid	LOLIGO PEALEI	621.440
Little Skate	LEUCORAJA ERINACEA	388.355

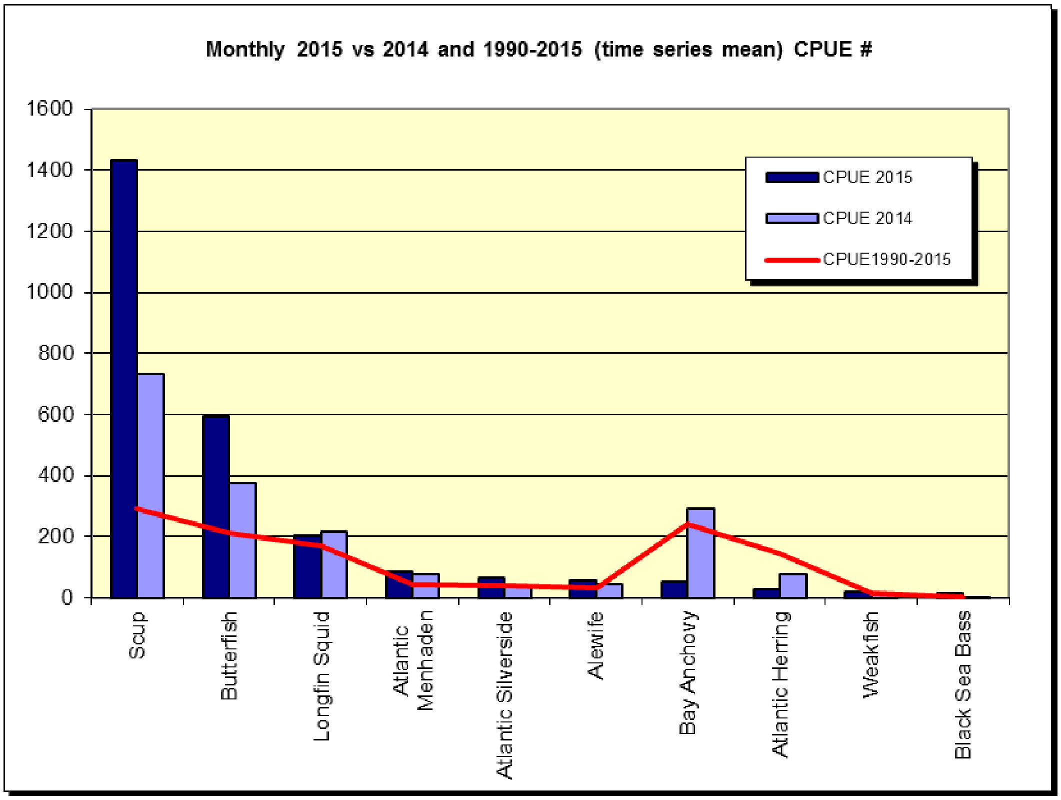
Black Sea Bass	CENTROPRISTIS STRIATA	232.845
Summer Flounder	PARALICHTHYS DENTATUS	149.775
Tautog	TAUTOGA ONITIS	141.465
Alewife	ALOSA PSEUDOHARENGUS	140.645
Atlantic Herring	CLUPEA HARENGUS	127.834
Atlantic Menhaden	BREVOORTIA TYRANNUS	80.421
Weakfish	CYNOSCION REGALIS	75.160
Smooth Dogfish	MUSTELUS CANIS	69.035
Striped Searobin	PRIONOTUS EVOLANS	60.806
American Lobster	HOMARUS AMERICANUS	59.205
Horseshoe Crab	LIMULUS POLYPHEMUS	54.305
Bluefish	POMATOMUS SALTATRIX	46.555
Winter Flounder	PLEURONECTES AMERICANUS	37.100
Striped Bass	MORONE SAXATILIS	32.840
Atlantic Silverside	MENIDIA MENIDIA	29.570
Clearnose Skate	RAJA EGLANTERIA	23.210
Rock Crab	CANCER IRRORATUS	21.300
Bay Anchovy	ANCHOA MITCHILLI	13.154
Windowpane Flounder	SCOPHTHALMUS AQUOSUS	11.715
Winter Skate	LEUCORAJA OCELLATA	10.175
Atlantic Moonfish	SELENE SETAPINNIS	8.710
Fourspot Flounder	PARALICHTHYS OBLONGUS	7.355
Northern Searobin	PRIONOTUS CAROLINUS	7.195
Rough Scad	TRACHURUS LATHAMI	7.080
Northern Kingfish	MENTICIRRHUS SAXATILIS	6.905
Spiny Dogfish	SQUALUS ACANTHIAS	6.800
Channeled Whelk	BUSYCOTYPUS CANALICULATUS	6.695
Longhorn Sculpin	MYOXOCEPHALUS OCTODECEMSPINOS	4.345
Knobbed Whelk	BUSYCON CARICA	3.880
Spotted Hake	UROPHYCIS REGIA	3.378
Blueback Herring	ALOSA AESTIVALIS	2.913
American Shad	ALOSA SAPIDISSIMA	2.470
Red Hake	UROPHYCIS CHUSS	2.075
Ocean Pout	MACROZOARCES AMERICANUS	1.860
Blue Crab	CALLINECTES SAPIDUS	1.745
Blue Runner	CARANX CRYSOS	1.580
Sea Raven	HEMITRIPTERUS AMERICANUS	1.485
Atlantic Cod	GADUS MORHUA	1.320
Inshore Lizardfish	SYNODUS FOETENS	1.265
Silver Hake	MERLUCCIUS BILINEARIS	1.250
Northern Stargazer	ASTROSCOPUS GUTTATUS	0.920
Jonah Crab	CANCER BOREALIS	0.605
Hickory Shad	ALOSA MEDIOCRIS	0.455

Spot	LEIOSTOMUS XANTHURUS	0.360
Atlantic Mackerel	SCOMBER SCOMBRUS	0.342
Bigeye	PRIACANTHUS ARENATUS	0.210
Hogchoker	TRINECTES MACULATUS	0.160
Mantis Shrimp	SQUILLA EMPUSA	0.120
Pollock	POLLACHIUS VIRENS	0.120
Northern Sennet	SPHYRAENA BOREALIS	0.085
Northern Puffer	SPHOEROIDES MACULATUS	0.075
Cunner	TAUTOGOLABRUS ADSPERSUS	0.057
Smallmouth Flounder	ETROPUS MICROSTOMUS	0.042
Rainbow Smelt	OSMERUS MORDAX	0.020
Rock Gunnel	PHOLIS GUNNELLUS	0.015
Striped Anchovy	ANCHOA HEPSETUS	0.015
Grubby	MYOXOCEPHALUS AENAEUS	0.010
Northern Pipefish	SYNGNATHUS FUSCUS	0.005
White Hake	UROPHYCIS TENUIS	0.002
Fourspine Stickleback	APELTES QUADRACUS	0.001
Bobtail Squid	ROSSIA MOELLERI	0.001

Figure 4 Monthly Survey Top Ten Species Catch in Number

Fish Name	Scientific Name	%
Scup	STENOTOMUS CHRYSOPS	56%
Butterfish	PEPRILUS TRIACANTHUS	23%
Longfin Squid	LOLIGO PEALEI	8%
Atlantic Menhaden	BREVOORTIA TYRANNUS	3%
Atlantic Silverside	MENIDIA MENIDIA	3%
Alewife	ALOSA PSEUDOHARENGUS	2%
Bay Anchovy	ANCHOA MITCHILLI	2%
Atlantic Herring	CLUPEA HARENGUS	1%
Weakfish	CYNOSCION REGALIS	1%
Black Sea Bass	CENTROPRISTIS STRIATA	1%

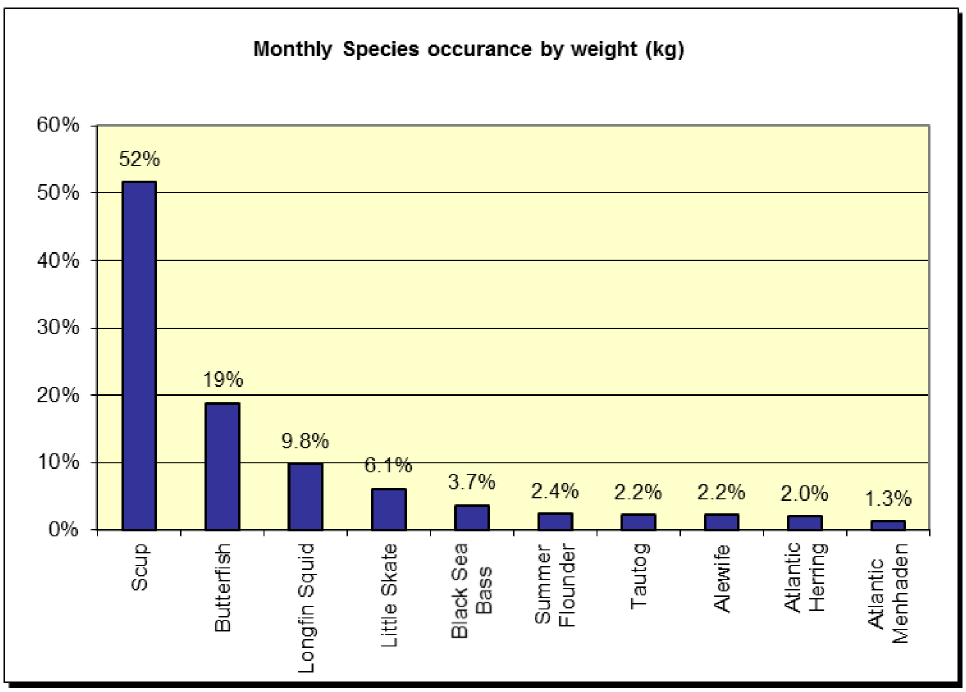


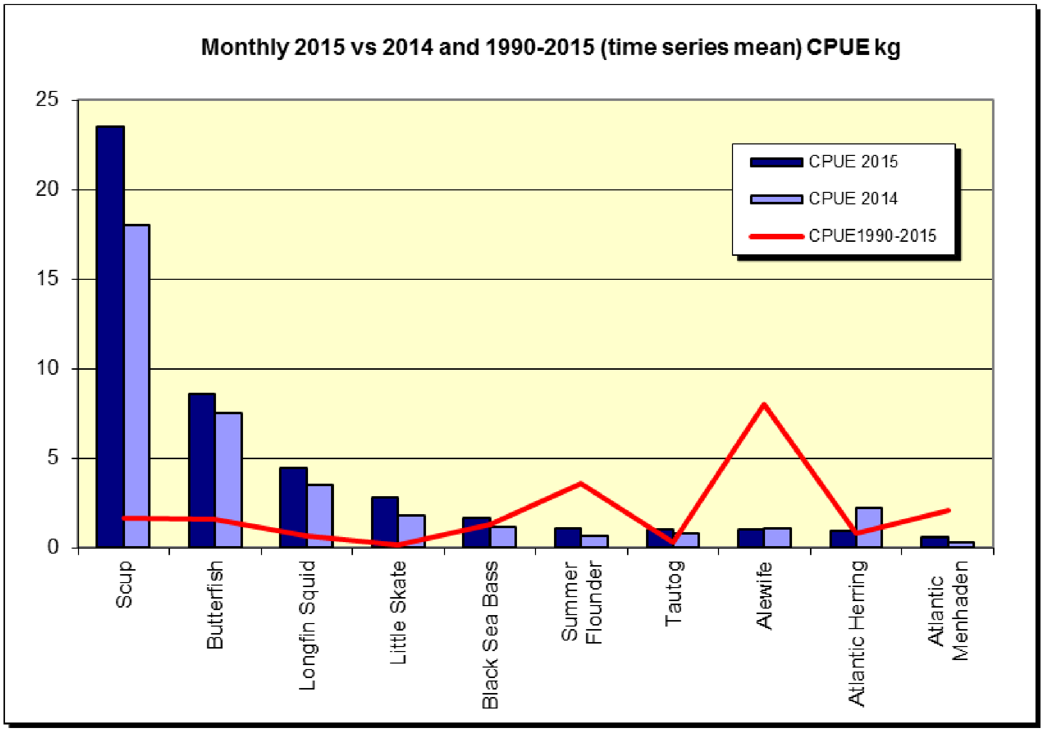


Monthly 2015 vs 2014 and 1990-2015 (time series mean) CPUE #
1600
1400
1200
1000
800
600
400
200
0
CPUE 2015
CPUE 2014
CPUE1990-2015
Scup
Butterfish
Longfin Squid
Atlantic Menhaden
Atlantic Silverside
Alewife
Bay Anchovy
Atlantic Herring
Weakfish
Black Sea Bass

Figure 5 Top Ten Species Catch in Kilograms

Fish Name	Scientific Name	%
Scup	STENOTOMUS CHRYSOPS	52%
Butterfish	PEPRILUS TRIACANTHUS	19%
Longfin Squid	LOLIGO PEALEI	9.8%
Little Skate	LEUCORAJA ERINACEA	6.1%
Black Sea Bass	CENTROPRISTIS STRIATA	3.7%
Summer Flounder	PARALICHTHYS DENTATUS	2.4%
Tautog	TAUTOGA ONITIS	2.2%
Alewife	ALOSA PSEUDOHARENGUS	2.2%
Atlantic Herring	CLUPEA HARENGUS	2.0%
Atlantic Menhaden	BREVOORTIA TYRANNUS	1.3%

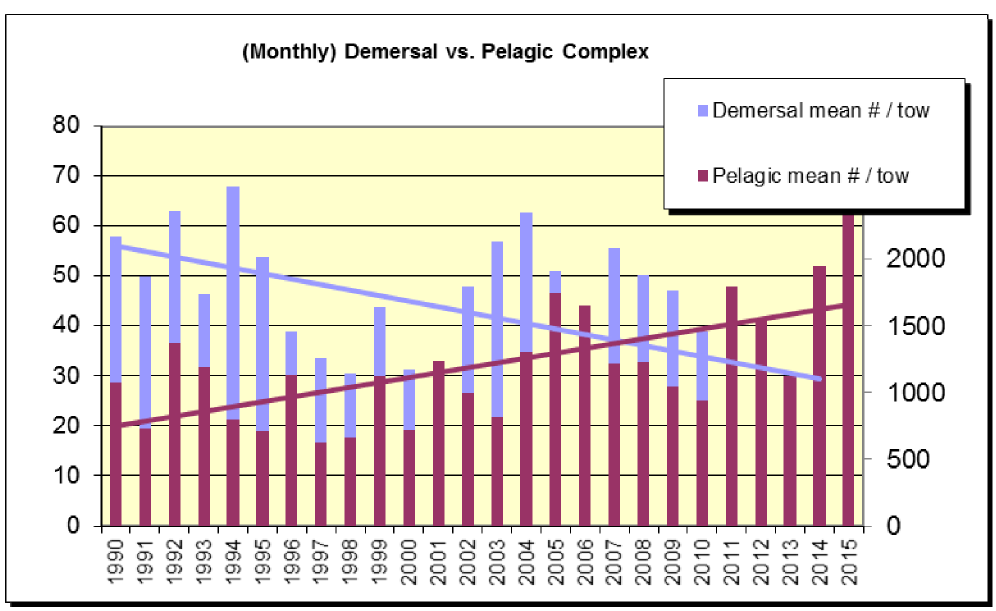


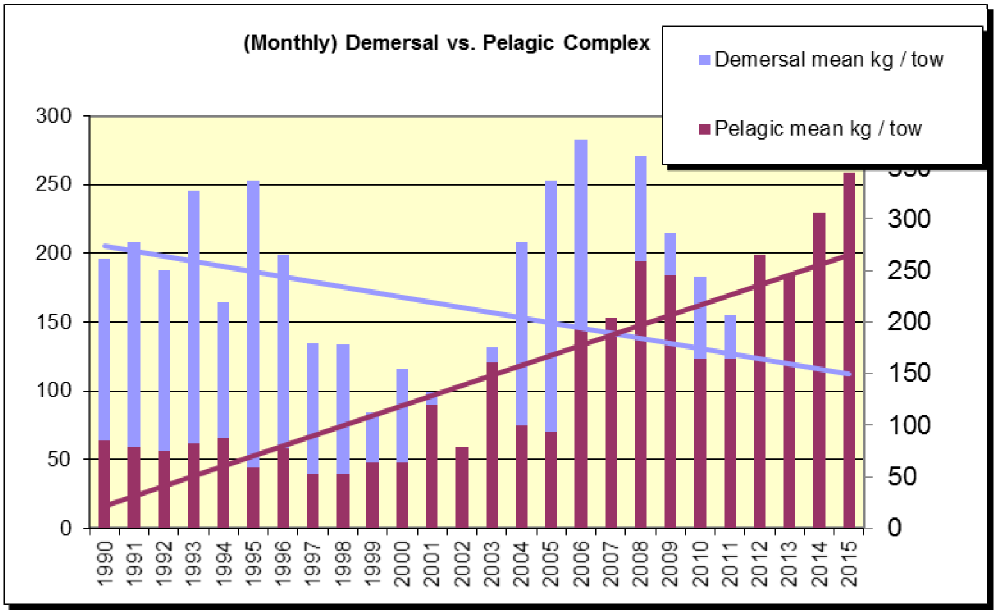

Monthly 2015 vs 2014 and 1990-2015 (time series mean) CPUE kg
CPUE 2015
CPUE 2014
CPUE1990-2015
0
5
10
15
20
25
Scup
Butterfish
Longfin Squid
Little Skate
Black Sea Bass
Summer Flounder
Tautog
Alewife
Atlantic Herring
Atlantic Menhaden

Demersal vs. Pelagic Species Complex

Demersal Species	**Pelagic/Multi-Habitat Species**
Cunner	Alewife
Four Spot Flounder	Atlantic Herring
Goosefish	Atlantic Moonfish
Hog Choker	Bay Anchovy
Lobster	Black Sea Bass
Longhorn Sculpin	Blueback Herring
Northern Searobin	Bluefish
Ocean Pout	Butterfish
Red Hake	Longfin Squid
Sea Raven	Menhaden
Silver Hake	Rainbow Smelt
Skates	Scup
Smooth Dogfish	Shad
Spiny Dogfish	Silverside
Spotted Hake	Striped Bass
Striped Searobin	Weakfish
Summer Flounder	
Tautog	
Windowpane Flounder	
Winter Flounder	

Figure 6 and 7

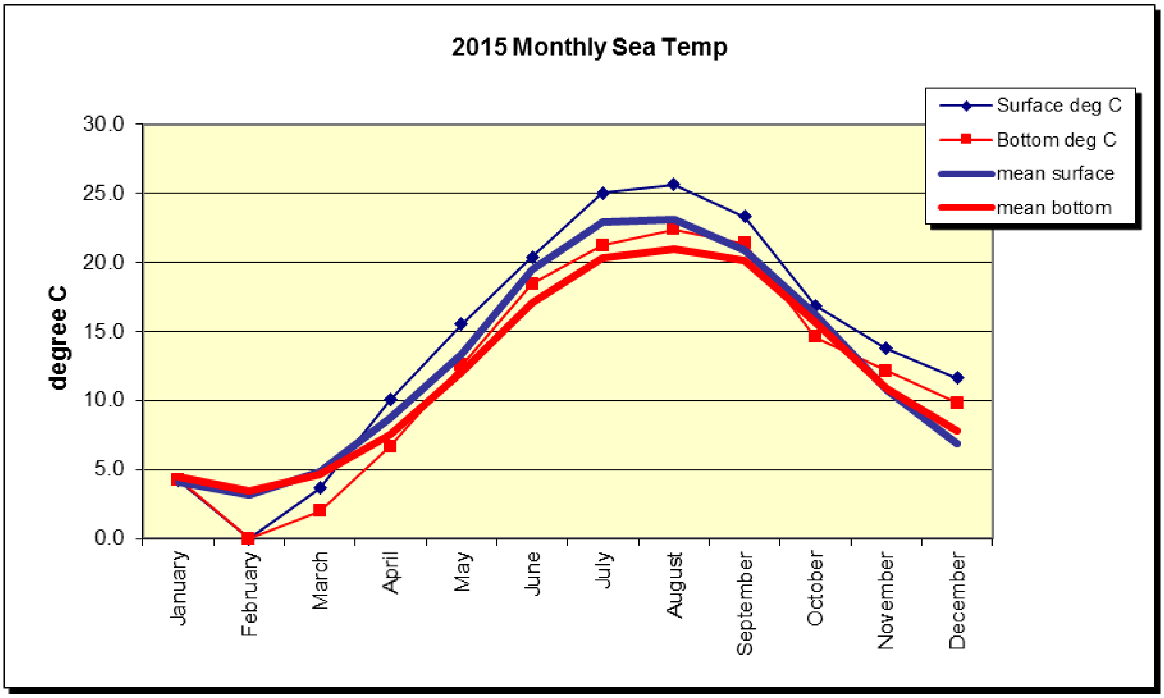


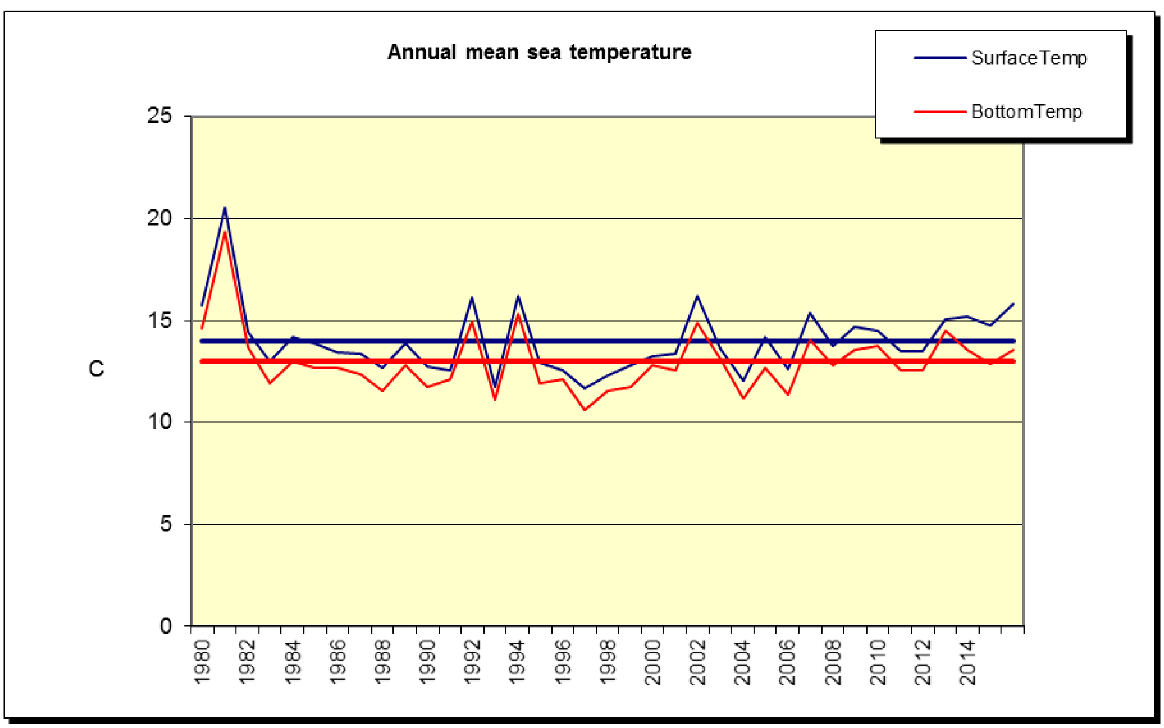


(Monthly) Demersal vs. Pelagic Complex
Demersal mean kg / tow
Pelagic mean kg / tow
300
250
200
150
100
50
0
300
250
200
150
100
50
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

Survey Temperature Profile   (Annual mean surface and bottom temperature)

Surface and bottom temperatures are collected at every station. The bottom temperature is collected by Niskin bottle at the average or maximum depth for each station.





Results: Job 2. The Seasonal Coastal Trawl Survey is defined by 12 fixed stations in Narragansett Bay, 14 random stations in Narragansett Bay, 6 fixed stations in Rhode Island Sound, 12 fixed stations in Block Island Sound.
64 species were observed and recorded during the 2015 Rhode Island Seasonal Trawl Survey, totaling 291,362 individuals or 3387.9 fish per tow. In weight, the catch accounted for 4295.6 kg. or 49.9 kg. per tow. (Figures 8 and 9) The top ten species by number and catch are represented in figures 10 and 11. The change between demersal and pelagic species is represented in figures 12 and 13.

Figure 8 (Total Catch in Number)

Fish Name	Scientific Name	Number
Scup	STENOTOMUS CHRYSOPS	221613
Butterfish	PEPRILUS TRIACANTHUS	31804
Longfin Squid	LOLIGO PEALEI	19662
Bay Anchovy	ANCHOA MITCHILLI	6539
Atlantic Moonfish	SELENE SETAPINNIS	2271
Weakfish	CYNOSCION REGALIS	2003
Bluefish	POMATOMUS SALTATRIX	1195
Atlantic Herring	CLUPEA HARENGUS	1147
Atlantic Menhaden	BREVOORTIA TYRANNUS	1142
Little Skate	LEUCORAJA ERINACEA	810
Alewife	ALOSA PSEUDOHARENGUS	801
Atlantic Cod	GADUS MORHUA	267
Blueback Herring	ALOSA AESTIVALIS	251
Northern Kingfish	MENTICIRRHUS SAXATILIS	176
Summer Flounder	PARALICHTHYS DENTATUS	164
Winter Flounder	PLEURONECTES AMERICANUS	159
Rock Crab	CANCER IRRORATUS	141
Black Sea Bass	CENTROPRISTIS STRIATA	137
Striped Searobin	PRIONOTUS EVOLANS	133
Winter Skate	LEUCORAJA OCELLATA	88
Spotted Hake	UROPHYCIS REGIA	84
American Shad	ALOSA SAPIDISSIMA	76
Rough Scad	TRACHURUS LATHAMI	76
Atlantic Silverside	MENIDIA MENIDIA	68
American Sand Lance	AMMODYTES AMERICANUS	63
Smooth Dogfish	MUSTELUS CANIS	54
American Lobster	HOMARUS AMERICANUS	51
Red Hake	UROPHYCIS CHUSS	41
Windowpane Flounder	SCOPHTHALMUS AQUOSUS	39
Clearnose Skate	RAJA EGLANTERIA	37
Longhorn Sculpin	MYOXOCEPHALUS OCTODECEMSPINOS	29
Horseshoe Crab	LIMULUS POLYPHEMUS	28

Ocean Pout	MACROZOARCES AMERICANUS	26
Northern Puffer	SPHOEROIDES MACULATUS	24
Inshore Lizardfish	SYNODUS FOETENS	20
Channeled Whelk	BUSYCOTYPUS CANALICULATUS	19
Silver Hake	MERLUCCIUS BILINEARIS	19
Smallmouth Flounder	ETROPUS MICROSTOMUS	16
Tautog	TAUTOGA ONITIS	14
Knobbed Whelk	BUSYCON CARICA	11
Blue Crab	CALLINECTES SAPIDUS	7
Jonah Crab	CANCER BOREALIS	6
Fourspot Flounder	PARALICHTHYS OBLONGUS	6
Sea Scallop	PLACOPECTEN MAGELLANICUS	6
Striped Anchovy	ANCHOA HEPSETUS	5
Mantis Shrimp	SQUILLA EMPUSA	5
Yellowtail Flounder	LIMANDA FERRUGINEUS	4
Northern Pipefish	SYNGNATHUS FUSCUS	3
Cunner	TAUTOGOLABRUS ADSPERSUS	3
Northern Searobin	PRIONOTUS CAROLINUS	3
Grubby	MYOXOCEPHALUS AENAEUS	2
Bluespotted Cornetfish	FISTULARIA TABACARIA	2
Round Scad	DECAPTERUS PUNCTATUS	1
Sea Raven	HEMITRIPTERUS AMERICANUS	1
Blue Runner	CARANX CRYSOS	1
Atlantic Mackerel	SCOMBER SCOMBRUS	1
Striped Cusk Eel	OPHIDION MARGINATUM	1
Northern Sennet	SPHYRAENA BOREALIS	1
Rainbow Smelt	OSMERUS MORDAX	1
Crevalle Jack	CARANX HIPPOS	1
Haddock	MELANOGRAMMUS AEGLEFINUS	1
Bigeye	PRIACANTHUS ARENATUS	1
Goosefish	LOPHIUS AMERICANUS	1
Dwarf Goatfish	UPENEUS PARVUS	1

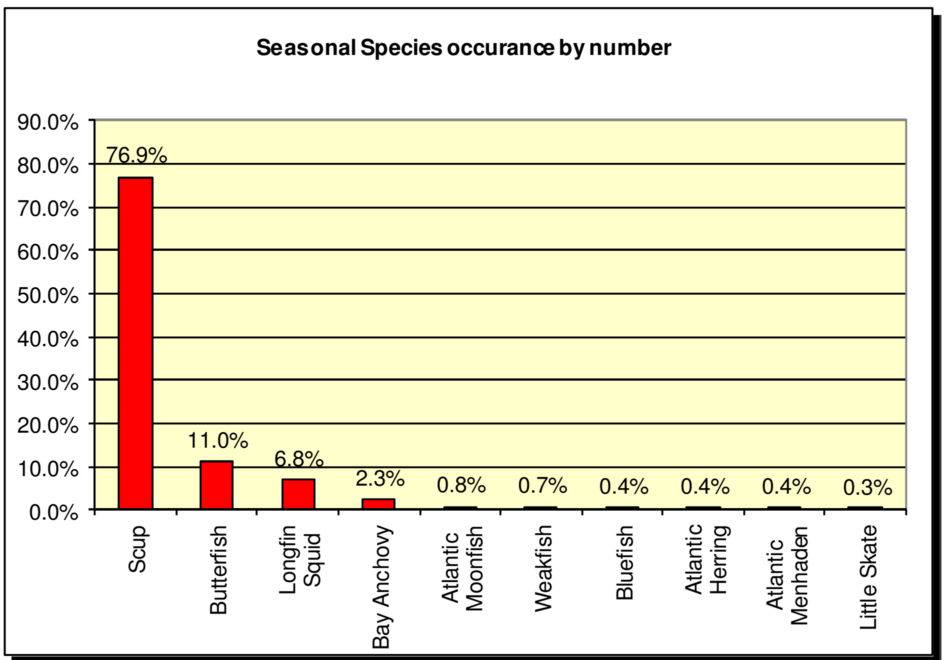
Figure 9 (Total Catch in Kilograms)

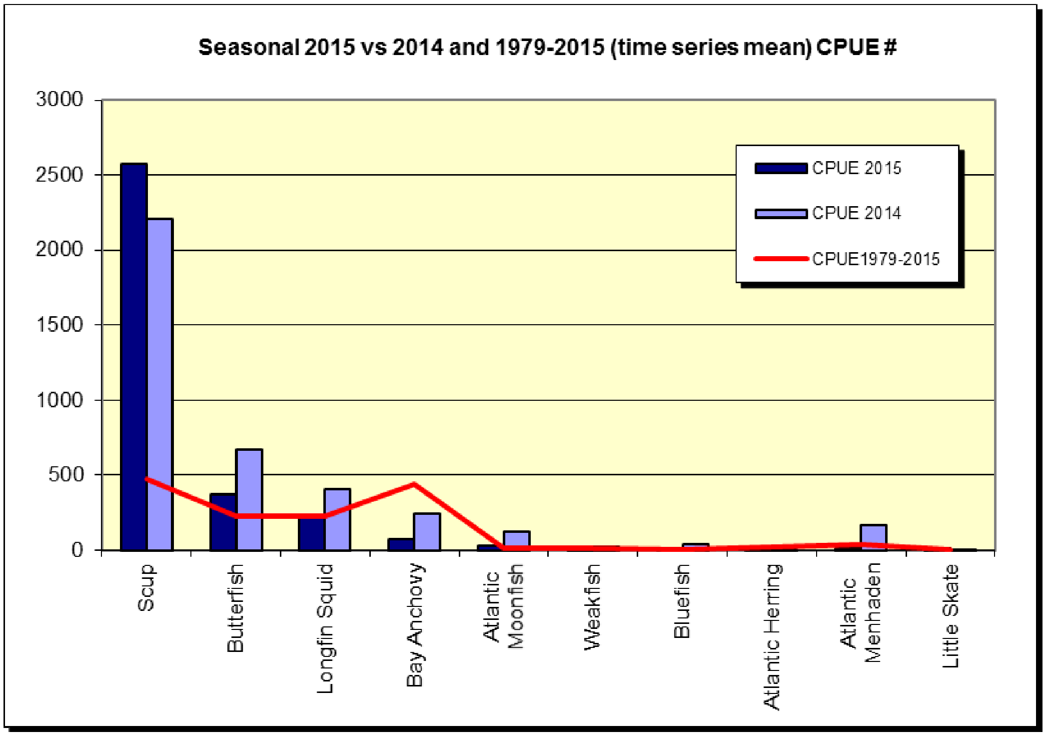
Fish Name	Scientific Name	Kg
Scup	STENOTOMUS CHRYSOPS	1842.040
Butterfish	PEPRILUS TRIACANTHUS	584.420
Longfin Squid	LOLIGO PEALEI	554.715
Little Skate	LEUCORAJA ERINACEA	468.095
Summer Flounder	PARALICHTHYS DENTATUS	123.750
Winter Skate	LEUCORAJA OCELLATA	88.520
Weakfish	CYNOSCION REGALIS	81.695
Black Sea Bass	CENTROPRISTIS STRIATA	69.287
Horseshoe Crab	LIMULUS POLYPHEMUS	59.045
Smooth Dogfish	MUSTELUS CANIS	58.985
Bluefish	POMATOMUS SALTATRIX	58.680
Clearnose Skate	RAJA EGLANTERIA	47.750
Winter Flounder	PLEURONECTES AMERICANUS	41.460
Striped Searobin	PRIONOTUS EVOLANS	36.250
Ocean Pout	MACROZOARCES AMERICANUS	24.235
Atlantic Moonfish	SELENE SETAPINNIS	17.906
Alewife	ALOSA PSEUDOHARENGUS	16.865
American Lobster	HOMARUS AMERICANUS	15.830
Rock Crab	CANCER IRRORATUS	13.208
Longhorn Sculpin	MYOXOCEPHALUS OCTODECEMSPINOS	12.885
Tautog	TAUTOGA ONITIS	11.420
Windowpane Flounder	SCOPHTHALMUS AQUOSUS	10.250
Northern Kingfish	MENTICIRRHUS SAXATILIS	9.965
Bay Anchovy	ANCHOA MITCHILLI	6.437
Atlantic Menhaden	BREVOORTIA TYRANNUS	5.841
Channeled Whelk	BUSYCOTYPUS CANALICULATUS	3.670
Blueback Herring	ALOSA AESTIVALIS	2.955
Knobbed Whelk	BUSYCON CARICA	2.745
Yellowtail Flounder	LIMANDA FERRUGINEUS	2.550
Spotted Hake	UROPHYCIS REGIA	2.518
Rough Scad	TRACHURUS LATHAMI	2.515
American Shad	ALOSA SAPIDISSIMA	2.315
Goosefish	LOPHIUS AMERICANUS	2.300
Inshore Lizardfish	SYNODUS FOETENS	2.010
Atlantic Herring	CLUPEA HARENGUS	2.003
Sea Raven	HEMITRIPTERUS AMERICANUS	1.590
Blue Crab	CALLINECTES SAPIDUS	1.125
Fourspot Flounder	PARALICHTHYS OBLONGUS	1.030
Cunner	TAUTOGOLABRUS ADSPERSUS	1.010
Red Hake	UROPHYCIS CHUSS	0.815
Jonah Crab	CANCER BOREALIS	0.775

Northern Puffer	SPHOEROIDES MACULATUS	0.645
Northern Searobin	PRIONOTUS CAROLINUS	0.570
Silver Hake	MERLUCCIUS BILINEARIS	0.490
Sea Scallop	PLACOPECTEN MAGELLANICUS	0.480
American Sand Lance	AMMODYTES AMERICANUS	0.476
Atlantic Silverside	MENIDIA MENIDIA	0.366
Mantis Shrimp	SQUILLA EMPUSA	0.220
Atlantic Cod	GADUS MORHUA	0.144
Blue Runner	CARANX CRYSOS	0.110
Northern Sennet	SPHYRAENA BOREALIS	0.105
Bluespotted Cornetfish	FISTULARIA TABACARIA	0.080
Smallmouth Flounder	ETROPUS MICROSTOMUS	0.079
Crevalle Jack	CARANX HIPPOS	0.070
Atlantic Mackerel	SCOMBER SCOMBRUS	0.065
Striped Anchovy	ANCHOA HEPSETUS	0.040
Dwarf Goatfish	UPENEUS PARVUS	0.035
Round Scad	DECAPTERUS PUNCTATUS	0.035
Haddock	MELANOGRAMMUS AEGLEFINUS	0.030
Bigeye	PRIACANTHUS ARENATUS	0.025
Striped Cusk Eel	OPHIDION MARGINATUM	0.025
Grubby	MYOXOCEPHALUS AENAEUS	0.018
Northern Pipefish	SYNGNATHUS FUSCUS	0.010
Rainbow Smelt	OSMERUS MORDAX	0.010

Figure 10 Top Ten Species Catch in Number

Fish Name	Scientific Name	%
Scup	STENOTOMUS CHRYSOPS	76.9%
Butterfish	PEPRILUS TRIACANTHUS	11.0%
Longfin Squid	LOLIGO PEALEI	6.8%
Bay Anchovy	ANCHOA MITCHILLI	2.3%
Atlantic Moonfish	SELENE SETAPINNIS	0.8%
Weakfish	CYNOSCION REGALIS	0.7%
Bluefish	POMATOMUS SALTATRIX	0.4%
Atlantic Herring	CLUPEA HARENGUS	0.4%
Atlantic Menhaden	BREVOORTIA TYRANNUS	0.4%
Little Skate	LEUCORAJA ERINACEA	0.3%

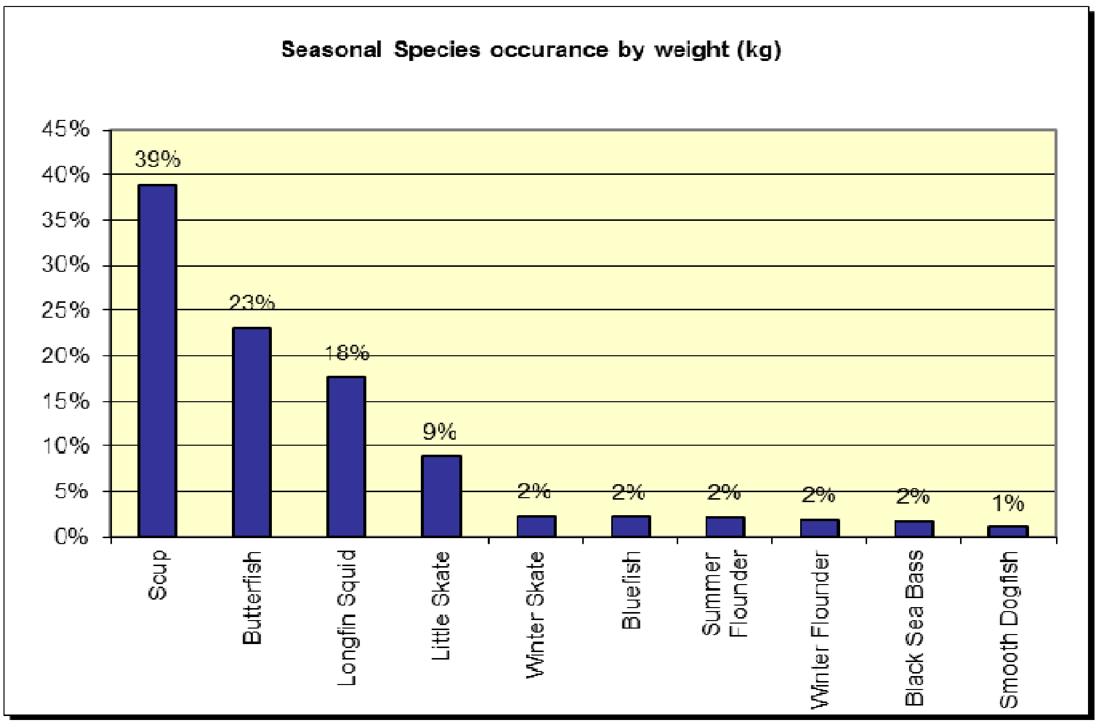


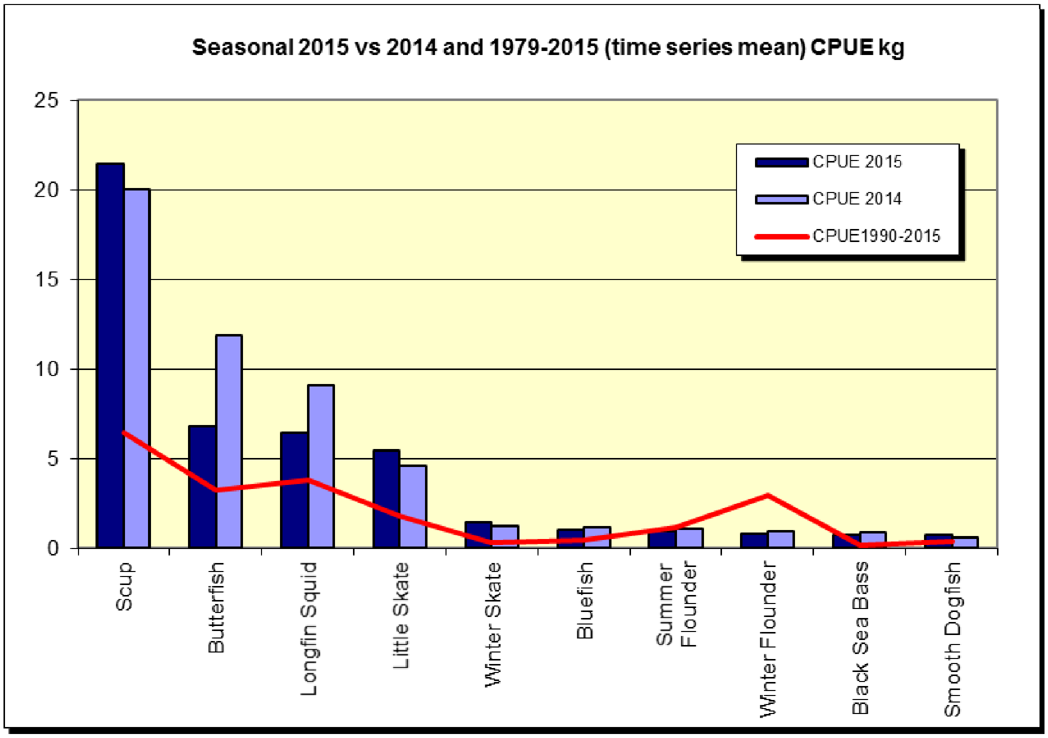


Seasonal 2015 vs 2014 and 1979-2015 (time series mean) CPUE #
3000
2500
2000
1500
1000
500
0
CPUE 2015
CPUE 2014
CPUE1979-2015
Scup
Butterfish
Longfin Squid
Bay Anchovy
Atlantic Moonfish
Weakfish
Bluefish
Atlantic Herring
Atlantic Menhaden
Little Skate

Figure 11 Top Ten Species Catch in Kilograms

Fish Name	Scientific Name	%
Scup	STENOTOMUS CHRYSOPS	39%
Butterfish	PEPRILUS TRIACANTHUS	23%
Longfin Squid	LOLIGO PEALEI	18%
Little Skate	LEUCORAJA ERINACEA	9%
Winter Skate	LEUCORAJA OCELLATA	2%
Bluefish	POMATOMUS SALTATRIX	2%
Summer Flounder	PARALICHTHYS DENTATUS	2%
Winter Flounder	PLEURONECTES	2%
Black Sea Bass	CENTROPRISTIS STRIATA	2%
Smooth Dogfish	MUSTELUS CANIS	1%

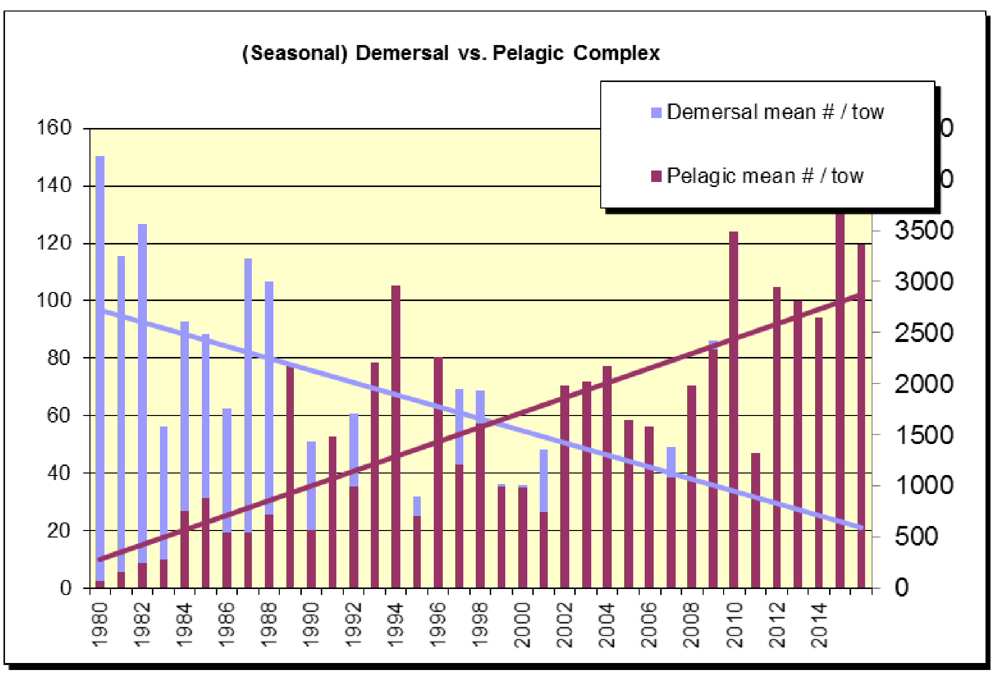


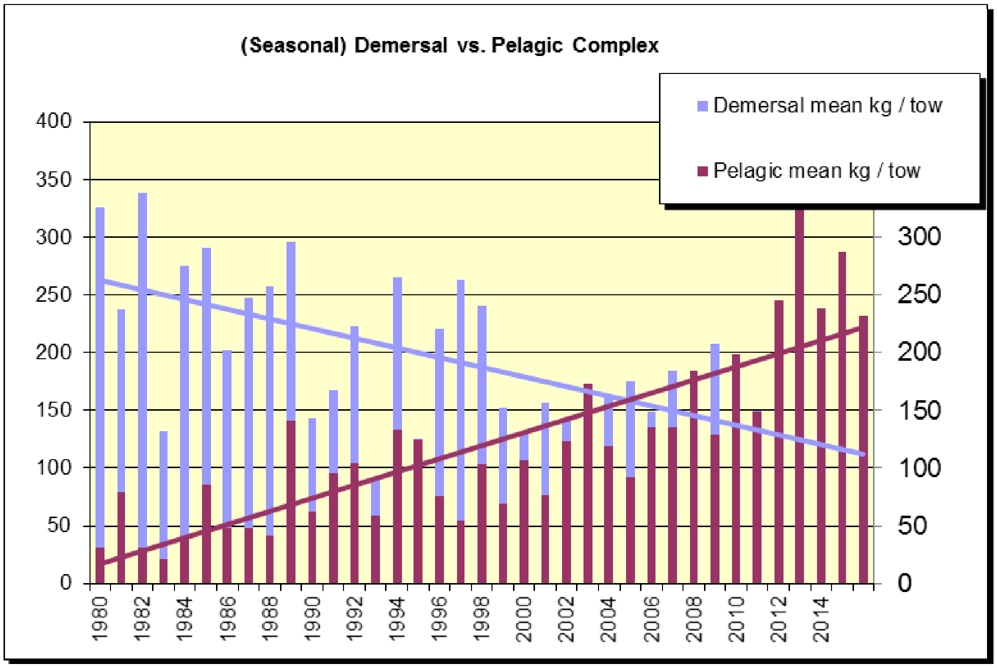

Seasonal 2015 vs 2014 and 1979-2015 (time series mean) CPUE kg
25
20
15
10
5
0
CPUE 2015
CPUE 2014
CPUE1990-2015
Scup
Butterfish
Longfin Squid
Little Skate
Winter Skate
Bluefish
Summer Flounder
Winter Flounder
Black Sea Bass
Smooth Dogfish

Demersal vs. Pelagic Species Complex

Demersal Species	**Pelagic/Multi-Habitat Species**
Cunner	Alewife
Four Spot Flounder	Atlantic Herring
Goosefish	Atlantic Moonfish
Hog Choker	Bay Anchovy
Lobster	Black Sea Bass
Longhorn Sculpin	Blueback Herring
Northern Searobin	Bluefish
Ocean Pout	Butterfish
Red Hake	Longfin Squid
Sea Raven	Menhaden
Silver Hake	Rainbow Smelt
Skates	Scup
Smooth Dogfish	Shad
Spiny Dogfish	Silverside
Spotted Hake	Striped Bass
Striped Searobin	Weakfish
Summer Flounder	
Tautog	
Windowpane Flounder	
Winter Flounder	

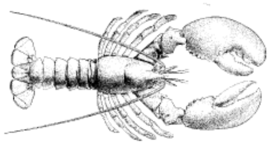
Figure 12 and 13





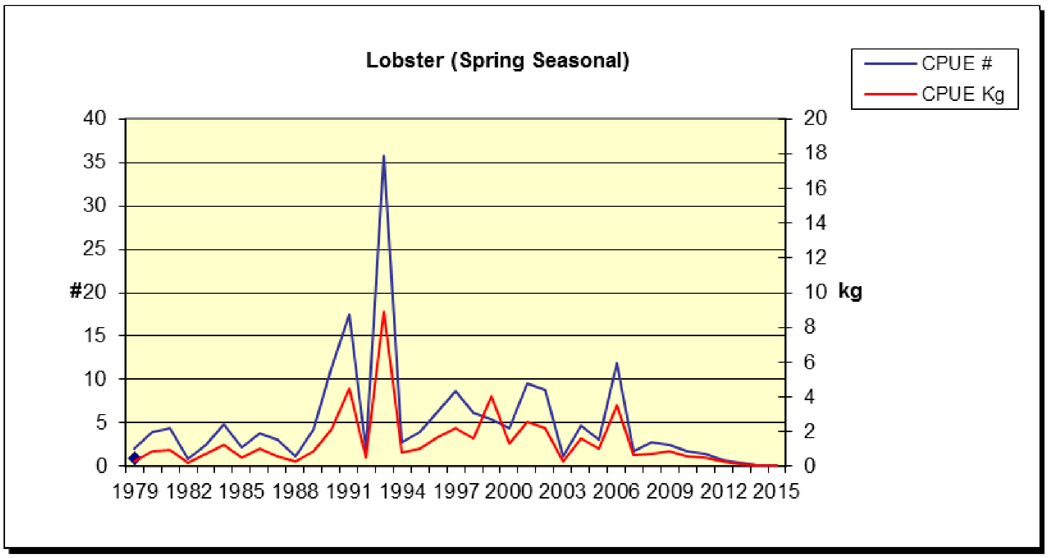
(Seasonal) Demersal vs. Pelagic Complex
Demersal mean kg / tow
Pelagic mean kg / tow
400
350
300
250
200
150
100
50
0
300
250
200
150
100
50
0
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

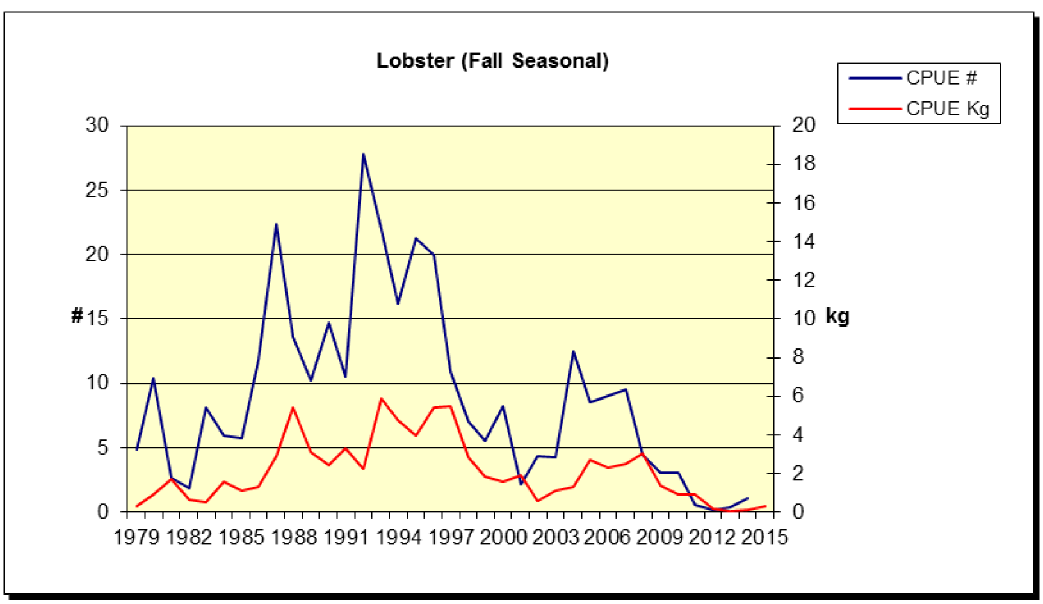
The following species represented are of high importance and are currently managed under fishery management plans through the Atlantic States Marine Fisheries Commission, New England Fishery Management Council, or the National Marine Fisheries Service. The seasonal portion of the Rhode Island Coastal Trawl Survey is an accurate indicator of relative abundance based on the biology and life history of a particular species. Values presented are expressed in either relative number or kilograms per tow. All data collected from both the Seasonal and Monthly Coastal Trawl Surveys are available upon request.



American Lobster ***Homarus americanus***

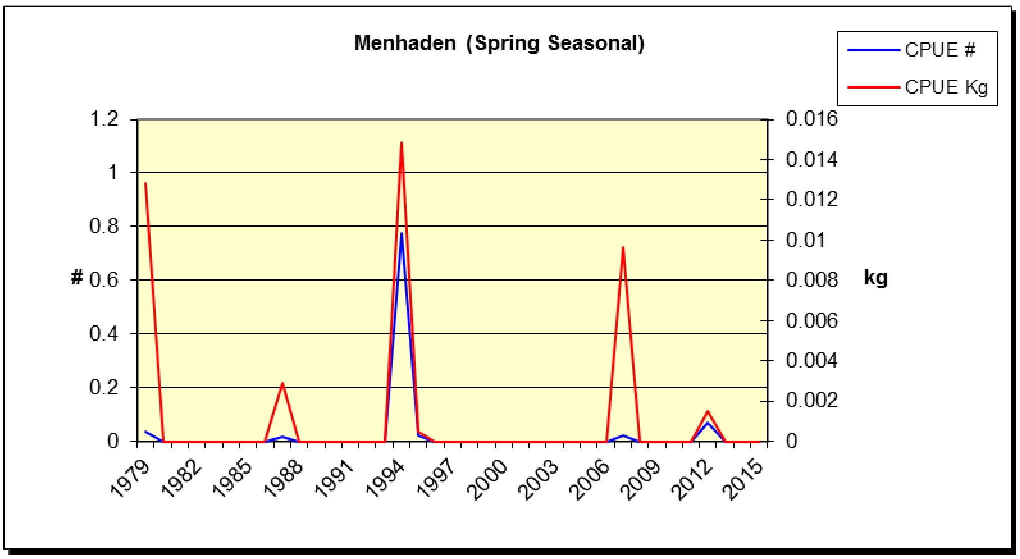
Stock Status: Southern New England Stock: overfished. Depleted Poor condition.
Management: ASMFC Amendment III, Addendum XXIII

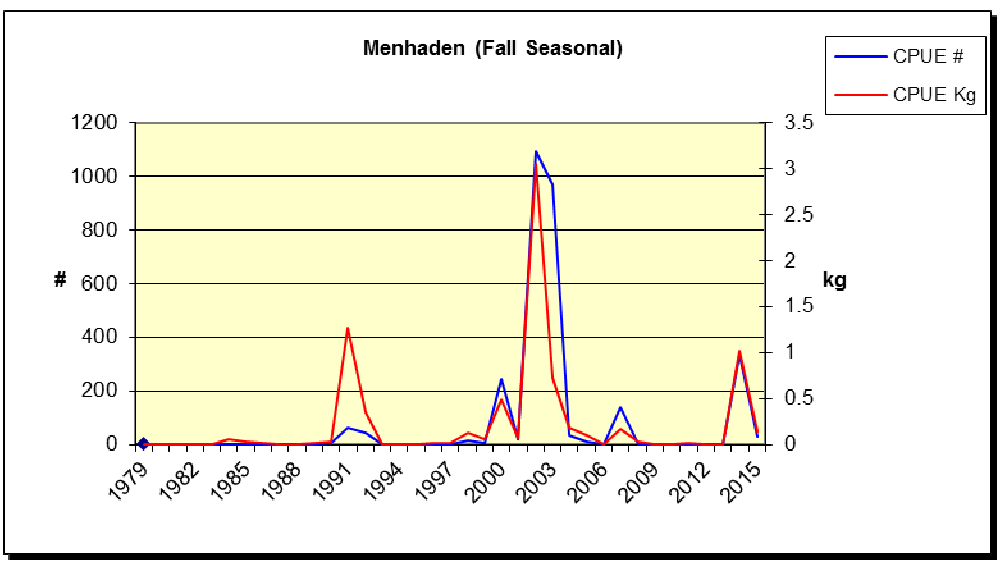




Atlantic Menhaden ***Brevoortia tyrannus***

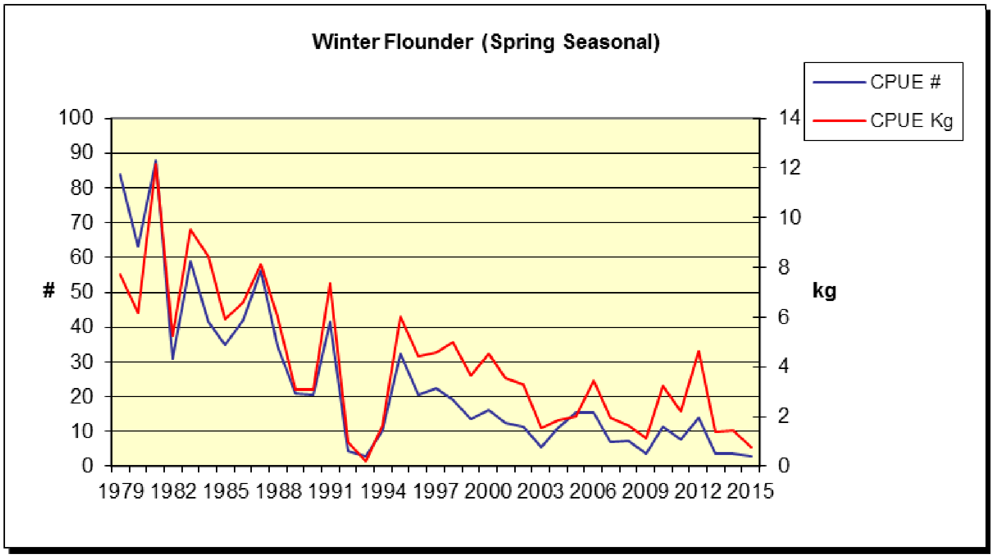
Stock Status: Not Overfished and overfishing is not occurring.
Management: ASMFC Amendment II

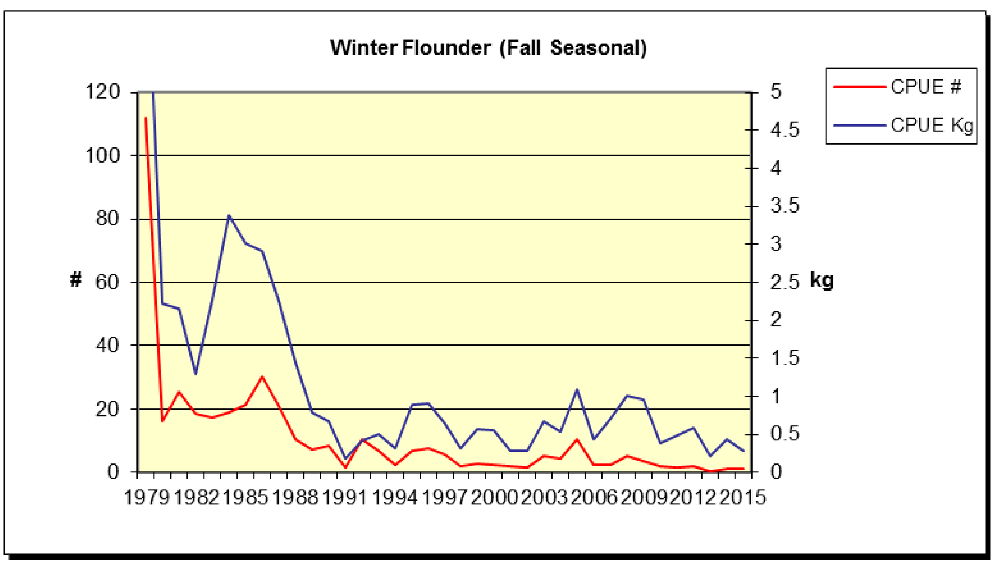




Winter Flounder ***Pleuronectes americanus***

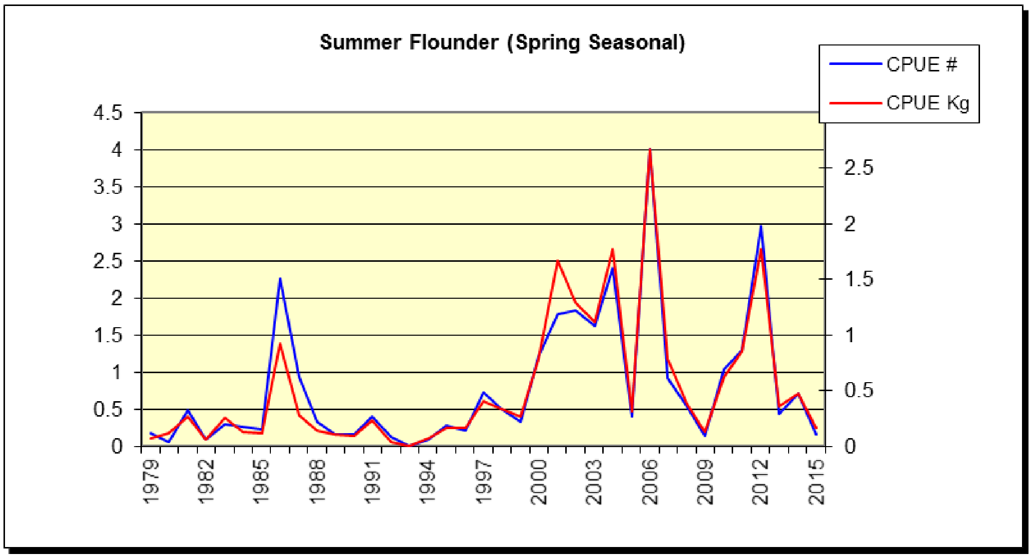
Stock Status: Overfished but overfishing is not occurring.
Management: ASMFC Amendment I, Addendum III

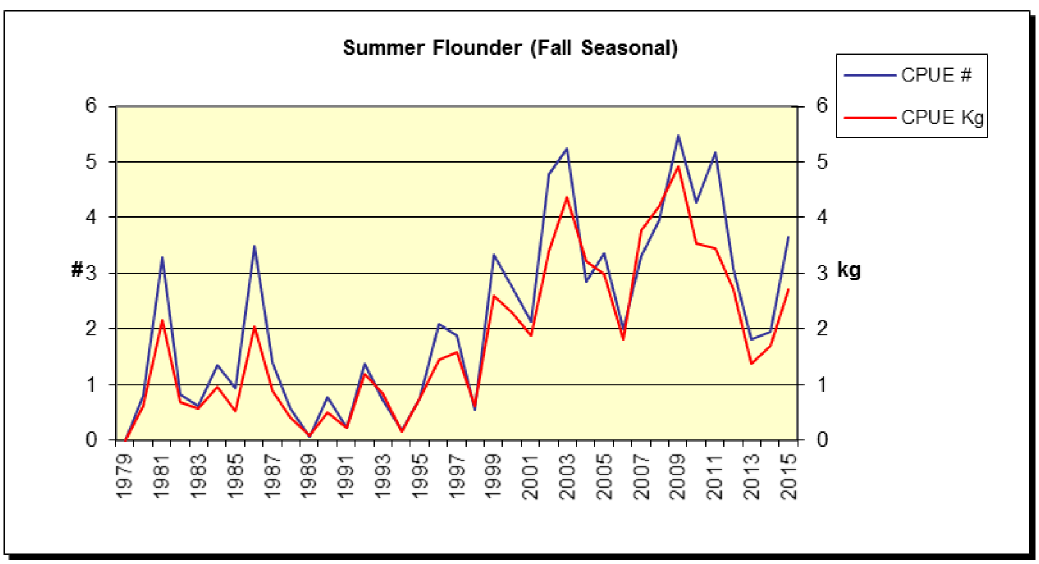




Summer Flounder ***Paralichthys dentatus***

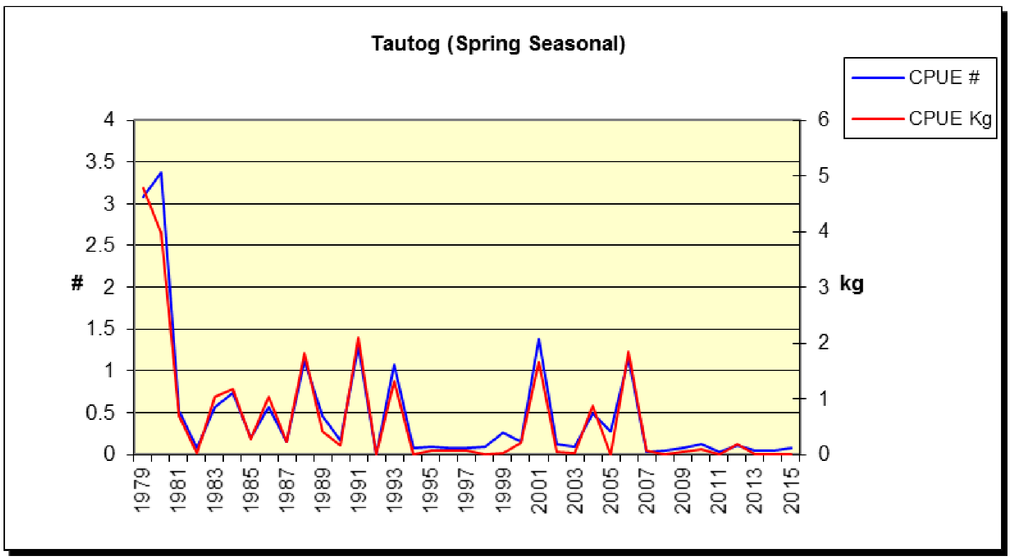
Stock Status: Not overfished and overfishing is occurring.
Management: ASMFC Amendment XV Addendum XXV

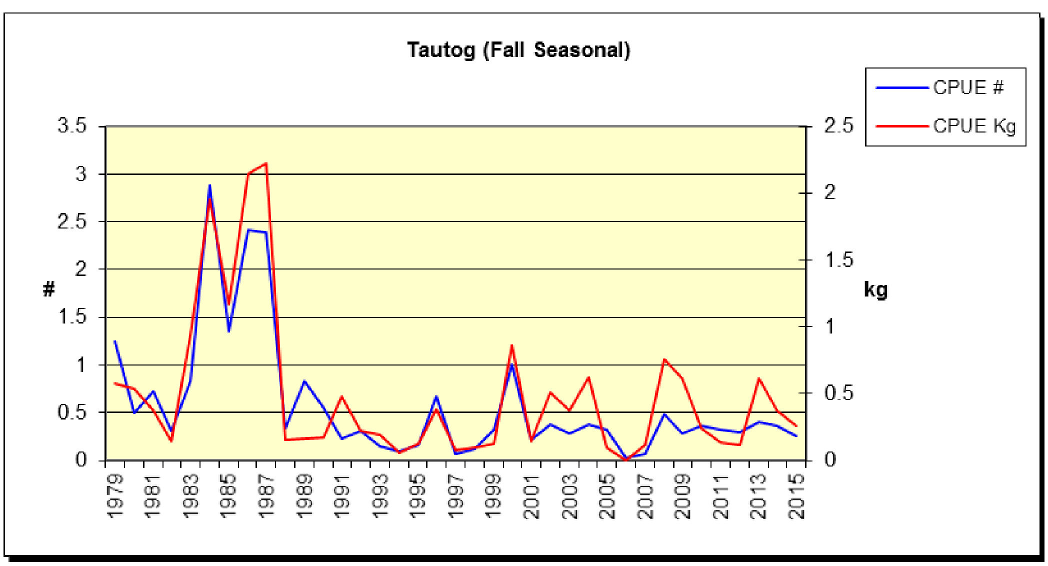


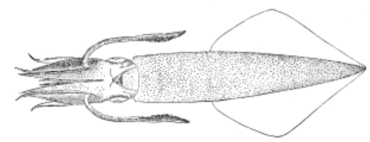


Tautog *Tautoga onitis*

Stock Status: Overfished and Overfishing is occurring based on Regional (Rhode Island and Massachusetts) Stock Assessment
Management: ASMFC Amendment I, Addendum VI

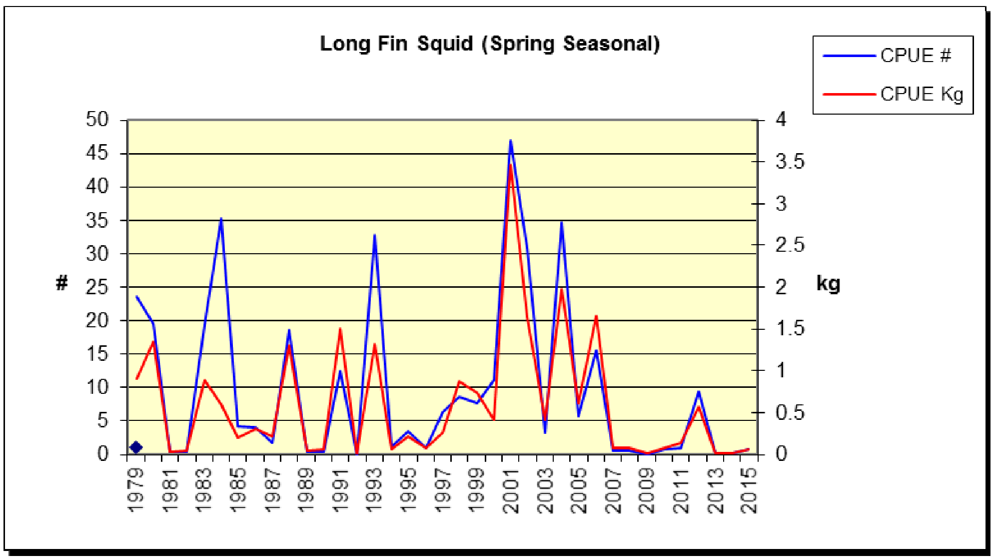


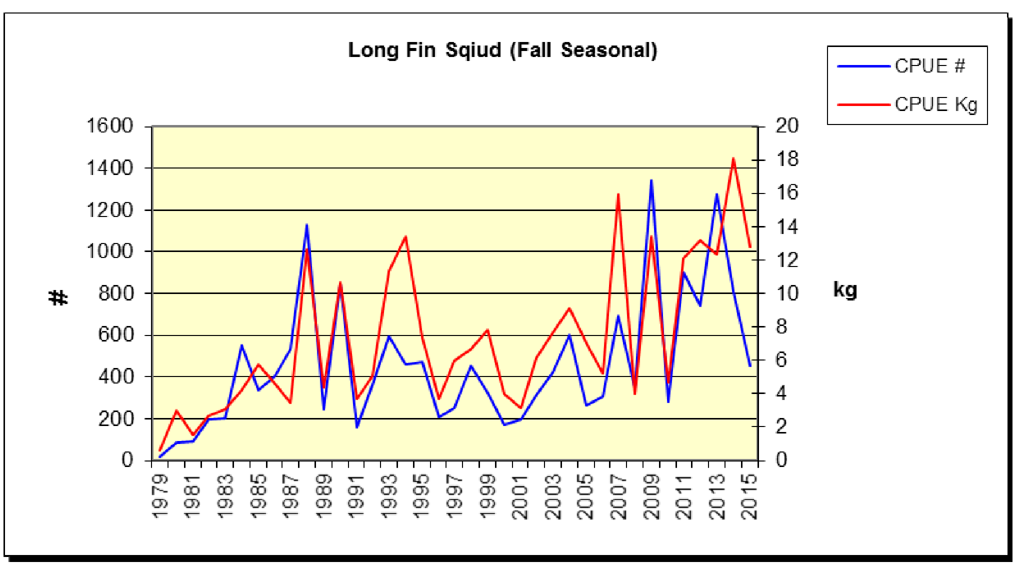




Longfin Squid ***Loligo pealei***

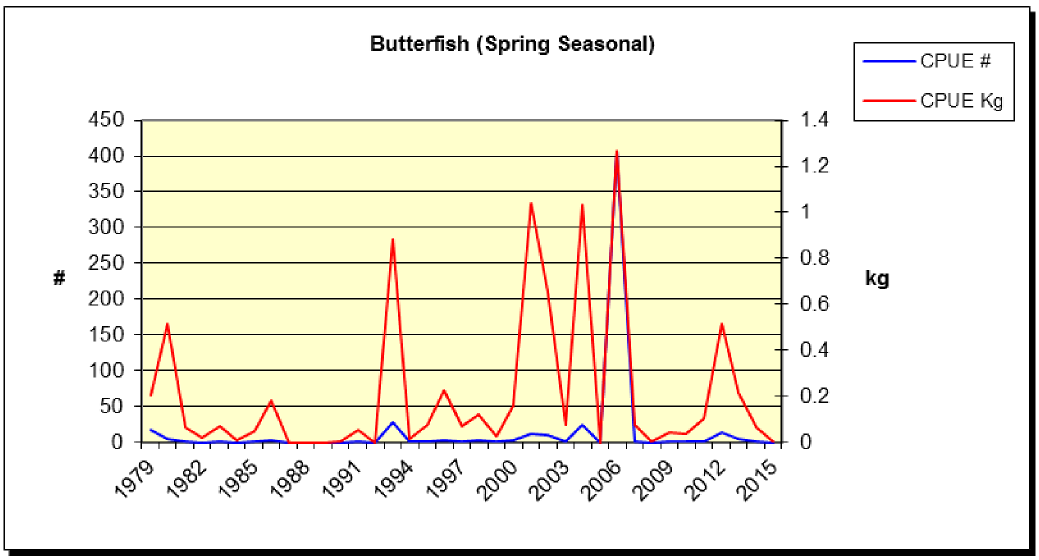
Stock Status: Overfishing undetermined not overfished
Management: NMFS, MAFMC, Atlantic Mackerel, Squid Butterfish FMP

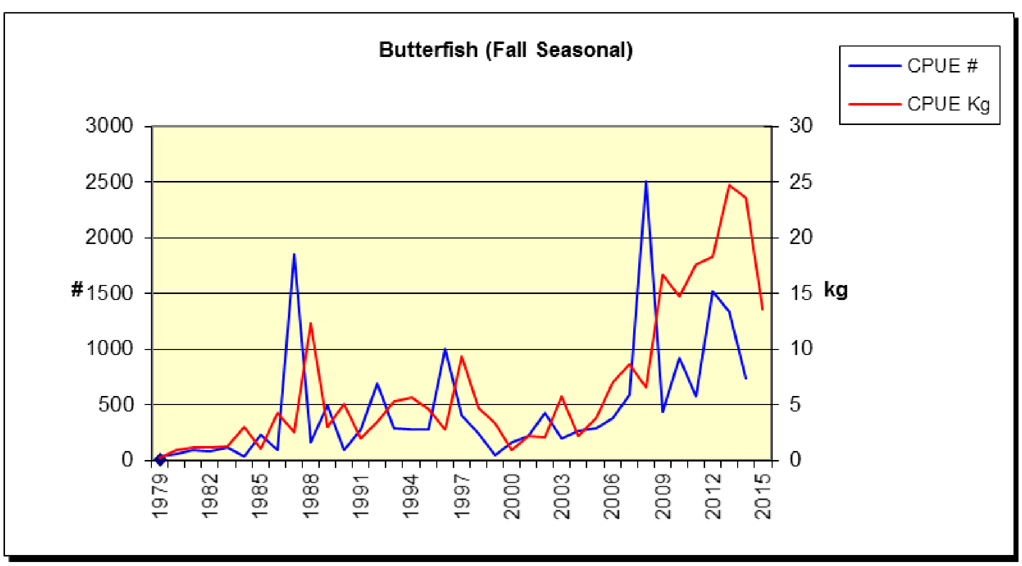




Butterfish ***Peprlilus triacanthus***

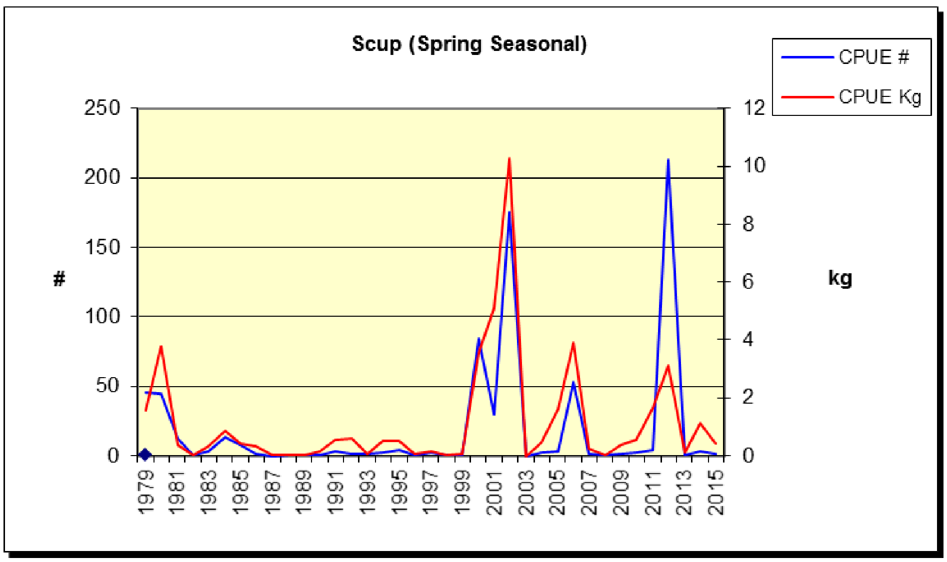
Stock Status: Variable / Uncertain
Management: Mid Atlantic Fishery Management Council, Atlantic Mackerel, Squid Butterfish FMP, ACL

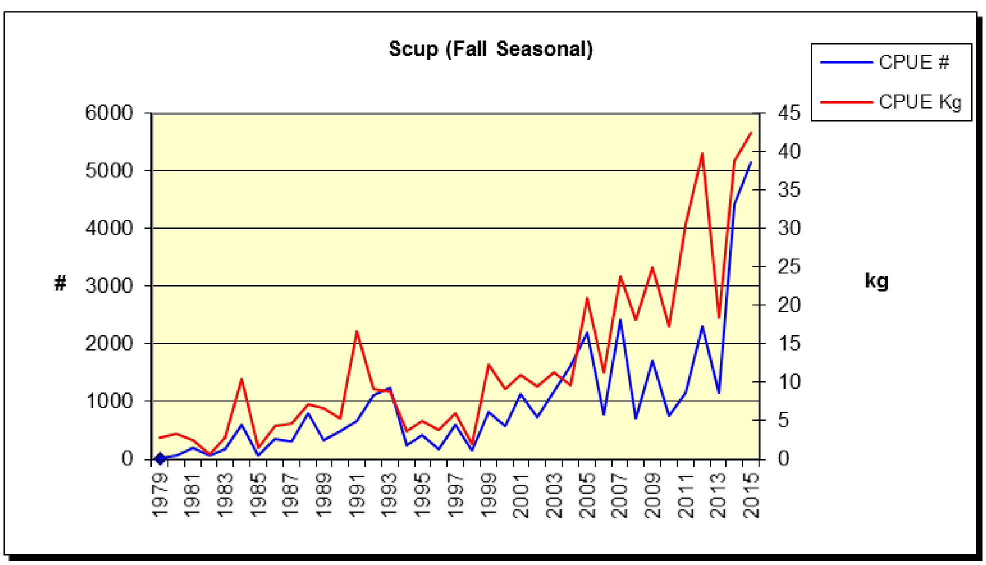




Scup ***Stenotomus chrysops***

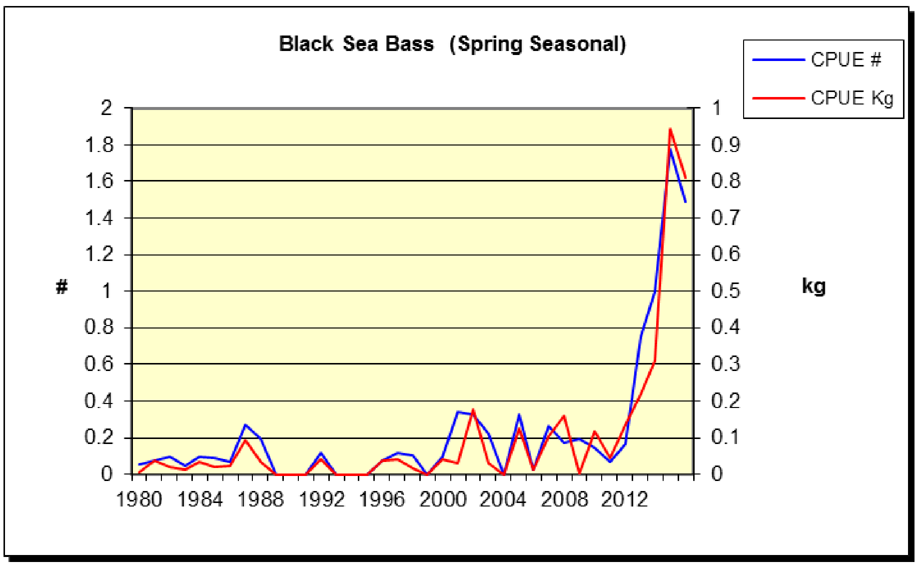
Stock Status: Rebuilt, not overfished and overfishing is not occurring
Management: ASMFC Amendment XIIV, Addendum XXII, Summer Flounder, Scup Black Sea Bass FMP

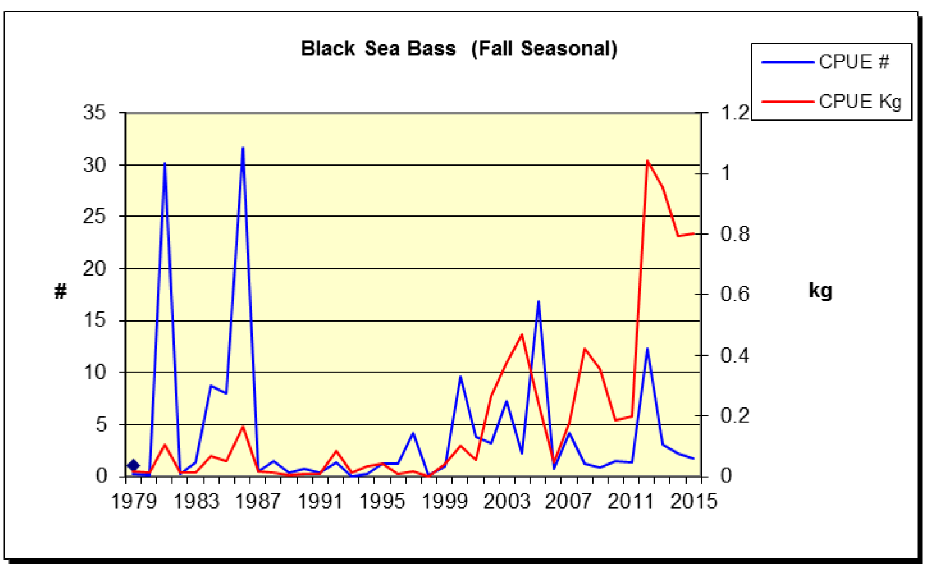




Black Sea Bass ***Centropristis striata***

Stock Status: Rebuilt, not overfished but overfishing is occurring
Management: ASMFC Amendment XIIV, Addendum XXIII





References:

ASMFC 2014.Current Fishery Management Plans; Stock Status Reports

Bigelow and Schroeder 2002. Fishes of the Gulf of Maine; Third Edition

NMFS 2014. Current Fishery Stock Status.

Lynch, Timothy R. 2007. Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters, Coastal Fishery Resource Assessment, Performance Report.

Assessment of Recreationally Important Finfish
Stocks in Rhode Island Coastal Ponds

Young of the Year Survey of Selected Rhode Island Coastal Ponds and Embayments

by
John Lake
Principal Biologist (Marine Fisheries)
john.lake@dem.ri.gov

Rhode Island Department of Environmental Management
Division of Fish and Wildlife
Fort Wetherill Marine Fisheries Laboratory
3 Fort Wetherill Road
Jamestown, RI 02835

Federal Aid in Sportfish Restoration
F-61-R

Performance Report – Job#3 March 2015

Performance Report

State: Rhode Island

Project Number: F-61-R
Segment Number: 22

Project Title: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters.

Period Covered: January 1, 2015 – December 31, 2015

Job Number & Title: Job 3 – Young of the Year Survey of Selected Rhode Island Coastal Ponds and Embayment's

Job Objectives: To collect, analyze, and summarize beach seine survey data from Rhode Island's coastal ponds and estuaries, for the purpose of forecasting recruitment in relation to the spawning stock biomass of winter flounder and other recreationally important species.

Summary: In 2015, Investigators caught 55 species of finfish representing 35 families. This number is similar to the 56 species from 34 families that were collected during 2014. Additionally, the numbers of individuals caught in 2015 decreased from the 2014 survey; 33014 collected in 2014 and 61086 collected in 2013.

Target Date: 2016

Status of Project: On Schedule

Significant Deviations: There were no significant deviations in 2015.

Recommendations: Continue into the next segment with the project as currently designed; continue at each of the 24 sample stations.

Remarks:

During 2015, Investigators sampled twenty four traditional stations in four coastal ponds, Winnapaug Pond, Quonochontaug Pond, Charlestown Pond, Point Judith Pond, Green Hill Pond, Potter's Pond, Little Narragansett Bay and Narrow River (Figures 1-3). For consistency, the time series species indices for young of the year (YOY) winter flounder will not include the data taken from the new stations added in 2011 (PP 1-2, GH 1-2, PR 1-3, PJ4). The potential bias the new stations could introduce to the time series is unknown. This potential bias will be examined further when these samples have been sampled for a few more years. For the calculation of the annual catch per unit effort statistics for all other species data from all stations will be used.

Materials and Methods:

As in previous years, investigators attempted to perform all seining on an incoming tide. To collect animals, investigators used a seine 130 ft. long (39.62m), 5.5 ft deep (1.67m) with ¼" mesh (6.4mm). The seine had a bag at its midpoint, a weighted footrope and floats on the head rope. Figure 4 describes the area covered by the seine net. The beach seine was set in a semi-circle, away from the shoreline and back again using an outboard powered 16' Lund aluminum boat. The net was then hauled toward the beach by hand and the bag was emptied into a large water-filled tote. All animals collected were identified to species, measured, enumerated, and sub-samples were taken when appropriate.   Water quality parameters temperature, salinity and dissolved oxygen, were measured at each station. Figure 1 shows the location of the subject coastal ponds and the Narrow River, while figures 2 - 3 indicate the location of the sampling stations within each pond.

Results and Discussion:

Winter Flounder (*Pseudopleuronectes americanus*)

Juvenile winter flounder were collected at 20 out of 24 stations over the course of the season. Winter flounder were not caught in Green Hill Pond (GH 1-2), Western Charlestown Pond (CP-4), or Northern Potters pond (PP-2). Winter flounder ranked fifth in overall species abundance (n=1196) in 2015, with the highest mean abundance, fish/seine haul, occurring in July (Table 1). This is the usual expected pattern of highest index values occurring in July. Some years like 2014 the peak occurs in June.

During 2015, 1196 winter flounder were collected, down from the 1506 collected in 2014. The juvenile winter flounder abundance index (YOY WFL index) for the survey measured using the mean fish/seine haul decreased slightly from 11.11 fish/seine haul in 2014 to 10.99 fish/seine haul in 2015. The 2015 index value remained relatively level compared to 2014 but is still two years out from the lowest recorded since the surveys inception observed in 2013. For the purposes of consistency, the YOY WFL index is only calculated using fish < 12 cm from the long term stations of the survey. Data collected from the new stations added in 2011 (PP1-2, GH 1-2, PR1-3, PJ4) is not included in the index so as not to bias the results. A standardization methodology will be required to integrate this data into the overall YOY WFL index. Table 2 and figure 5b display the mean catch per seine haul (CPUE) of winter flounder for each month by pond during the 2015 survey. Figure 5a displays the abundance indices over the duration of the coastal pond survey. Figure 15 displays the annual abundance index for all stations combined.

Winnipaug and Quonochontaug Ponds trended upward in 2015. Narrow River trended down slightly but remains at an average index value. Point Judith pond remained level at a low index value. Charlestown pond continued its downward trend and remains at the lowest index value since the inception of the survey. This low index value is particularly concerning because in years past high abundances of winter flounder have been observed consistently in Charlestown Pond. Green Hill pond was absent of YOY WFL, in past years high abundances were caught in May and June decreasing to no fish found in July.   Similarly, in 2015 Potter pond which usually displays the same pattern, low abundances were observed. The Lower Pawcatuck River is a more open system than the other ponds sampled in the survey. Instead of an inlet breaching a barrier beach there is only a mostly sub tidal sandbar separating the water body from the ocean. With the exception of August the water temperatures are cooler than the other pond temperatures (Table 13). YOY WFL were caught at all three stations in the Lower Pawcatuck River with station 1 catching the most consistent numbers (Table 1).

The index values by pond peaked in July remained high in August but then were reduced in September and October (figure 5b). Winter flounder catch per tow during October was similar in 2014 (3.12 fish/tow) and 2015 (3.16 fish/tow), much higher than low point of the survey 2013 (0.58 fish/tow) but below the total survey index value (5.79 fish/tow). These results indicate that 2015 recruitment from the coastal ponds should be similar to 2014 and improved from 2013.

Two other RIDFW surveys target juvenile and adult winter flounder, the Narragansett Bay Spring Seasonal Trawl Survey and the Narragansett Bay Juvenile Survey. A comparison of the Coastal Pond Survey to these other projects reveals that despite some slight differences, they display similar trends (Figure 16). The downward YOY trend is mirrored in the Narragansett Bay Seine Survey. The continued low abundance in YOY WFL numbers was also observed in Narragansett Bay (McNamee Pers Comm) but improved slightly to an index value of 4.38 fish / tow. . The spring Trawl Survey WFL index did not improve and remains at a low value of 2.79 fish/tow, likely a result of regulations which changed ending the prohibition on possession of winter flounder in federal waters of Southern New England in 2012. Federal possession limits were either unlimited or set to 5000 lbs per trip depending on the permit category of the vessel. It is believed that these high limits encourage a directed fishery for winter flounder in the spring. Possession limits remain 50 pounds in State waters. The Narragansett Bay Seine Survey collects the most YOY WFL in June (McNamee Pers Comm). It should be noted that the Narragansett Bay Survey does not begin sampling until June and may miss those juvenile finfish which occur in May in the shallow coves etc. The Spring Trawl Survey collects the greatest number of winter flounder in April and May and is considered the best indicator for estimating local abundance especially for post spawn adults (Olszewski Pers Comm).

The time series of the survey shows that the ponds exhibit fluctuations of WFL abundance over time. One exception is Point Judith pond which has experienced a significant decline since 2000 and bottomed out at 0.89 fish/seine haul during 2010. Between 2011 and 2015 , the overall YOY WFL index in Point Judith pond increased slightly from the low 2010 value and as remained relatively level with index values averaging approximately 4 fish / tow (3.67 fish/tow in 2015).. This trend in abundance might reflect the recent no possession rule in the pond as well as the former coast wide closure. It is important to note that the YOY WFL population in Point Judith Pond crashed in September and did not recover. Point Judith Pond is the only coastal pond where both a juvenile survey and an adult winter flounder survey occur annually. When relative abundance and number of WFL per seine haul of juvenile winter flounder are compared to the relative abundance and number of WFL per fyke net haul of the Adult Winter Flounder Tagging Survey, (Figure 17), a decline in relative abundance of winter flounder is observed in both surveys. The index value observed on the adult spawner survey was the lowest ever recorded at 0.8 WFL per net haul in 2014, but recovered slightly in 2015 to 4.0 fish /haul. The decline in adult spawner abundance and related decline in juvenile abundance does not support a fishery in the pond due to the lack of surplus production (Gibson, 2010). Given that winter flounder population shows an affinity for discrete spawning locations and the young of year tend to remain near the spawning location, the fish in this pond are in danger of depletion (Buckley et. al. 2008). A regulation was enacted 4/8/11 to close Point Judith Pond to both recreational and commercial fishing for winter flounder (RIMF Regulations Part 7 sec 8). Data from this survey and the Adult winter flounder spawning survey was the evidence used for justification of this regulation.

In 2014, juvenile winter flounder ranged in size from 1 to 30 cm, representing age groups 0-2+. The size range of animals collected is similar to those caught from 2004 through 2013 where the flounder ranged from 1 to 19 cm, 2 to 18 cm, 2 to 17 cm, 1 to 22, 1 to 19 cm, 2 to 19, 2 to 18, 2 to 35, 2 to 36, 2 to 15, 1 to 25 respectively. Length frequency distributions indicate that the majority of individuals collected during sampling season were group 0 fish, less than 12 cm total length (Figure 6). During 2015, 95% of all winter flounder caught were <12 cm in length. The size ranges of these fish agree with ranges for young-of-the-year winter flounder in the literature (Able & Fahay 1998; Berry 1959; Berry et al. 1965). Mean monthly lengths for winter flounder are presented in Table 3. Length frequency distributions for coastal ponds by month are shown in Figures 7 -14. The WFL frequency histograms for each pond over time in years past have displayed two peaks in average size for YOY WFL suggesting two cohorts or a protracted spawning event. This result was not clearly observed in the Coastal Pond Survey during 2015. Instead a more traditional one peaked histogram describes the size range of YOY WFL caught in the survey this year (figures 7 and 9).

Bluefish *(Pomatomus saltatrix)*

One hundred twenty four bluefish were collected in July, August, September, and October occurring in each of the coastal ponds sampled in 2015. This is an increase from the 53 fish caught in 2014 and similar to than the 144 individuals captured during 2013. The abundance index for 2015 was 0.86 fish/seine higher than the 2014 value of 0.37 fish/seine and similar to the value of 1.00 fish/seine haul observed in 2013. Table 4 contains the abundance indices for the survey by month and pond. Bluefish ranged in size from 4 cm to 16 cm. No adult bluefish were caught in 2015. Figure 18 displays the annual abundance index of bluefish for all stations combined.

Tautog (*Tautoga onitis*)

Two hundred and nineteen tautog were collected between May and October in each of the ponds except Green Hill pond in 2015. This is higher than the 2014 catch of 136 individuals. The total survey 2015 abundance index was 1.52 fish/seine haul increased from the 2014 abundance index of 0.94 fish/seine haul. Table 5 contains the abundance indices for the survey by month and pond. The highest abundances in 2015 occurred in the Pawcatuck River. Tautog caught in 2015 ranged in size from 3 cm to 15 cm. Figure 19 displays the annual abundance index of tautog for all stations combined.

Black Sea Bass (*Centropristis striata*)

A total of 348 juvenile black sea bass were collected from August to October from each of the ponds except Green Hill and Potter's Pond in 2015. This is less than the 175 fish that were caught in 2014 and less than the 219 fish collected in 2013. It is the second highest value recorded in the history of the survey. The highest abundances were found in Charlestown Pond. The total survey 2015 abundance index was 2.42 fish/seine haul up from the 2014 abundance index of 1.22 fish/seine haul as well as above the 2013 value of 1.52 fish/ seine haul. The population in the ponds continues trending upwards, the high BSB index value of 2015 represents another high value consistent with observations for other recent years. Black sea bass abundance throughout state waters was high again during 2015 (McNamee, pers comm.). Table 5 contains the abundance indices for the survey by month and pond. Black sea bass caught in 2015 ranged in size from 2 cm to 8 cm. Figure 20 displays the annual abundance index of black sea bass for all stations combined.

Scup *(Stenotomus chrysops)*

One hundred forty three scup were collected during the 2015 in July, August, September, and October in each of the ponds except Narrow River, Green Hill and Potter's ponds. This is higher than the 30 scup caught in 2014. The total survey abundance index was 0.64 fish per haul. Table 7 contains the abundance indices for the survey by month and pond. Scup caught in 2015 ranged in size from 3 cm to 9 cm. Figure 21 displays the annual abundance index of scup for all stations combined.

Clupeids:

In 2015 four species of clupeids were caught in the coastal pond survey, Atlantic menhaden (*Brevoortia tyrannus*), Blueback herring (*Alosa aestivalis*), Atlantic herring (*Alosa harengus*) and Alewife (*Alosa pseudoharengus*). Thirty five alewife were captured in 2015. The total survey abundance was 0.24 fish / seine haul. This represents a relative low value in an upward trend. Seven thousand one hundred twenty three Atlantic menhaden were caught during 2015. The total survey abundance was 49.46 fish /seine haul. There were several schools of YOY menhaden captured in 2015. Eight Atlantic herring were captured in 2015 and one Blueback herring were caught in 2015. Table 8 contains the abundance indices for culpeids by month pooled across all 5 ponds. Figures 22a and 22b display the annual abundance index of clupeids for all stations combined. Menhaden are plotted on a separate axis for scale issues.

Baitfish Species:

Atlantic Silversides *(Menidia sp.)*

Silversides had the highest abundance of all species with 14220 caught during the 2015 survey, up compared to the 19356 silversides collected in 2014. Silversides were collected in each of the ponds throughout the time period of the survey (May – October). The highest abundances were observed in Charlestown Point Judith ponds, and the Pawcatuck River. The total survey abundance index was 98.75 fish / seine haul. Table 9 contains the abundance indices for the survey by month and pond. Atlantic silversides caught in 2015 ranged in size from 2 cm to 14 cm.

Striped Killifish *(Fundulus majalis)*

Striped killifish ranked third in species abundance with 4063 fish caught during 2015. This is higher than the 901 fish caught during 2014. They occurred in each of the ponds except Green Hill and were caught each month during the survey. Point Judith Pond had the highest abundance of striped killifish. The total survey abundance index was 28.21 fish / seine haul, rebounding to average levels from the record low recorded in 2014. Table 10 contains the abundance indices for the survey by month and pond. Striped killifish caught in 2015 ranged in size from 3 cm to 12 cm.

Common Mummichog *(Fundulus heteroclitus)*

The mummichog was fourth in overall abundance in 2015 with 2846 individuals collected. This value is an increase from 1038 mummichogs collected in 2014. Mummichogs occurred in each of the ponds and were caught each month during the survey. Winnipaug Pond had the highest abundances of Mummichogs. The total 2015 survey abundance index was 19.76 fish / seine haul. It should be noted this value continues to rebound from the lowest on record in 2013 of 2.09 fish/ seine haul. Table 11 contains the abundance indices for the survey by month and pond. Mummichogs caught in 2015 ranged in size from 2 cm to 10 cm.

Sheepshead Minnow *(Cyprinodon variegatus)*

The Sheepshead minnow ranked eleventh in overall abundance with 163 individuals collected. This is an increase from the 56 fish caught in 2014. Sheepshead minnow occurred in each of the ponds except Point Judith and were caught between July and October. Quononchontaug Pond had the highest abundances of Sheepshead minnows. The total survey abundance index was 1.13 fish / seine haul. Table 12 contains the abundance indices for the survey by month and pond. Sheepshead minnow caught in 2015 ranged in size from 2 cm to 6 cm.

Figure 23 displays the annual abundance index of the baitfish species for all stations combined.

<u>Physical and Chemical Data:</u>

Physical and Chemical data for the 2015 Coastal Pond Survey is summarized in tables 13 – 15. Water temperature in 2015 averaged 21.2 ºC, with a range of 10.9ºC in May to 31.5 ºC in August. Salinity ranged from 13.6 ppt to 29.7 ppt, and averaged 26.6 ppt. Dissolved oxygen ranged from 5.6 mg/l to 15.0 mg/l with an average of 8.1 mg/l.

<u>New Station Preliminary Data</u>

This year was the fifth year of sampling the three additional ponds. On a whole the samples were consistent with 2011 -2014 with the exception of no winter flounder caught in Green Hill Pond. A brief description of each pond follows.

<u>Green Hill Pond</u>: Green Hill Pond is a small coastal pond located east of Charlestown Pond. It does not open directly to the ocean, instead its only inlet is via Charlestown Pond and is thus not well flushed. Green Hill pond has water quality issues including high summer temperatures, high nutrient load, and a permanent shellfish closure. GH – 1 is in the northeastern quadrant of the pond on a small island. The bottom substrate is mud with shell hash. GH – 2 is in the southeastern quadrant of the pond on a sand bar. The bottom substrate is muddy fine sand. WFL YOY have been caught in relatively high abundance in May suggesting spawning activity within the pond. The WFL YOY decreased in abundance at the stations in July and August when the water was warm and were not caught frequently after it had cooled in the fall. Other species frequently present in the pond are the baitfish species, naked goby, and blue crabs.

<u>Potter Pond:</u> Potter Pond is a small coastal pond located west of Point Judith Pond. Similarly to Green Hill Pond, it does not open directly to the ocean; instead its only inlet is via Point Judith Pond. The local geography is such that the tide flushes the pond more than in Green Hill. The inlet to Potter Pond is closer to the inlet to Point Judith Pond and its inlet is shorter. PP – 1 is in the southwestern quadrant of the pond in a shallow cove. The bottom substrate is mud. PP – 2 is in the northwestern quadrant of the pond adjacent to a deep (~25') glacial kettle hole. The bottom substrate is fine sand with some cobble. WFL YOY have been caught at both stations but only PP – 1 with high frequency. Similarly to the Green Hill during both stations WFL YOY are highest in May and decreased in abundance as the season progressed. The water temperature in Potter's Pond does not get as warm as Green Hill Pond but still may be a factor at station PP – 1. The geography of this station does not facilitate flushing and water quality may explain the lack of WFL YOY in mid-summer. Interestingly all three years had small catches of 1 year old flounder at station PP-1 during the late summer and early fall. Water temperatures are higher than the pond proper and dissolved oxygen was lower in that section of the pond. The rest of the pond does not have the same water quality issues. Other species frequently caught in the pond include the baitfish species, American eel, oyster toad fish, naked goby, tautog, and blue crabs.

<u>Lower Pawcatuck River</u>: The lower Pawcatuck River or Little Narragansett Bay is the mouth

of a coastal estuary formed by the Pawcatuck River. It is different form the other stations on the survey in that it does not have a traditional barrier beach pierced by an inlet; instead it is relatively open to Block Island Sound. PR – 1 is a small protected beach in a small cove surrounded by large boulders. The bottom substrate is fine sand. This station had the most consistent catch of WFL YOY which were present during all months of the survey. PR – 2 is located on a sand bar island in the middle of Little Narragansett Bay on the protected side. This sand bar is all that is left of a larger barrier beach which existed prior to the 1938 hurricane. The bottom substrate is coarse sand. This station caught WFL YOY but at lower frequencies that PR – 1, the highest catch number was observed in October. PR – 3 was originally located in the southern part of Little Narragansett Bay on the protected side of Napatree Beach. After it was initially sampled in May 2011, the station was relocated because it was extremely shallow and a high wave energy area. PR – 3 is currently located in the northern section of Little Narragansett Bay at the mouth of the river near G. Willie Cove. The station is on a *Spartina spp*. covered bank at the head of G. Willie Cove. The bottom substrate is cobble. This station was selected to best characterize the species assemblage in the Lower Pawcatuck River as the majority of the shoreline consists of marsh grass covered banks. The station has been sampled in all 6 months since 2012. WFL YOY are not present in high frequencies at the station which is not unexpected due to the bottom substrate. Other species frequently caught in the river include the baitfish species, alewife, tomcod, menhaden, and bluefish.

<u>Point Judith Pond</u>: The new station PJ – 4 is located in the eastern section of the pond on Ram Island. The bottom substrate is silty sand with some large cobble. The station was selected because of its proximity to three fyke net stations sampled during the Adult Winter Flounder Spawner Survey. The station was added to better classify the species in the pond and to better document the decline of WFL YOY in the pond. The station had higher catch frequencies of WFL YOY than the other stations in the pond combined but still is low in comparison to the other ponds.

The first five years of sampling the new stations successfully collected target species, notably WFL YOY. It is recommended that these stations be sampled into the future so as to continue to provide species assemblage information from these coastal ponds. The additional catch frequencies and distributions of WFL YOY will provide a better understanding of the population, notably in areas where the fish only occur in the spring / early summer. Further analysis will be required to integrate data from these new stations into the traditional abundance indices. Until then the data will be presented separately for the time series indices but not for the annual information.

Summary

In 2015, Investigators caught 55 species of finfish representing 35 families. This number is similar to the 56 species from 34 families that were collected during 2014. Additionally, the numbers of individuals landed in 2015 decreased from the 2014 survey; 33014 collected in 2015 and 61086 collected in 2014. This decrease in number of animals caught is reflective of the fact that high numbers of Atlantic menhaden that were caught during 2014. Appendix 1 displays the frequency of all species caught by station during the 2015 Coastal Pond Survey. Additional data is available by request.

References

Able, K., and M.P. Fahay. 1998. The First Year in the Life of Estuarine Fishes in the Middle Atlantic Bight. Rutgers University Press.

Berry, R.J. 1959. Critical growth studies of winter flounder, *Pseudopleuronectes Americanus* (Waldbaum), in Rhode Island waters. MS Thesis, Univ. of Rhode Island. 52 p.

Berry, R.J., S.B. Saila and D.B. Horton. 1965. Growth studies of winter flounder, *Pseudopleuronectes americanus* (Waldbaum), in Rhode Island. Trans. Amer. Fish. Soc. 94:259-264.

Buckley, L., J. Collie, L. Kaplan, and J. Crivello. 2008. Winter Flounder Larval Genetic Population Structure in Narragansett Bay, RI: Recruitment to Juvenile Young-of-the-Year. Estuaries and Coasts. 31:745-754.

Gibson, M. 2010. Salt Pond Winter Flounder Fishery Issue Paper, Internal document RI Division of Fish and Wildlife, 11p.

McNamee, Jason. 2012. Personal Communication

Olszewski, Scott. 2012. Personal Communication

Table 1: 2015 Coastal Pond Survey Winter Flounder Frequency by Station and Month

Station	May	Jun	Jul	Aug	Sep	Oct	Totals	Mean	STD
CP1	0	2	26	8	0	0	**36**	**6.00**	**9.38**
CP2	0	1	0	0	0	0	**1**	**0.17**	**0.37**
CP3	0	0	1	0	1	5	**7**	**1.17**	**1.77**
CP4	0	0	0	0	0	0	**0**	**0.00**	**0.00**
GH1	0	0	0	0	0	0	**0**	**0.00**	**0.00**
GH2	0	0	0	0	0	0	**0**	**0.00**	**0.00**
NR1	3	6	16	5	0	0	**30**	**5.00**	**5.42**
NR2	8	23	113	83	16	13	**256**	**42.67**	**40.32**
NR3	1	12	74	142	12	11	**252**	**42.00**	**50.77**
PJ1	0	5	3	2	0	0	**10**	**1.67**	**1.89**
PJ2	0	3	15	16	0	1	**35**	**5.83**	**6.91**
PJ3	0	1	1	0	1	3	**6**	**1.00**	**1.00**
PJ4	0	28	2	7	0	0	**37**	**6.17**	**10.07**
PP1	0	1	3	0	0	1	**5**	**0.83**	**1.07**
PP2	0	0	0	0	0	0	**0**	**0.00**	**0.00**
PR1	2	19	34	1	2	10	**68**	**11.33**	**11.94**
PR2	0	3	7	6	2	1	**19**	**3.17**	**2.54**
PR3	0	0	1	4	2	0	**7**	**1.17**	**1.46**
QP1	0	46	8	9	3	0	**66**	**11.00**	**16.04**
QP2	0	12	5	38	1	2	**58**	**9.67**	**13.27**
QP3	0	6	78	10	0	1	**95**	**15.83**	**28.04**
WP1	0	5	44	10	5	11	**75**	**12.50**	**14.55**
WP2	0	61	10	25	5	13	**114**	**19.00**	**20.31**
WP3	0	2	7	0	6	4	**19**	**3.17**	**2.73**
Totals	**14**	**236**	**448**	**366**	**56**	**76**			
Mean	**0.58**	**9.83**	**18.67**	**15.25**	**2.33**	**3.17**			
STD	**1.71**	**15.32**	**29.25**	**31.80**	**3.98**	**4.55**			

Table 2: 2015 Coastal Pond Survey winter flounder abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0.0	0.8	6.8	2.0	0.3	1.3
Green Hill Pond	0.0	0.0	0.0	0.0	0.0	0.0
Narrow River	4.0	13.7	67.7	76.7	9.3	8.0
Point Judith Pond	0.0	9.3	5.3	6.3	0.3	1.0
Potter's Pond	0.0	0.5	1.5	0.0	0.0	0.5
Pawcatuck River	1.0	7.3	14.0	3.7	2.0	3.7
Quonochontaug Pond	0.0	21.3	30.3	19.0	1.3	1.0
Winnipaug Pond	0.0	22.7	20.3	11.7	5.3	9.3
Total	**6.5**	**18.6**	**12.3**	**20.1**	**2.1**	**3.1**

Table 3: 2015 Coastal Pond Survey average lengths (cm) of juvenile winter flounder by pond and month.

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond		4.23	5.43	6.24	6.10	6.62
Green Hill Pond						
Narrow River	5.29	3.99	4.37	4.82	6.48	7.91
Point Judith Pond		4.22	5.77	6.47	7.00	9.35
Potter's Pond		6.20	7.67			10.50
Pawcatuck River	9.60	3.70	4.55	6.17	5.63	7.64
Quonochontaug Pond		4.70	4.95	5.54	8.53	9.27
Winnipaug Pond		2.94	4.23	5.18	6.08	6.59

Table 4: 2015 Coastal Pond Survey bluefish abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0	0	0	0	0.75	0
Green Hill Pond	0	0	0	0	0.50	0
Narrow River	0	0	1.00	0	20	0
Point Judith Pond	0	0	0	0	0.25	0
Potter's Pond	0	0	0.50	0	0.50	0
Pawcatuck River	0	0	0	2.67	5.00	0
Quonochontaug Pond	0	0	0	9.00	0.33	0
Winnipaug Pond	0	0	0	0	0	1.00
Total pond index	**0**	**0**	**0.17**	**1.46**	**3.42**	**0.13**

Table 5: 2015 Coastal Pond Survey tautog abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0.50	0	1.25	9.75	7.25	0.75
Green Hill Pond	0	0	0	0	0	0
Narrow River	0	0	0	0.67	0.33	0
Point Judith Pond	0	0	0	1.75	0.50	0
Potter's Pond	0	0	0	1.50	0	0
Pawcatuck River	0.33	7.00	3.00	23.67	7.33	0
Quonochontaug Pond	0	0	0	0.33	0	0
Winnipaug Pond	0	0	0	0.33	0	0
Total pond index	**0**	**0**	**0.58**	**5.17**	**2.25**	**0.13**

Table 6: 2015 Coastal Pond Survey black sea bass abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0	0	0	9.25	21.25	3.75
Green Hill Pond	0	0	0	0	0	0
Narrow River	0	0	0	16.00	2.33	0
Point Judith Pond	0	0	0	2.25	6.75	0
Potter's Pond	0	0	0	0	0	0
Pawcatuck River	0	0	0	0.33	0	0
Quonochontaug Pond	0	0	0	21.00	7.33	0
Winnipaug Pond	0	0	0	10.67	0.67	0
Total pond index	**0**	**0**	**0**	**7.92**	**5.96**	**0.63**

Table 7: 2015 Coastal Pond Survey Scup abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0	0	1.50	0	0.75	0
Green Hill Pond	0	0	0	0	0	0
Narrow River	0	0	0	0	0	0
Point Judith Pond	0	0	0.25	0.25	0	0
Potter's Pond	0	0	0	0	0	0
Pawcatuck River	0	0	0	2.00	0.33	0
Quonochontaug Pond	0	0	0	6.33	18.00	0
Winnipaug Pond	0	0	0	0.67	0	0
Total pond index	**0**	**0**	**0.29**	**1.17**	**2.42**	**0**

Table 8: 2015 Coastal Pond Survey Clupeid abundance indices (fish/seine haul) by month

Species	May	Jun	Jul	Aug	Sep	Oct
Alewife	0	0.17	1.17	0	0.13	0
Atlantic Menhaden	0	0	0	57.67	144.50	94.63
Atlantic Herring	0.33	0	0	0	0	0
Blueback Herring	0	0	0.04	0	0	0

Table 9: 2015 Coastal Pond Survey Atlantic Silverside abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	8.50	1.50	366.00	52.75	136.75	134.75
Green Hill Pond	34.50	13.50	54.50	22.00	13.00	7.50
Narrow River	0.67	1.67	1.00	88.00	104.67	421.33
Point Judith Pond	27.25	3.50	13.00	48.75	698.75	87.00
Potter's Pond	71.50	40.50	3.00	40.50	55.00	38.50
Pawcatuck River	29.67	47.33	19.00	35.00	668.00	100.33
Quonochontaug Pond	18.00	12.33	31.33	60.00	79.00	128.67
Winnipaug Pond	28.67	36.67	54.00	197.33	65.33	144.67
Total pond index	**24.42**	**17.58**	**81.13**	**69.67**	**259.54**	**140.17**

Table 10: 2015 Coastal Pond Survey Striped Killifish abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0	0	8.00	17.00	14.00	16.75
Green Hill Pond	0	0	0	0	0	0
Narrow River	0	0	1.67	5.33	26.00	7.67
Point Judith Pond	1.50	149.25	2.25	15.00	1.75	19.25
Potter's Pond	0	0.50	0	21.50	19.00	0.50
Pawcatuck River	1.67	0	0	37.00	10.33	42.33
Quonochontaug Pond	0	0	0.33	65.00	8.67	38.00
Winnipaug Pond	0	0	0	99.00	401.33	256.00
Total pond index	**0.46**	**24.92**	**1.96**	**32.92**	**60**	**49.04**

Table 11: 2015 Coastal Pond Survey Mumichog abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0.25	0.50	4.50	36.50	45.25	3.75
Green Hill Pond	0	6.50	7.00	15.00	0.50	9.00
Narrow River	8.33	13.33	51.33	7.67	0	22.67
Point Judith Pond	0.75	4.00	2.00	0.50	0	2.00
Potter's Pond	4.50	22.00	12.50	203.00	4.00	22.50
Pawcatuck River	0.67	0	0.33	0.67	0	15.00
Quonochontaug Pond	0.33	0	29.00	3.00	0.67	2.67
Winnipaug Pond	0.33	7.33	35.67	398.67	5.33	8.00
Total pond index	**1.75**	**5.71**	**17.25**	**75.58**	**8.67**	**9.63**

Table 12: 2015 Coastal Pond Survey Sheepshead Minnow abundance indices (fish/seine haul) by pond and month

Pond	May	Jun	Jul	Aug	Sep	Oct
Charlestown Pond	0	0	0.25	0.25	0	3.75
Green Hill Pond	0	0	0.50	1.00	0	8.00
Narrow River	0	0	0.33	0	0	9.67
Point Judith Pond	0	0	0	0	0	0
Potter's Pond	0	0	0	0	0.50	0.50
Pawcatuck River	0	0	0	0	0	1.00
Quonochontaug Pond	0	0	0	0	0	24.00
Winnipaug Pond	0	0	0	1.33	0.67	4.67
Total pond index	**0**	**0**	**0.13**	**0.29**	**0.13**	**6.25**

Table 13: 2015 Coastal Pond Survey average water temperature (degrees Celcius) by pond and month Note: Temperatures were taken with a thermometer in September as YSI was on loan.

Station	May	June	July	August	September	October
Charlestown Pond	16.40	20.78	25.48	27.70	21.93	16.55
Green Hill Pond	20.35	27.85	28.40	29.10	22.30	13.30
Narrow River	19.57	23.63	25.43	25.90	23.00	12.63
Point Judith Pond	15.08	20.48	26.53	27.30	23.00	13.90
Potter's Pond	17.80	21.10	27.60	28.50	24.35	14.05
Pawcatuck River	13.25	22.07	22.47	25.83	20.83	13.00
Quonochontaug Pond	14.37	22.83	22.90	26.37	22.70	15.03
Winnipaug Pond	13.97	19.70	22.63	26.60	21.10	16.53
Average	**16.35**	**22.30**	**25.18**	**27.16**	**22.40**	**14.38**

Table 14: 2015 Coastal Pond Survey average salinity (ppt) by pond and month
Note: Limited salinity measurements were taken in September 2015 as YSI was on loan.

Station	May	June	July	August	September	October
Charlestown Pond	27.13	27.99	28.11	28.51		27.82
Green Hill Pond	23.97	23.80	25.38	22.99		24.74
Narrow River	19.43	20.33	19.22	24.99		24.72
Point Judith Pond	15.27	27.98	27.51	28.26		27.24
Potter's Pond	24.85	26.53	26.60	26.12		27.20
Pawcatuck River	26.36	21.75	26.22	28.05		27.77
Quonochontaug Pond	28.64	29.07	26.81	28.95		29.40
Winnipaug Pond	27.80	27.68	28.66	28.57	28.34	28.32
Average	**24.18**	**25.64**	**26.06**	**27.06**	**28.34**	**27.15**

Table 15: 2015 Coastal Pond Survey average dissolved oxygen (mg/l) by pond and month
Note: Limited oxygen measurements were taken in September 2015 as YSI was on loan.

Station	May	June	July	August	September	October
Charlestown Pond	9.12	7.48	7.76	8.74		8.68
Green Hill Pond	7.38	9.00	7.42	6.58		8.23
Narrow River	8.40	8.04	7.11	7.40		8.16
Point Judith Pond	8.95	7.85	6.97	7.10		8.73
Potter's Pond	7.06	7.64	7.48	6.86		6.78
Pawcatuck River	10.36	9.46	8.87	6.55		8.57
Quonochontaug Pond	8.64	7.90	6.85	6.03		8.35
Winnipaug Pond	10.50	10.48	8.77	8.46	7.27	8.16
Average	**8.80**	**8.48**	**7.65**	**7.21**	**7.27**	**8.21**

Figure 1: Location of coastal ponds sampled by the Coastal Pond Juvenile Finfish Survey in Southern Rhode Island.

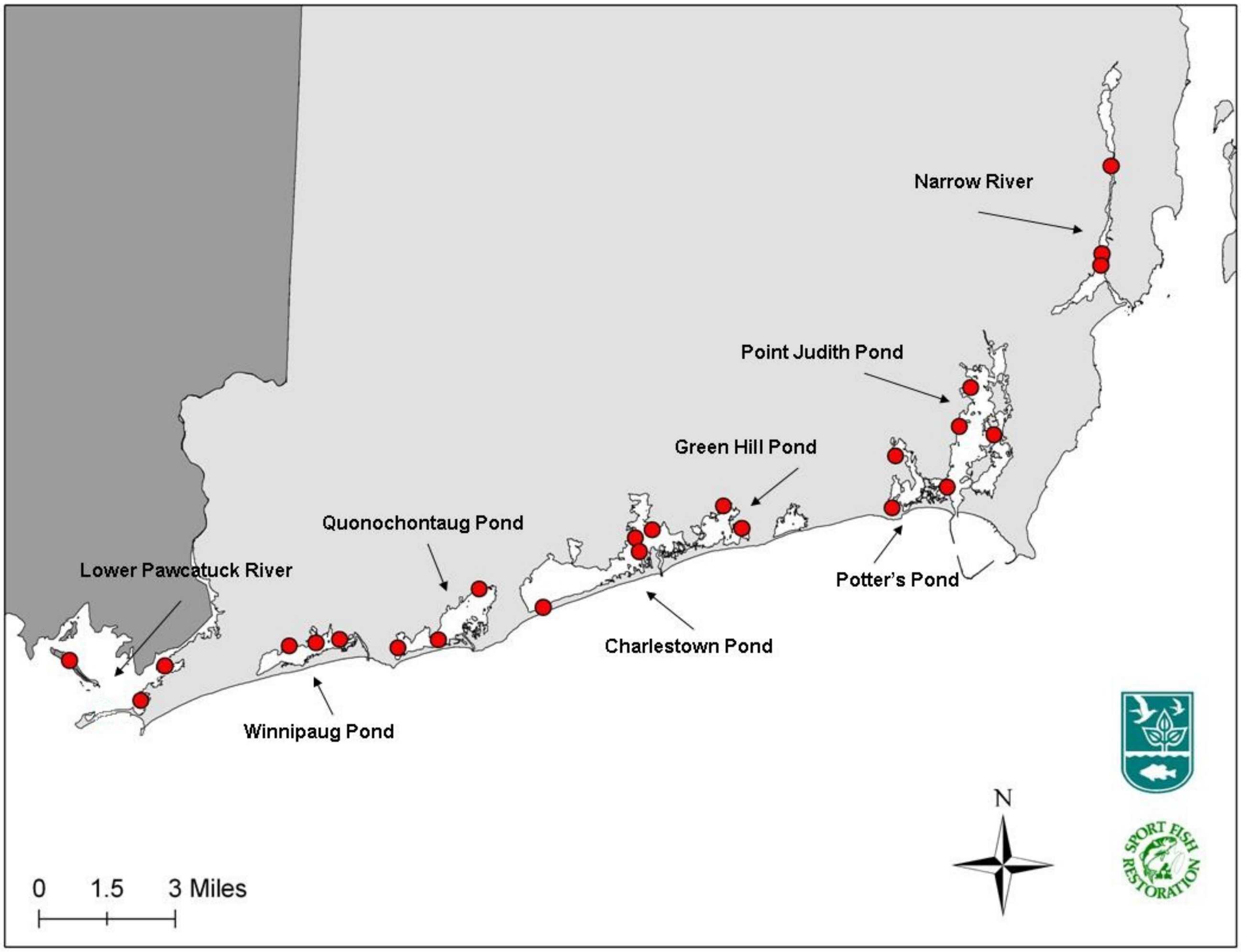


Figure 2: Coastal Pond Juvenile Finfish Survey station locations (western ponds).

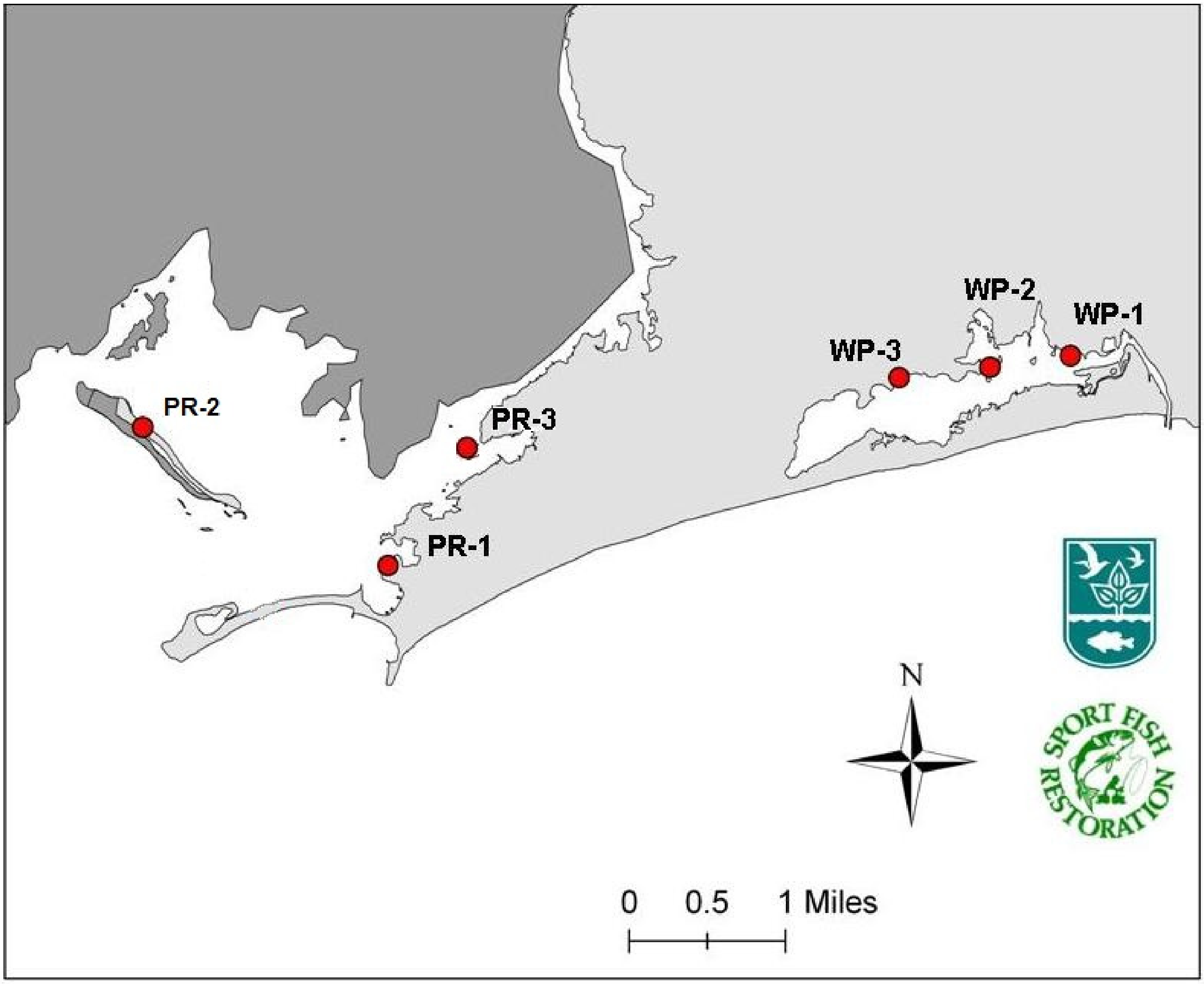


Figure 2 (cont): Coastal Pond Juvenile Finfish Survey station locations (western ponds).

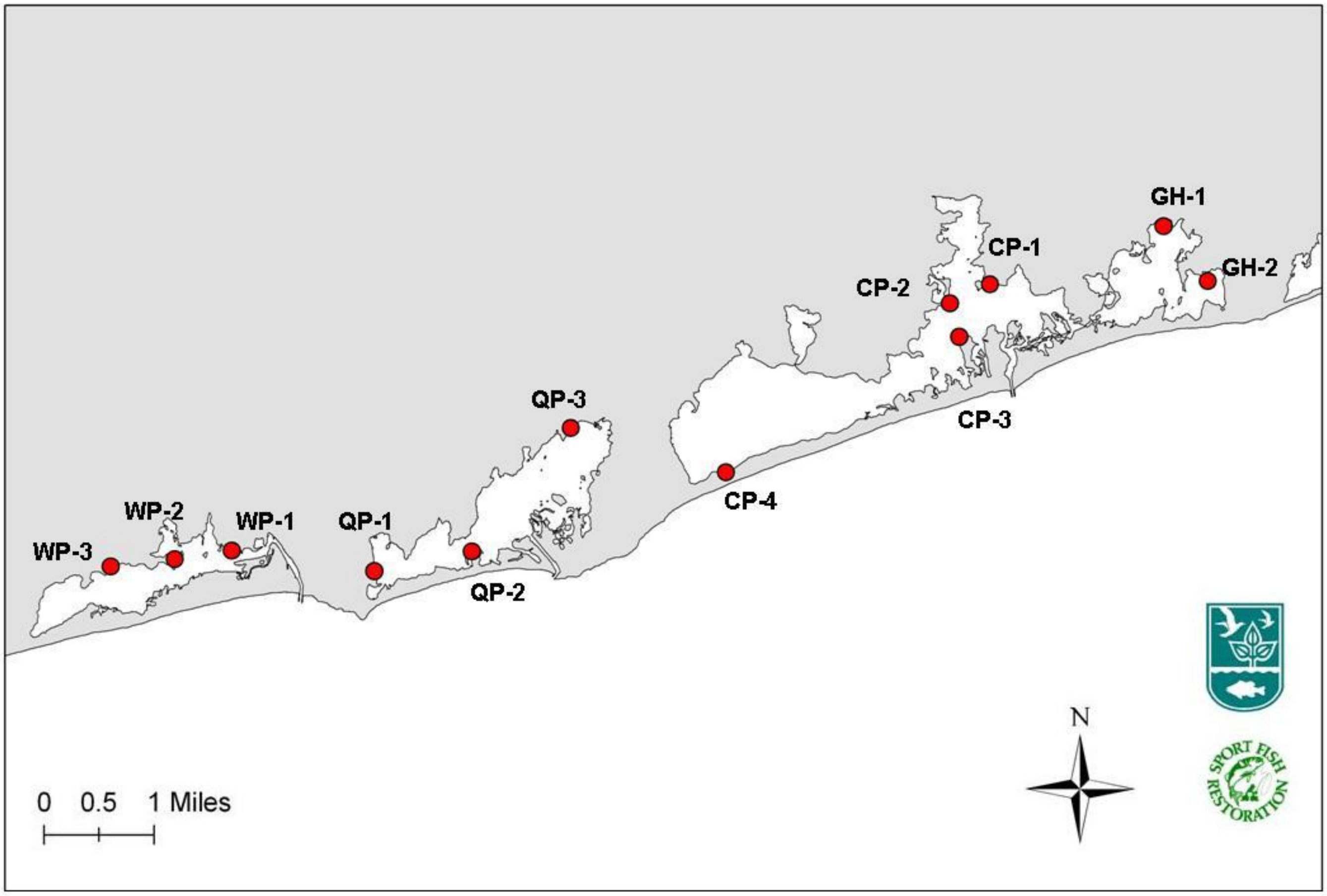


Figure 3: Coastal Pond Juvenile Finfish Survey station locations (eastern ponds).

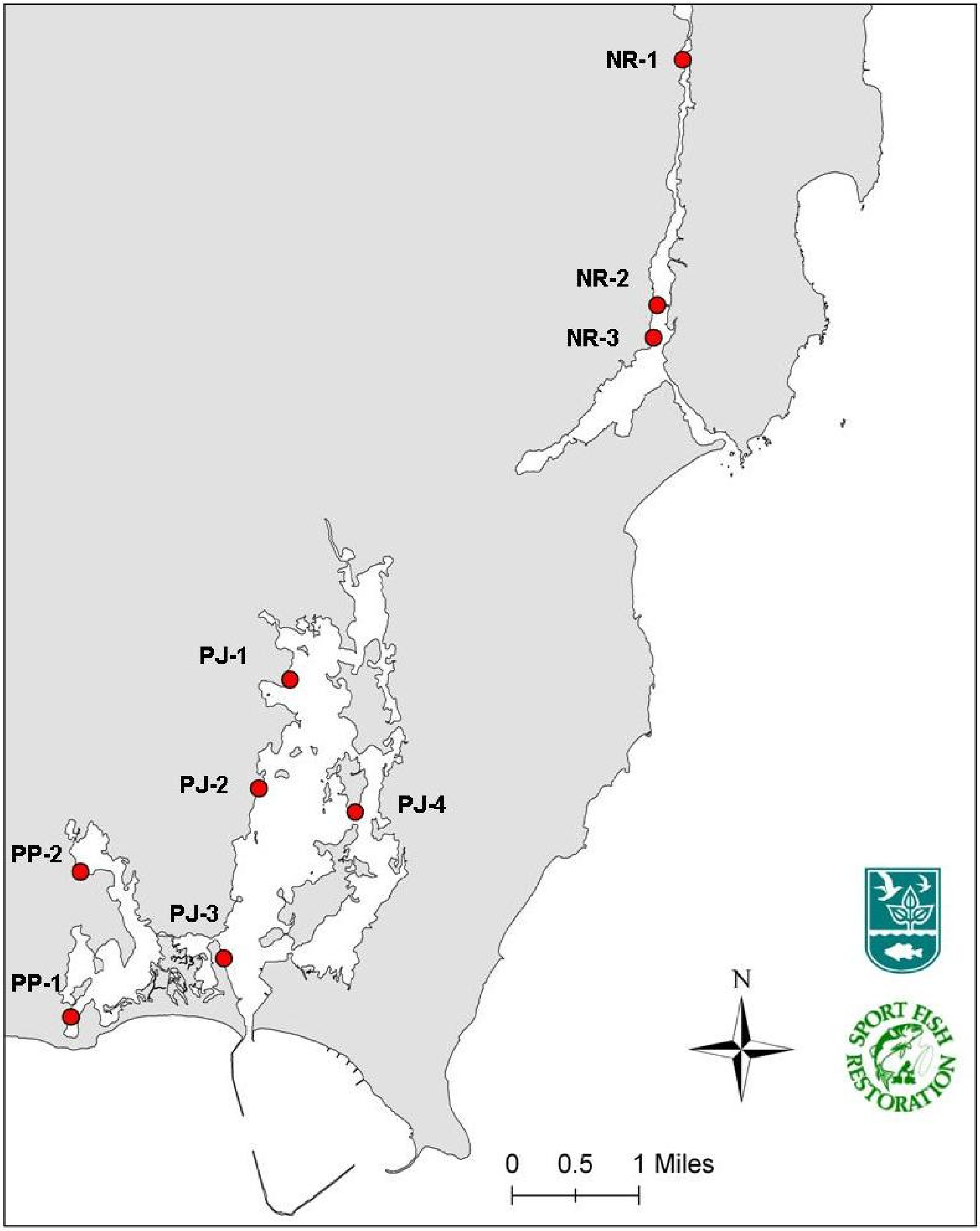


Figure 4
Coastal Pond Juvenile Finfish Survey

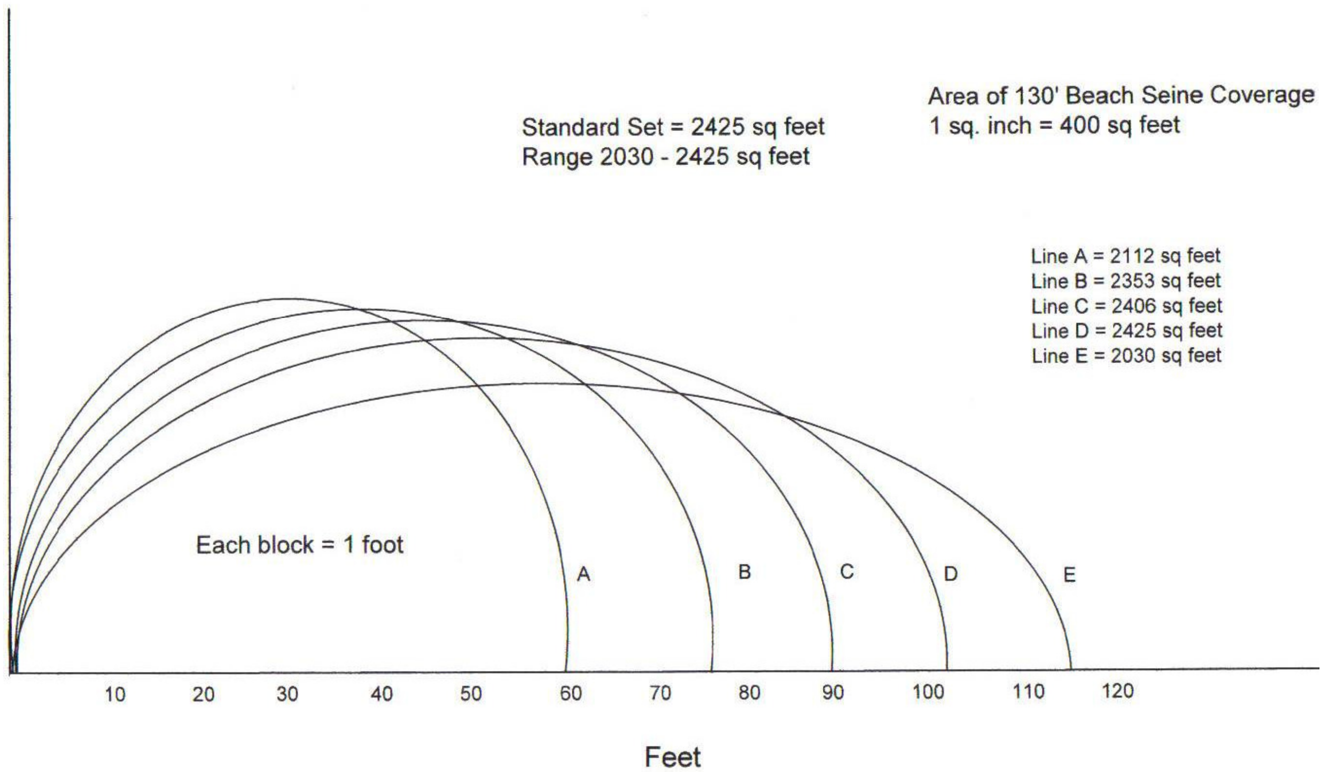


Figure 5a: Time series of abundance indices (fish/seine haul) for winter flounder YOY from each Coastal Pond in the survey.

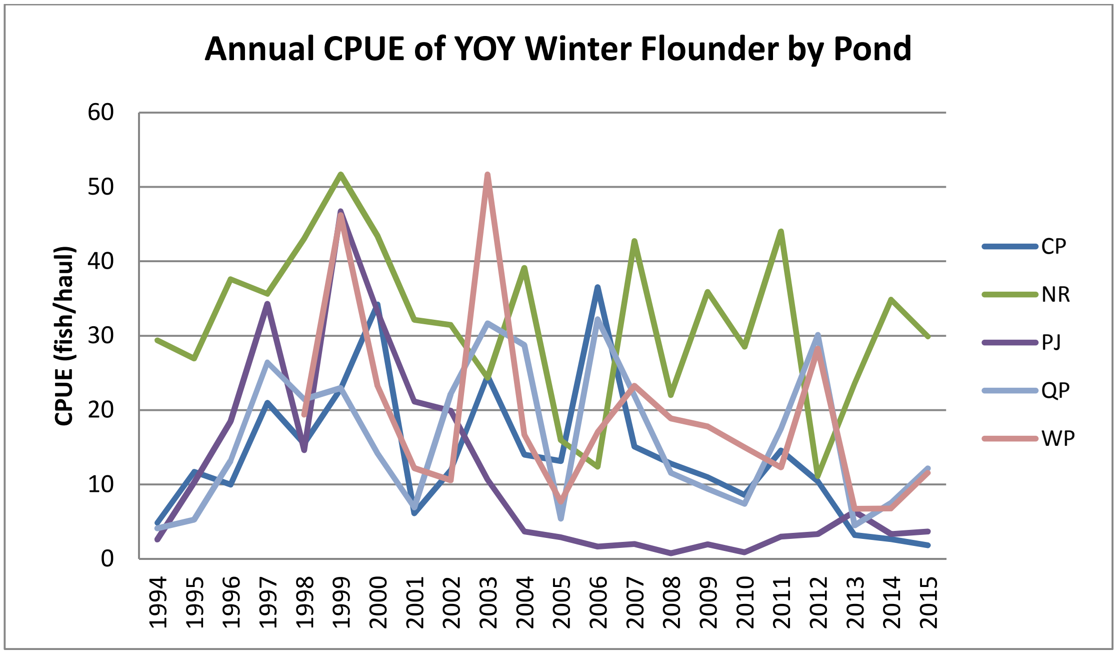


Figure 5b: 2015 time series of abundance indices (fish/seine haul) by month for winter flounder YOY for each Coastal Pond in the survey.

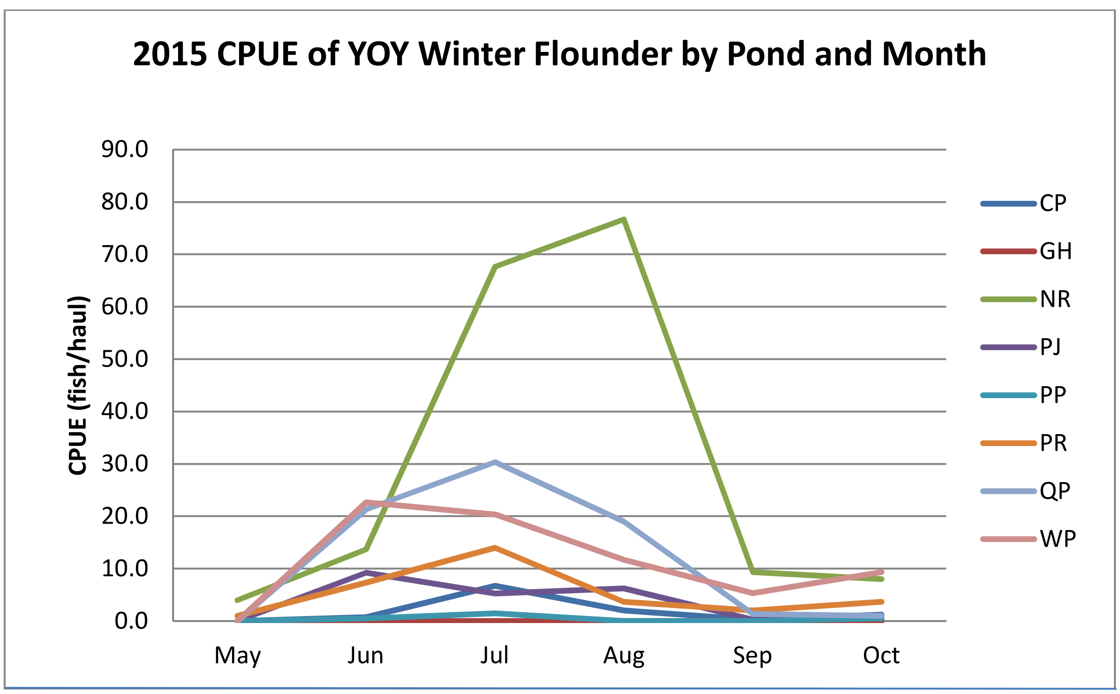


Figure 6: Length frequency of all winter flounder caught in Coastal Pond Survey during 2015.

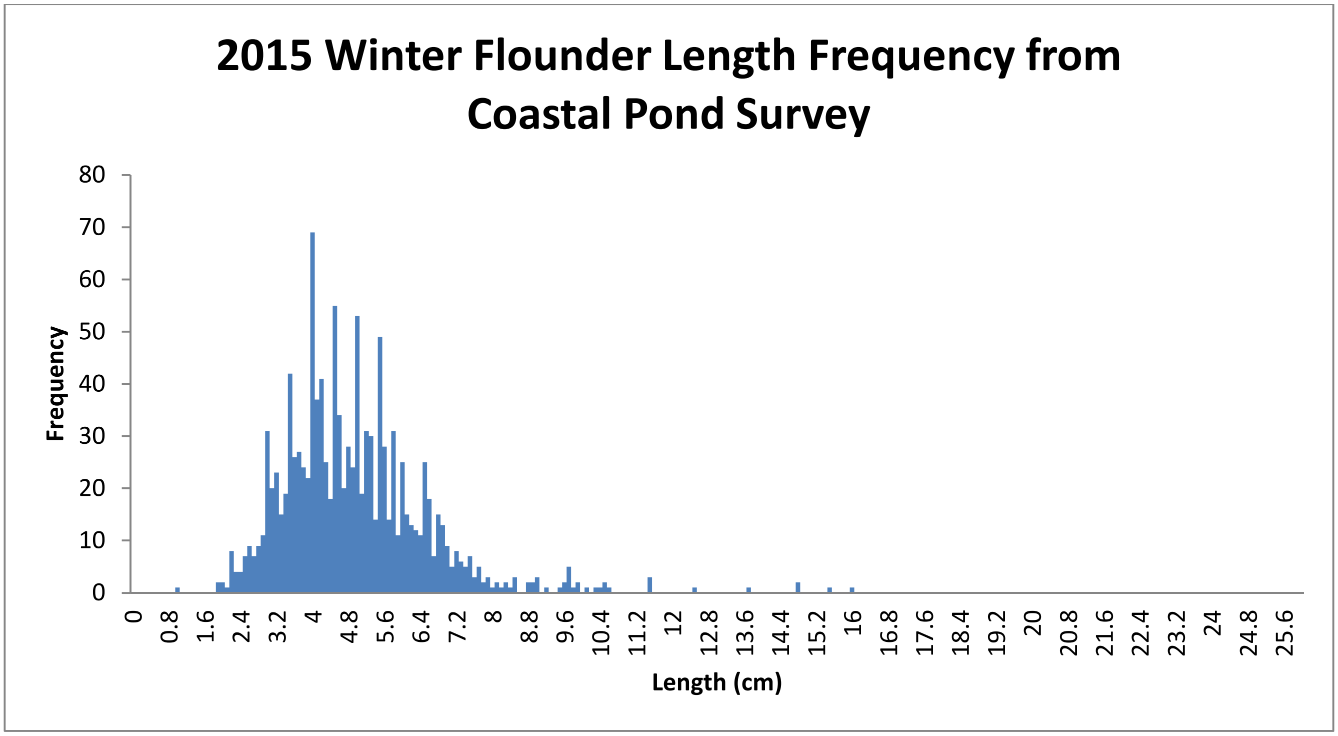


Figure 7: Monthly length frequency of winter flounder from Charlestown Pond, 2015.

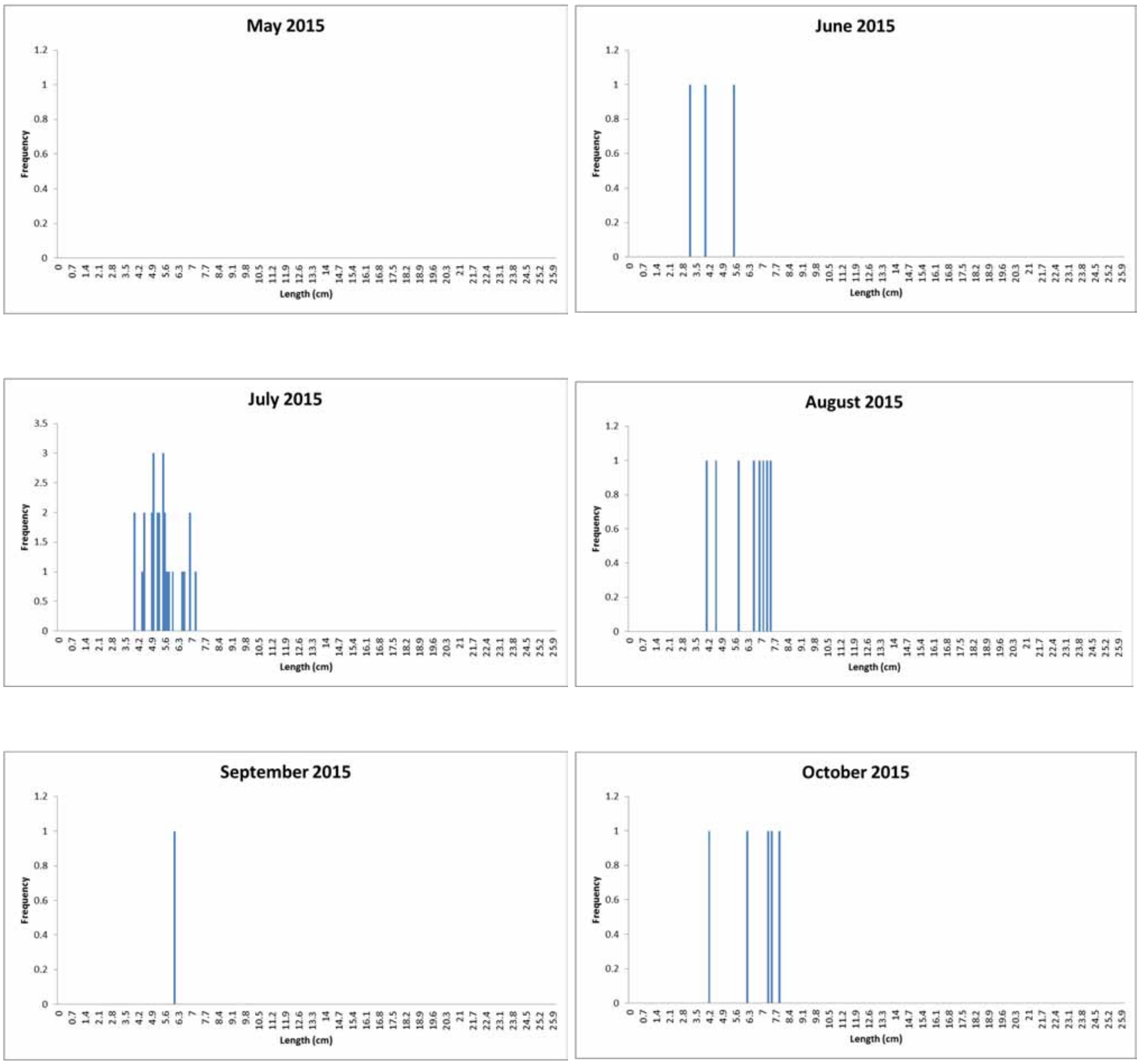


Figure 8: Monthly length frequency of winter flounder from Green Hill Pond, 2015.

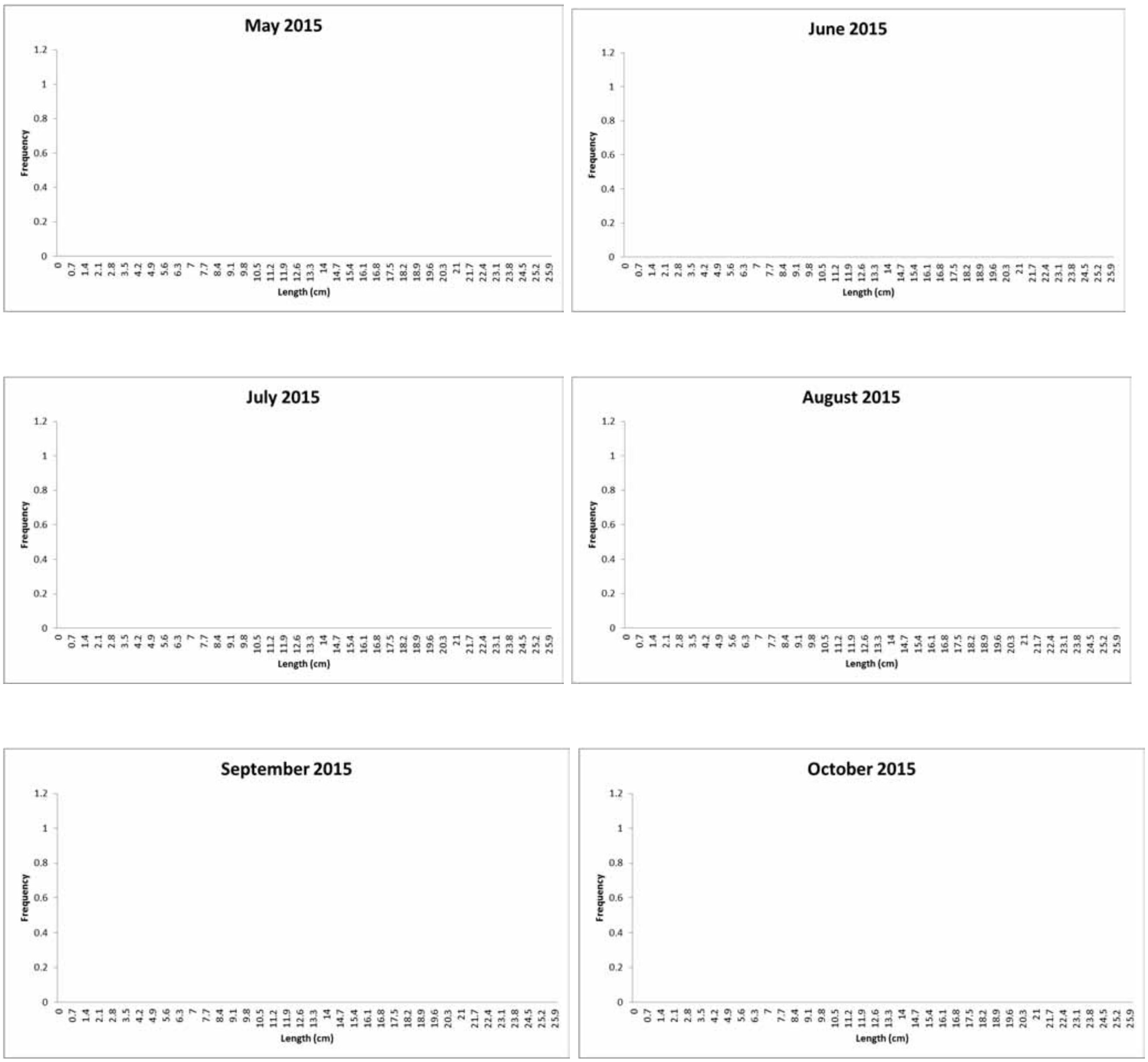


Figure 9: Monthly length frequency of winter flounder from Narrow River, 2015.

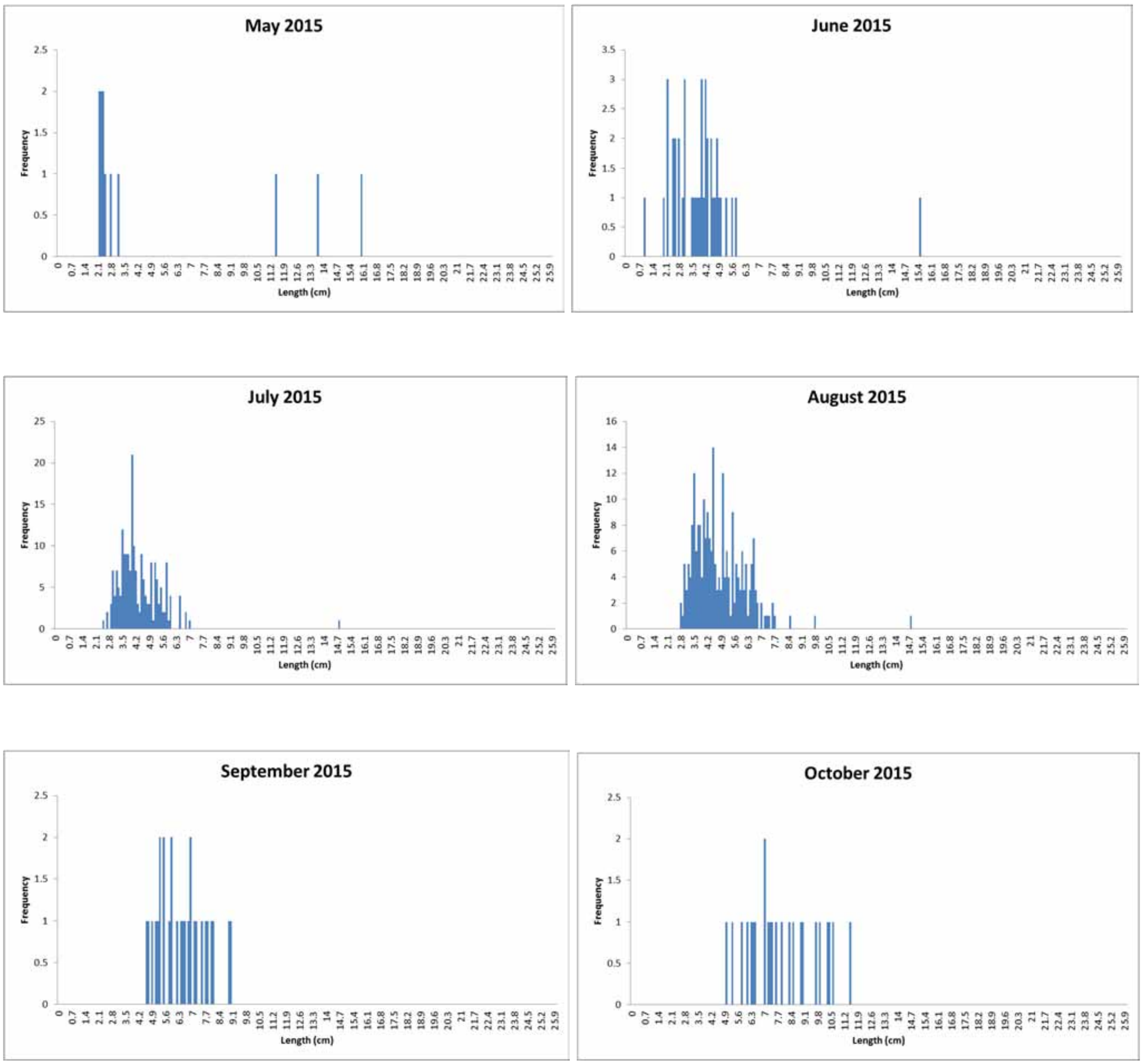


Figure 10: Monthly length frequency of winter flounder from Point Judith Pond, 2015.

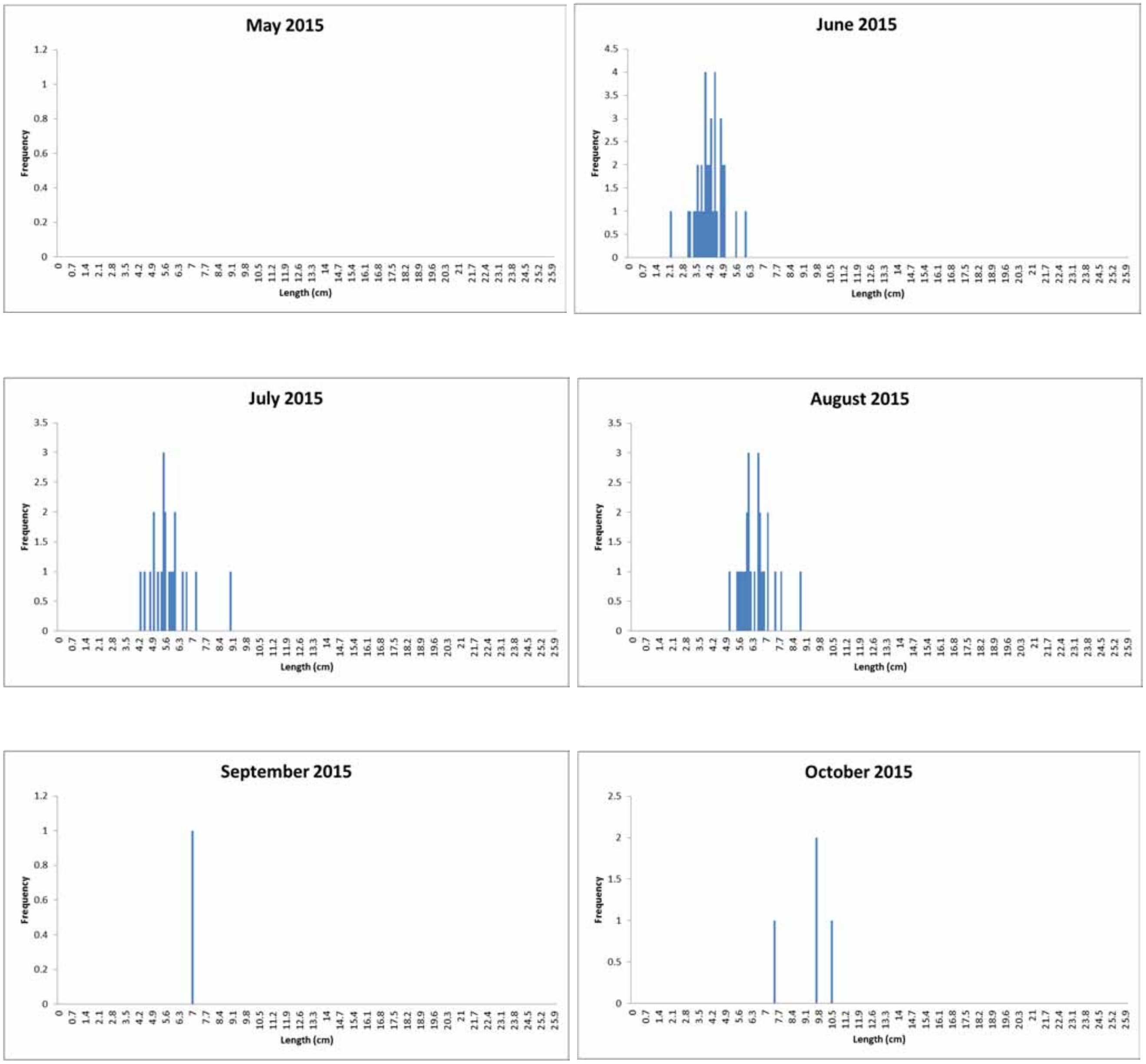


Figure 11: Monthly length frequency of winter flounder from Potter Pond, 2015.

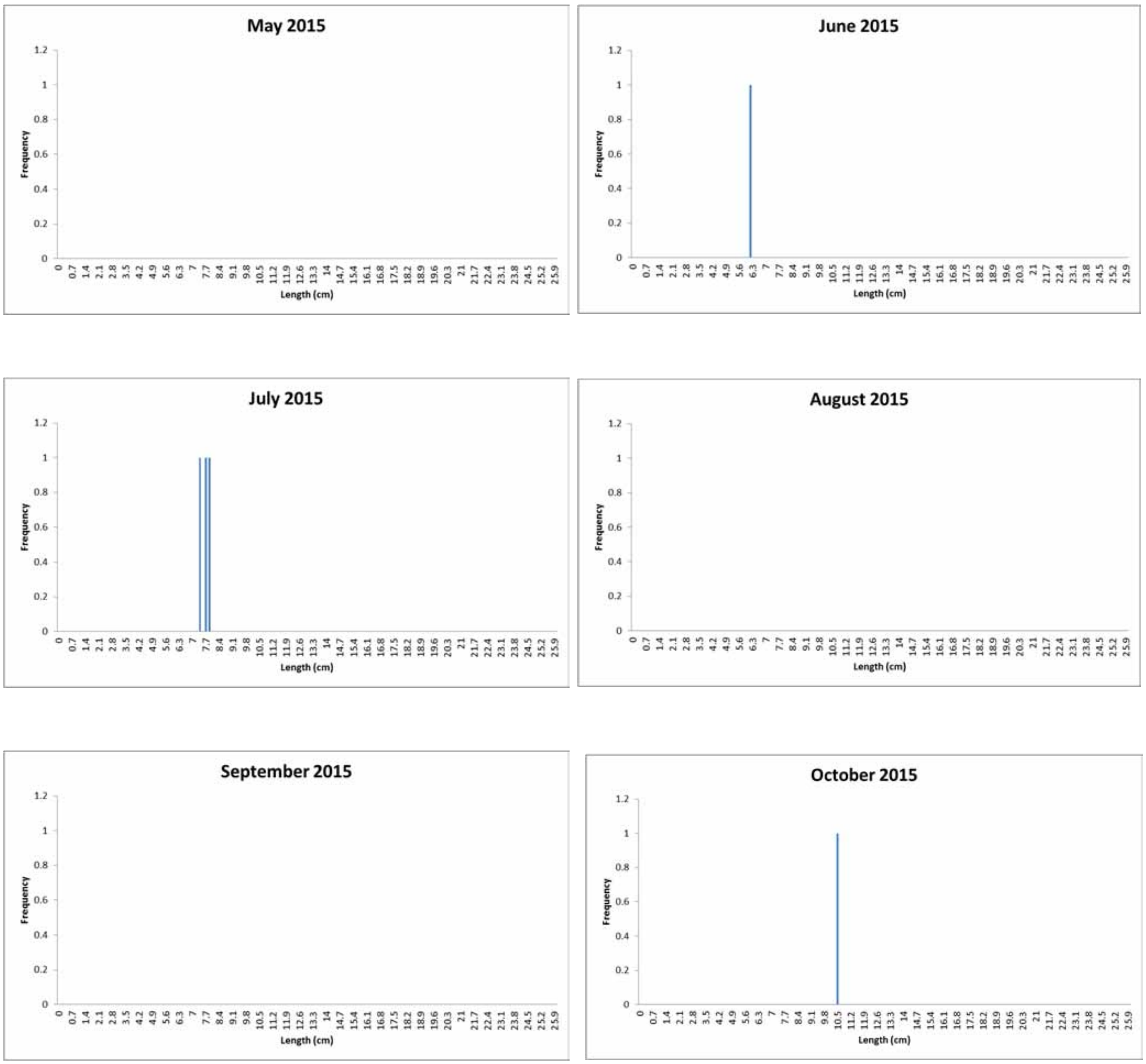


Figure 12: Monthly length frequency of winter flounder from Pawcatuck River, 2015.

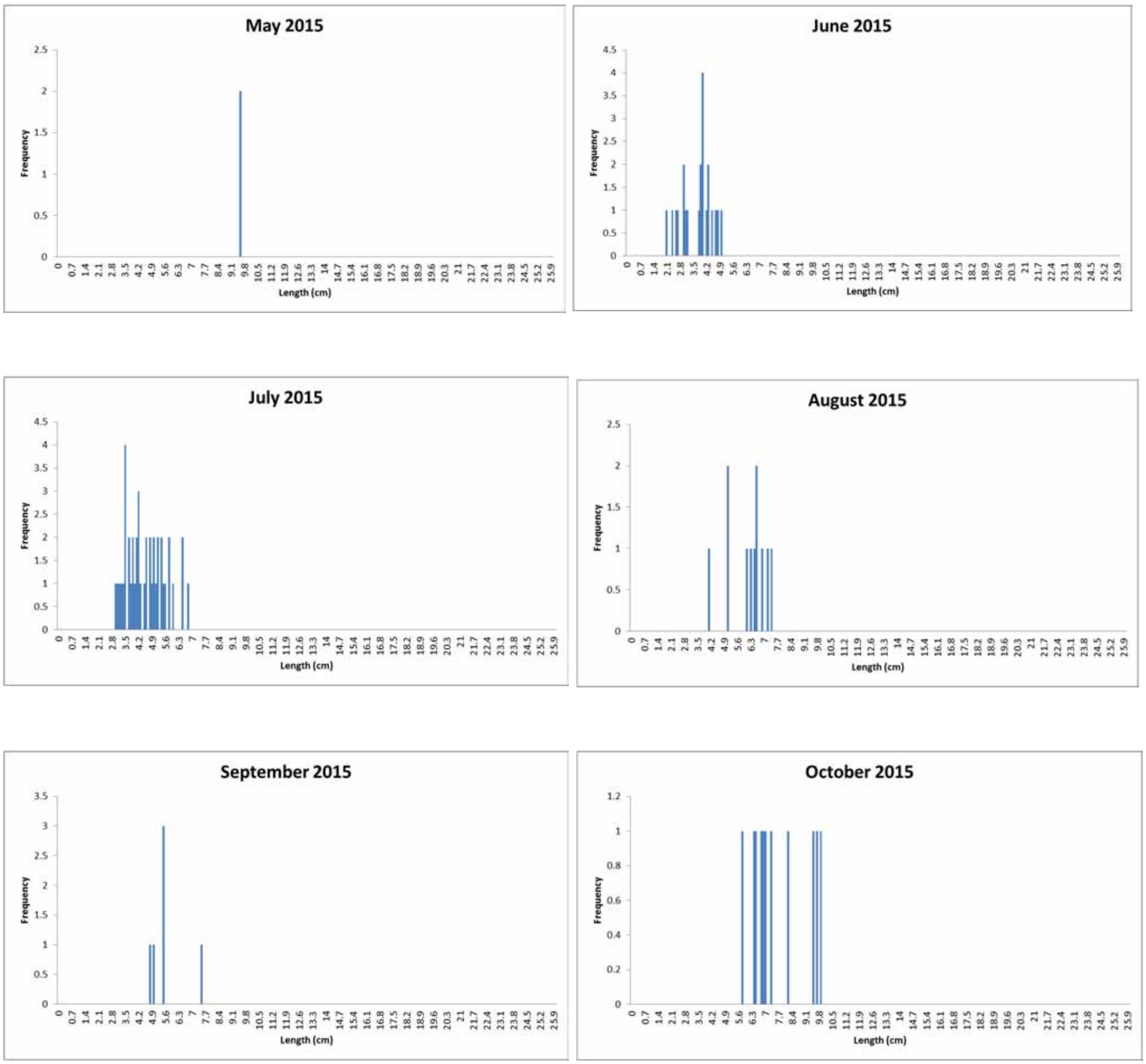


Figure 13: Monthly length frequency of winter flounder from Quonochontaug Pond, 2015.

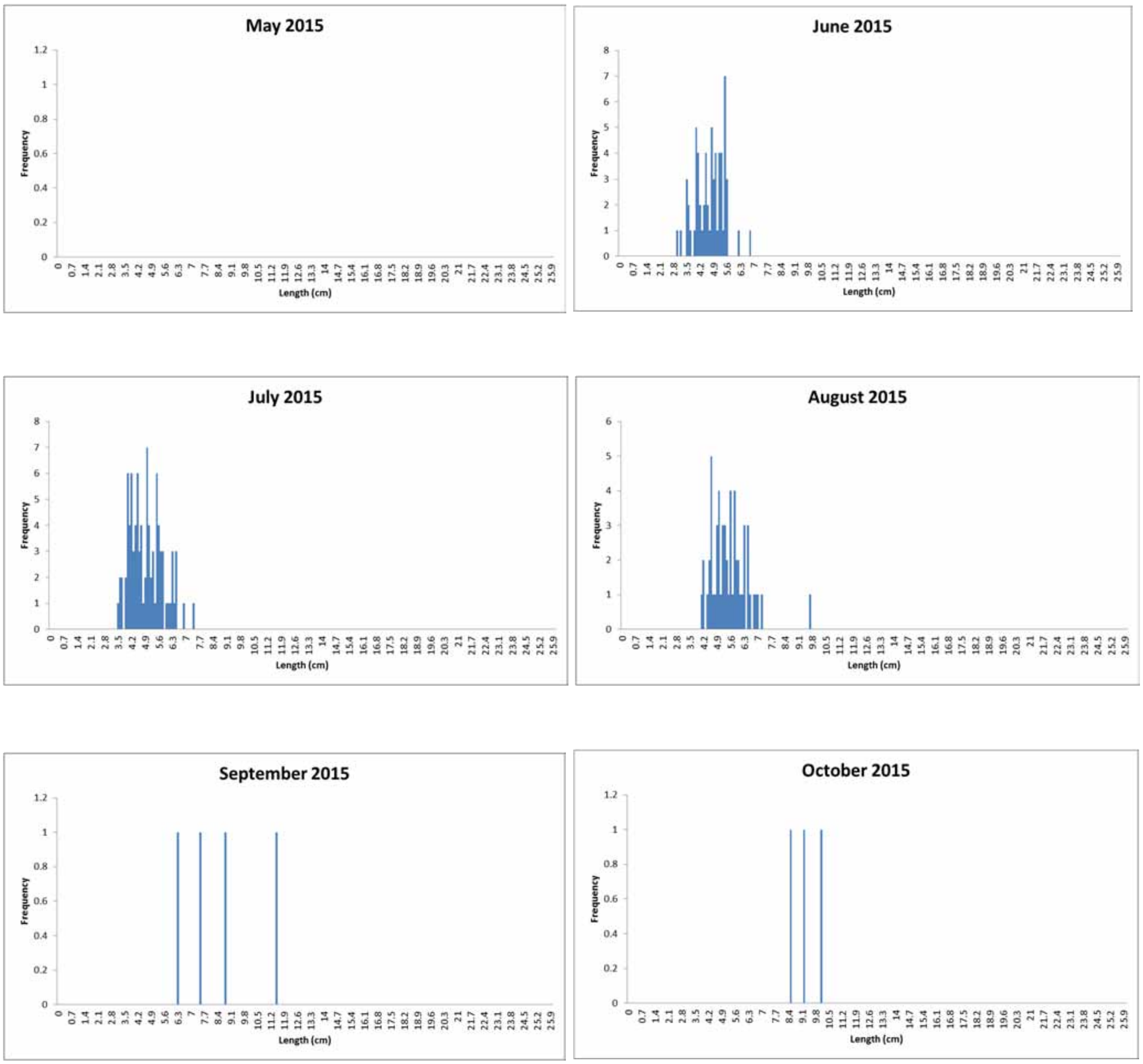


Figure 14: Monthly length frequency of winter flounder from Winnipaug Pond, 2015.

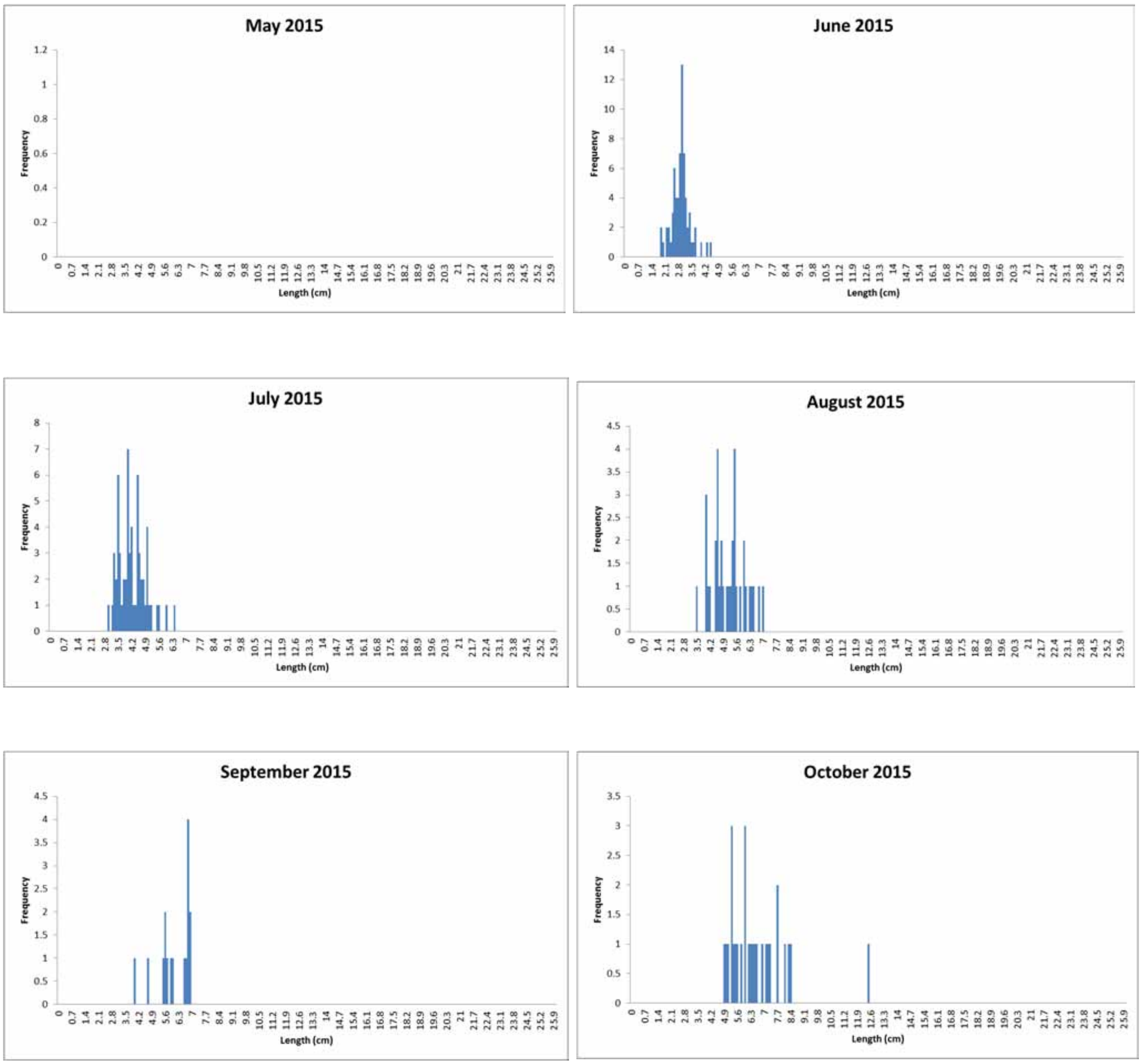


Figure 15: Time series of annual abundance indices for winter flounder YOY from the coastal pond survey.

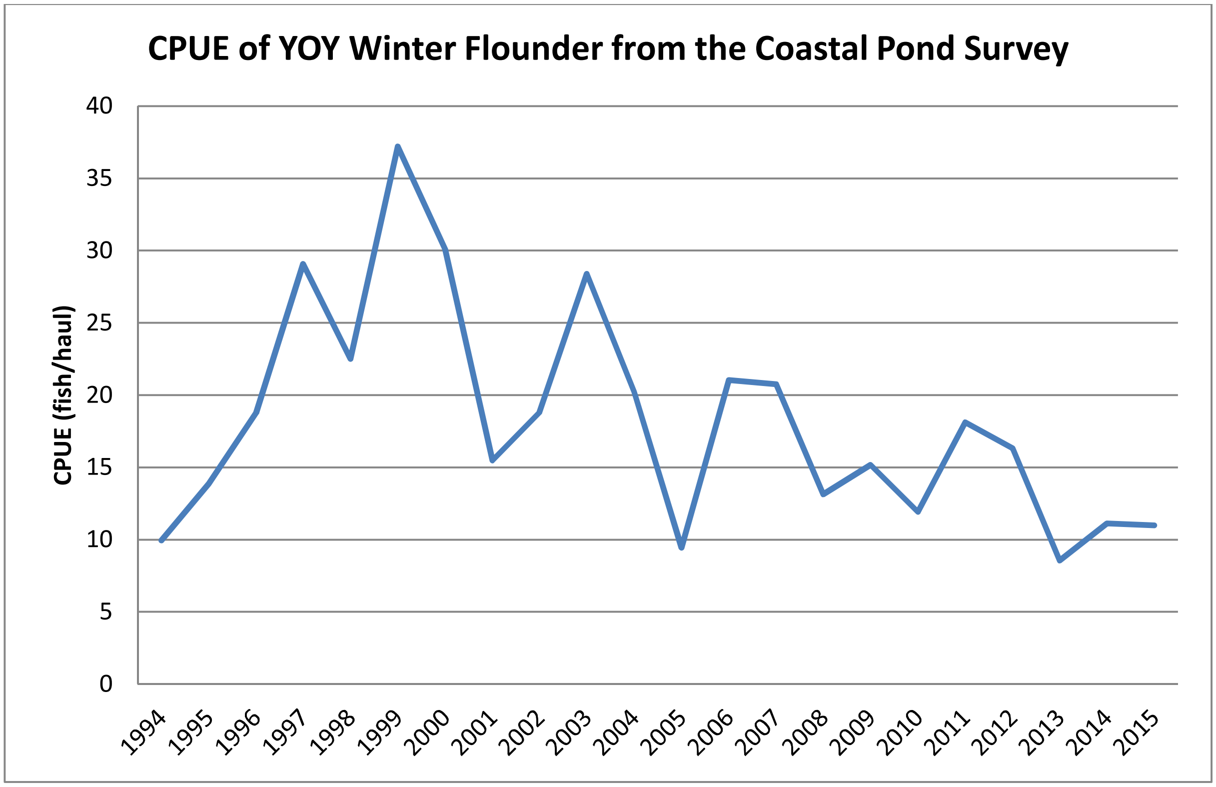


Figure 16: Abundance indices (fish/haul) from the Coastal Pond Survey, Narragansett Bay Seine Survey, and RIDFW Trawl Survey for winter flounder.

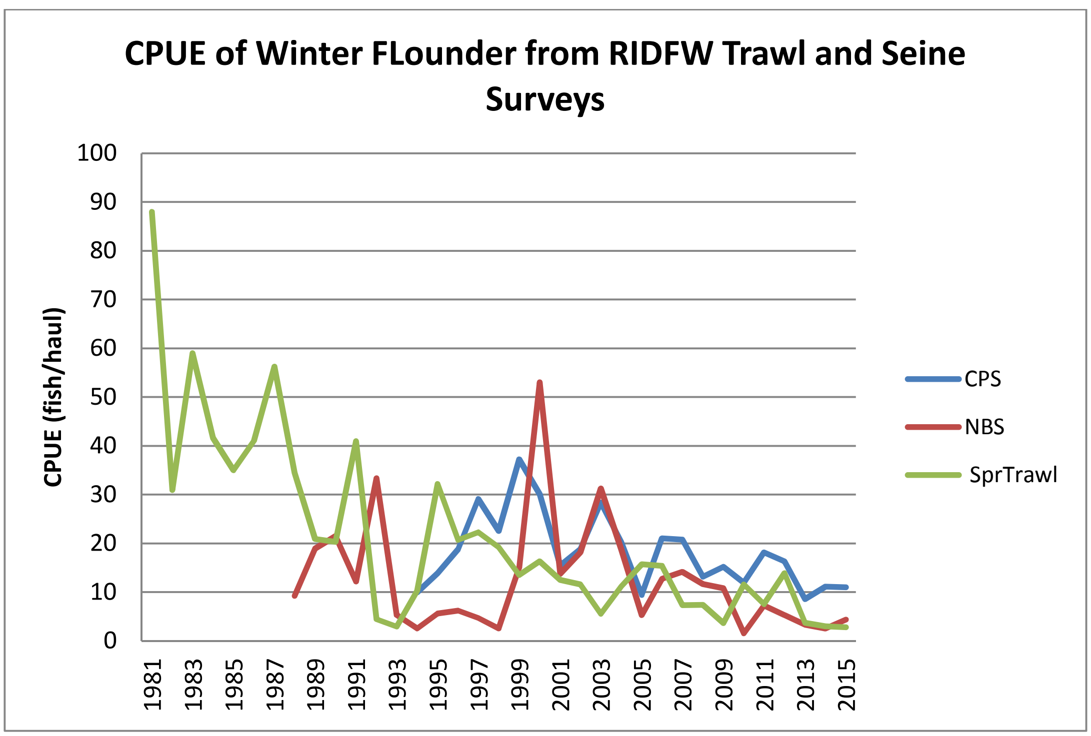


Figure 17: Abundance indices (fish/haul) from the Coastal Pond Survey and the Adult Winter Flounder Tagging Survey for winter flounder.

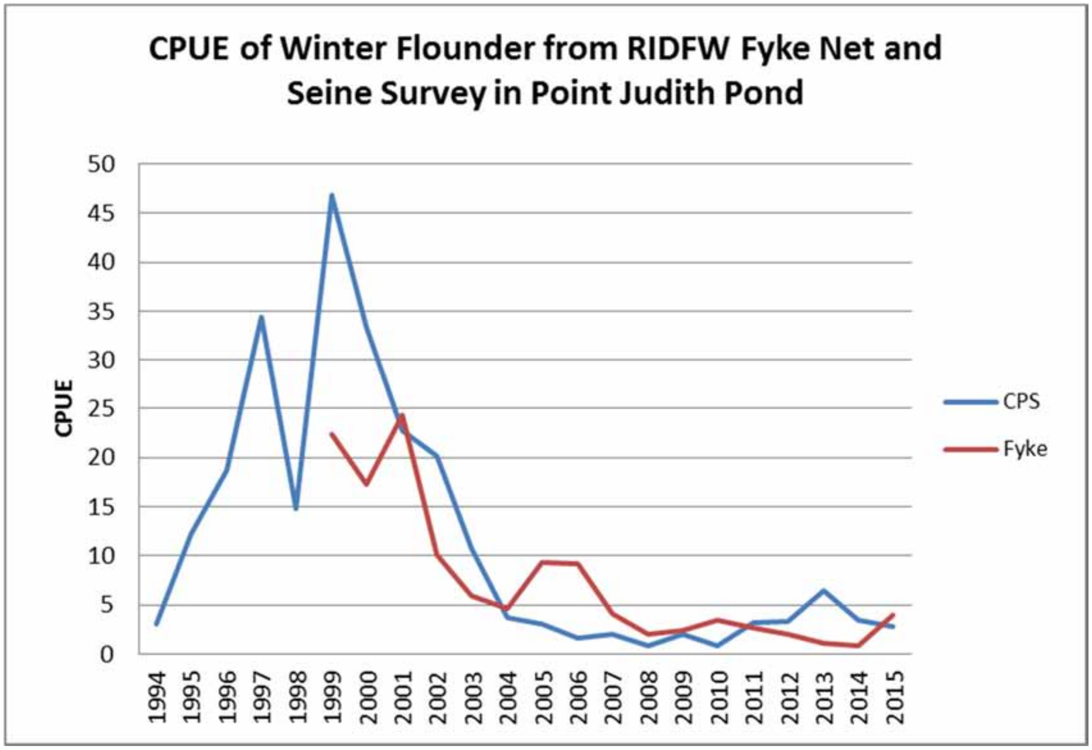


Figure 18. Time series of annual abundance indices for bluefish from the coastal pond survey.

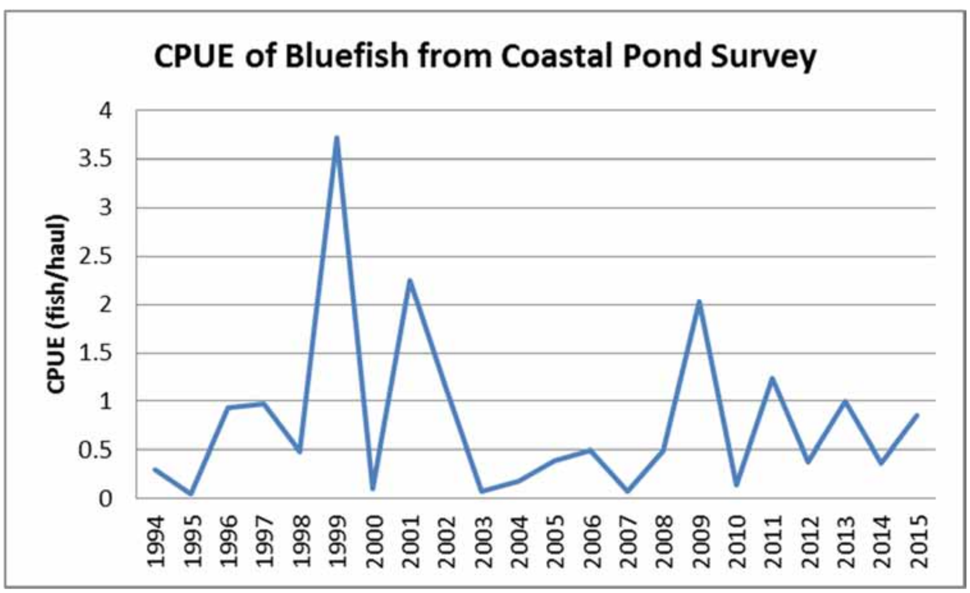


Figure 19. Time series of annual abundance indices for Tautog from the coastal pond survey.

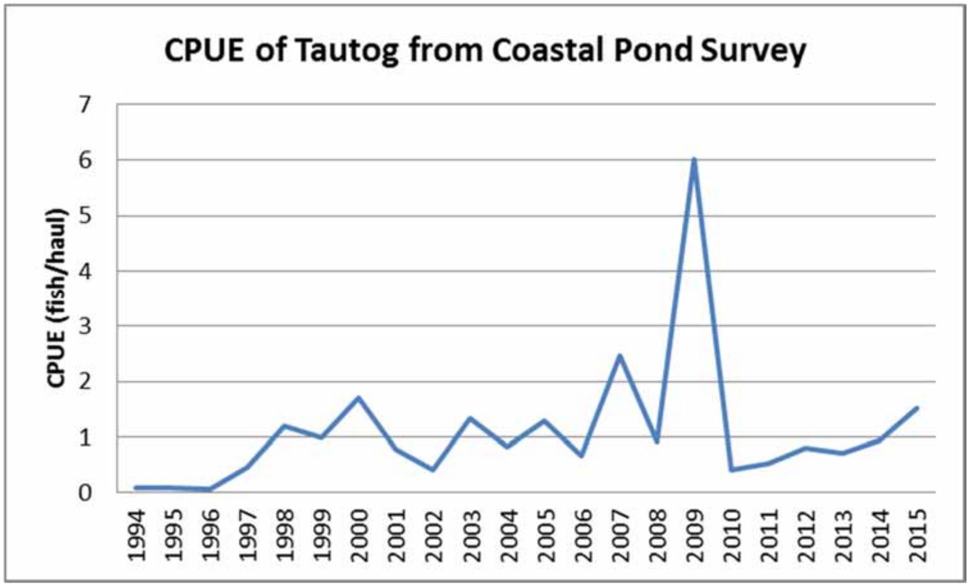


Figure 20. Time series of annual abundance indices for Black Sea Bass from the coastal pond survey.

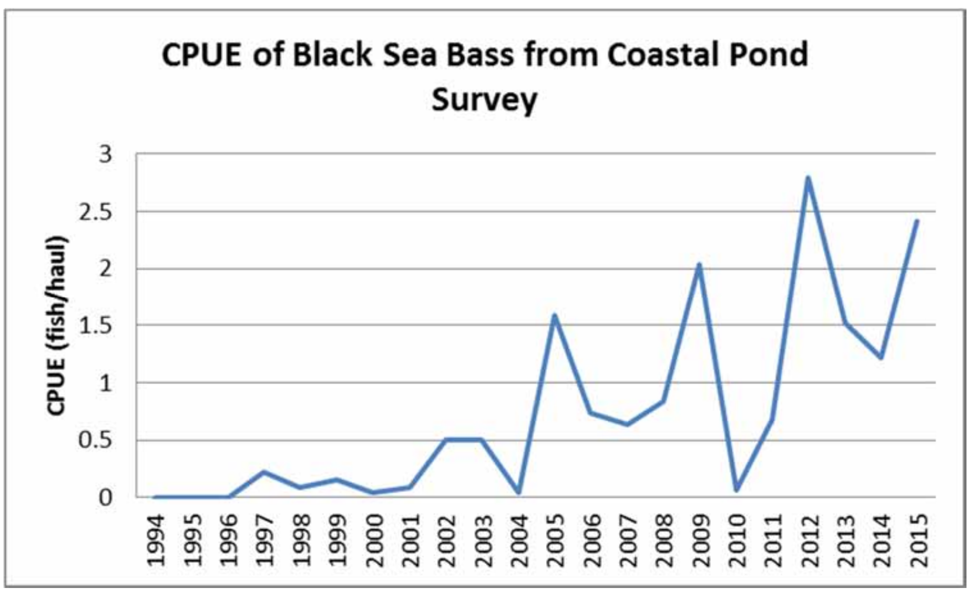


Figure 21. Time series of annual abundance indices for Scup from the coastal pond survey.

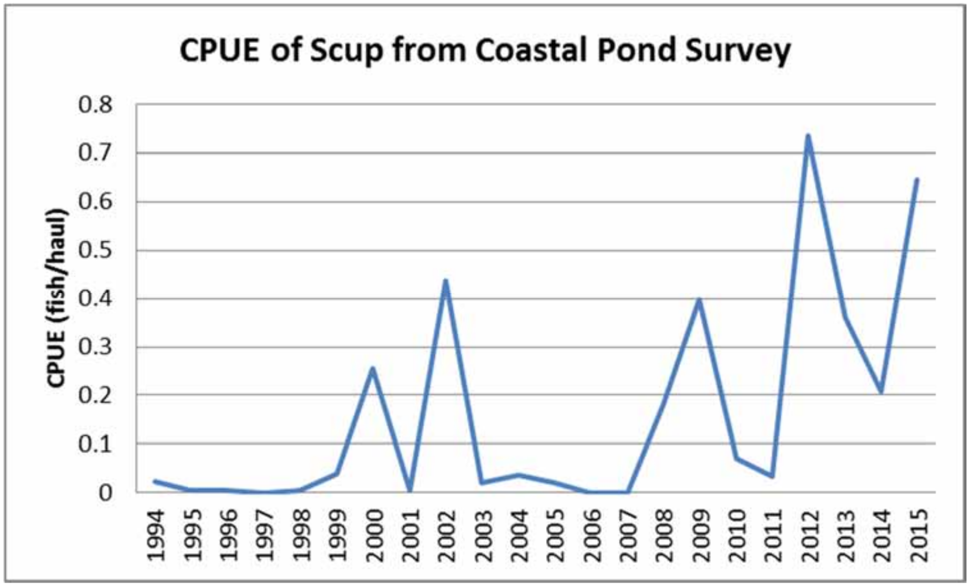


Figure 22. Time series of annual abundance indices for Clupeids from the coastal pond survey (menhaden on right y- axis)

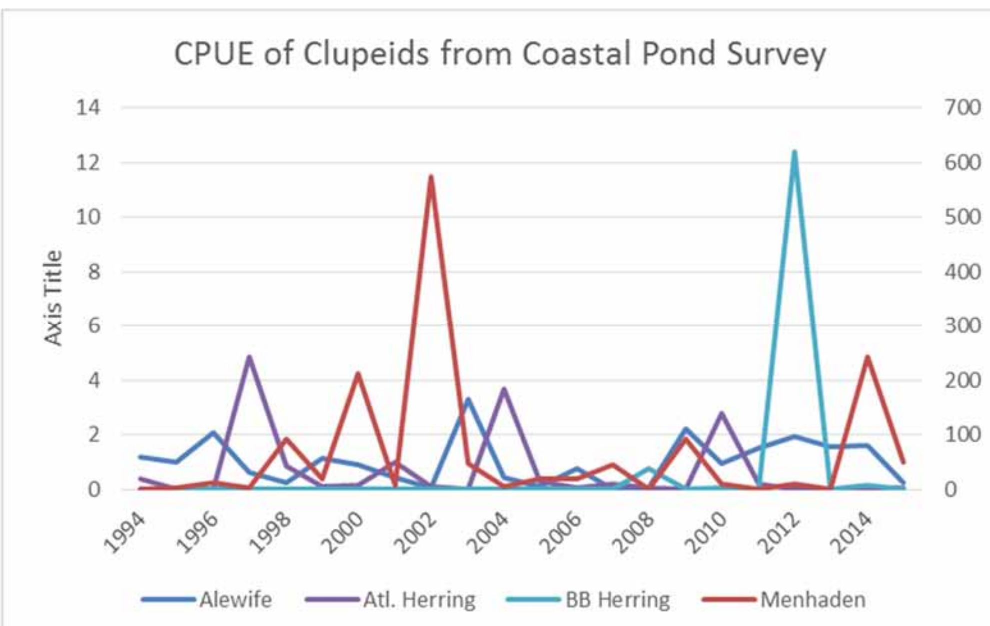
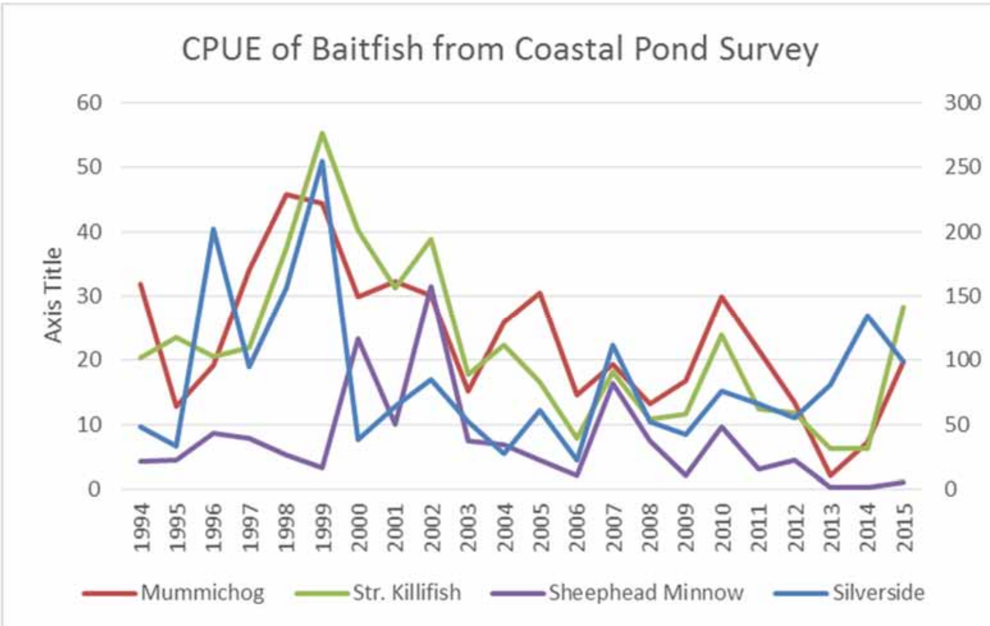


Figure 23. Time series of annual abundance indices for Baitfish from the coastal pond survey (silversides on right y- axis).



Appendix 1a: Catch frequency of all species by station for 2015 Coastal Pond Survey original ponds.

Species	CP1	CP2	CP3	CP4	NR1	NR2	NR3	PJ1	PJ2	PJ3	PJ4	QP1	QP2	QP3	WP1	WP2	WP3
ALEWIFE (ALOSA PSEUDOHARENGUS)		1	2		10	4		1					2				
ANCHOVY BAY (ANCHOA MITCHILLI)			28			6				1				1		1	
BASS STRIPED (MORONE SAXATILIS)							1									1	
BLUE CRAB (CALLINECTES SAPIDIUS)	7		2	100	48		3	3	1	6	5	1					5
BLUE CRAB FEMALE (CALINECTES SAPIDIUS)	8		1	4	24	3		10	1		12	6	1	1		1	2
BLUE CRAB MALE (CALINECTES SAPIDIUS)	7	4	1	2	24	2	2	12			8	11		1			6
BLUEFISH (POMATOMUS SALTATRIX)			3		54	3	6			1		21	3	4		3	
BONEFISH (ALBULA VULPES)				13		1											
BUTTERFISH (PEPRILUS TRIACANTHUS)			1														
COD ATLANTIC (GADUS MORHUA)																1	
CORNETFISH BLUESPOTTED (FISTULARIA TABACARIA)			1														
CUNNER (TAUTOGOLABRUS ADSPERSUS)			6														
CUSK-EEL STRIPED (OPHIDION MARGINATUM)																	1
EEL AMERICAN (ANGUILLA ROSTRATA)		2	1												1		
FLOUNDER SMALLMOUTH (ETROPUS MICROSTOMUS)	4			1		1	1		2	1				4		1	7
FLOUNDER SPOTFIN (CYCLOPSETTA FIMBRIATA)	2								2							2	
FLOUNDER SUMMER (PARALICHTHYS DENTATUS)						4											
FLOUNDER WINTER (PSEUDOPLEURONECTES AMERICANUS)	36	1	7		30	256	252	10	35	6	37	66	58	95	75	114	19
GOBY NAKED (GOBIOSOMA BOSC)	2			2				1	1		1						3
GRUBBY (MYOXOCEPHALUS AENAEUS)			2				34		6			3	11		18	9	
GUNNEL ROCK (PHOLIS GUNNELLUS)																	
HAKE RED (UROPHYCIS CHUSS)			1														
HERRING ATLANTIC (CLUPEA HARENGUS)								1	3			1					2
HERRING BLUEBACK (ALOSA AESTIVALIS)																	
HOGCHOKER (TRINECTES MACULATUS)					2												
HORSESHOE CRAB (LIMULUS POLYPHEMUS)	3			2		5		3				4	2	2			1
JACK CREVALLE (CARANX HIPPOS)					1												
KILLIFISH STRIPED (FUNDULUS MAJALIS)	38		111	74	12	103	7	22	9	712	13	38	97	201	359	12	1898
KINGFISH NORTHERN (MENTICIRRHUS SAXATILIS)						11					2	2	2	1			
LIZARDFISH INSHORE (SYNODUS FOETENS)					1	2	1	2	7		7	4		2		7	
MANTIS SHRIMP (SQUILLA MANTIS)																	
MENHADEN ATLANTIC (BREVOORTIA TYRANNUS)	81	6	3	4		118	9	3		19		1			682	6	578
MINNOW SHEEPSHEAD (CYPRINODON VARIEGATUS)		12	3	2	1	29						2		70	5		15
MOJARRA SPOTFIN (EUCINOSTOMUS ARGENTEUS)				2	2	7		26							1		
MULLET WHITE (MUGIL CUREMA)					2							2	9				42
MUMMICHOG (FUNDULUS HETEROCLITUS)		201	136	26	10	281	19	19	2	8	8		100	7	645	7	714
NEEDLEFISH ATLANTIC (STRONGYLURA MARINA)			1				2				2	1	2				1
PERCH WHITE (MORONE AMERICANA)		7			19	1											
PERMIT (TRACHINOTUS FALCATUS)		3															
PIPEFISH NORTHERN (SYNGNATHUS FUSCUS)	6	9	11	2	1	3	6	4	7		4	3	3			4	5
POLLOCK (POLLACHIUS VIRENS)			1				1										
PUFFER NORTHERN (SPHOEROIDES MACULATUS)	1					8	2		1			1					
RAINWATER KILLIFISH (LUCANIA PARVA)	39	32	90	4				1									16
SCAD BIGEYE (SELAR CRUMENOPHTHALMUS)															1		
SCUP (STENOTOMUS CHRYSOPS)		9						1	1			73			2		
SEA BASS BLACK (CENTROPRISTIS STRIATA)	85	17	35			25	30		10		26	35	47	3	25	9	
SEAROBIN NORTHERN (PRIONOTUS CAROLINUS)														1			1
SEAROBIN STRIPED (PRIONOTUS EVOLANS)	1					27	2	1	8		6	2	3	7		6	3
SENNET NORTHERN (SPHYRAENA BOREALIS)		11															
SILVERSIDE ATLANTIC (MENIDIA MENIDIA)	175	427	1331	868	81	1356	415	2014	185	816	498	310	213	465	202	976	402
SNAKEFISH (TRACHINOCEPHALUS MYOPS)	27			1													
SQUID LONGFIN (LOLIGO PEALEI)													4				
STICKLEBACK FOURSPINE (APELTES QUADRACUS)	2	296	385	3	1	10	13	4	2				1		2		54
STICKLEBACK THREESPINE (GASTEROSTEUS ACULEATUS)		6		1		23	8								20		
TAUTOG (TAUTOGA ONITIS)	1	21	56			3		1	2		6		1		1		
TOADFISH OYSTER (OPSANUS TAU)			2		1						1	1					3
TOMCOD ATLANTIC (MICROGADUS TOMCOD)		3					1										
TRUNKFISH (LACTOPHRYS TRIGONUS)									1								1
WEAKFISH (CYNOSCION REGALIS)												1					
WINDOWPANE (SCOPHTHALMUS AQUOSUS)																1	

Appendix 1b: Catch frequency of all species by station for 2015 Coastal Pond Survey (new ponds).

Species	GH1	GH2	PP1	PP2	PR1	PR2	PR3
ALEWIFE (ALOSA PSEUDOHARENGUS)							15
ANCHOVY BAY (ANCHOA MITCHILLI)						2	
BASS STRIPED (MORONE SAXATILIS)							
BLUE CRAB (CALLINECTES SAPIDIUS)	1		54			3	
BLUE CRAB FEMALE (CALINECTES SAPIDIUS)	3	1	22	1		2	
BLUE CRAB MALE (CALINECTES SAPIDIUS)	3	1	37	2	1		
BLUEFISH (POMATOMUS SALTATRIX)		1	2		6	3	14
BONEFISH (ALBULA VULPES)							
BUTTERFISH (PEPRILUS TRIACANTHUS)							
COD ATLANTIC (GADUS MORHUA)					2		
CORNETFISH BLUESPOTTED (FISTULARIA TABACARIA)							
CUNNER (TAUTOGOLABRUS ADSPERSUS)					2		5
CUSK-EEL STRIPED (OPHIDION MARGINATUM)							
EEL AMERICAN (ANGUILLA ROSTRATA)		2	2				1
FLOUNDER SMALLMOUTH (ETROPUS MICROSTOMUS)					3		
FLOUNDER SPOTFIN (CYCLOPSETTA FIMBRIATA)					1		
FLOUNDER SUMMER (PARALICHTHYS DENTATUS)					1		
FLOUNDER WINTER (PSEUDOPLEURONECTES AMERICANUS)			5		68	19	7
GOBY NAKED (GOBIOSOMA BOSC)	11	20	19	1			
GRUBBY (MYOXOCEPHALUS AENAEUS)			1		15	1	1
GUNNEL ROCK (PHOLIS GUNNELLUS)					1		
HAKE RED (UROPHYCIS CHUSS)							
HERRING ATLANTIC (CLUPEA HARENGUS)				1			
HERRING BLUEBACK (ALOSA AESTIVALIS)	1						
HOGCHOKER (TRINECTES MACULATUS)							
HORSESHOE CRAB (LIMULUS POLYPHEMUS)		1			2		
JACK CREVALLE (CARANX HIPPOS)							
KILLIFISH STRIPED (FUNDULUS MAJALIS)			37	46	218	55	1
KINGFISH NORTHERN (MENTICIRRHUS SAXATILIS)					2		
LIZARDFISH INSHORE (SYNODUS FOETENS)					3		
MANTIS SHRIMP (SQUILLA MANTIS)			1				
MENHADEN ATLANTIC (BREVOORTIA TYRANNUS)	1835		3770	5		2	1
MINNOW SHEEPSHEAD (CYPRINODON VARIEGATUS)	15	4	1	1	2		1
MOJARRA SPOTFIN (EUCINOSTOMUS ARGENTEUS)							
MULLET WHITE (MUGIL CUREMA)							
MUMMICHOG (FUNDULUS HETEROCLITUS)	65	11	508	29	2	1	47
NEEDLEFISH ATLANTIC (STRONGYLURA MARINA)	1		1				1
PERCH WHITE (MORONE AMERICANA)	1						
PERMIT (TRACHINOTUS FALCATUS)							
PIPEFISH NORTHERN (SYNGNATHUS FUSCUS)	5	2	4	2	6	1	
POLLOCK (POLLACHIUS VIRENS)							
PUFFER NORTHERN (SPHOEROIDES MACULATUS)					2		4
RAINWATER KILLIFISH (LUCANIA PARVA)	10	58	73	10			2
SCAD BIGEYE (SELAR CRUMENOPHTHALMUS)							
SCUP (STENOTOMUS CHRYSOPS)					5	1	1
SEA BASS BLACK (CENTROPRISTIS STRIATA)						1	
SEAROBIN NORTHERN (PRIONOTUS CAROLINUS)							
SEAROBIN STRIPED (PRIONOTUS EVOLANS)					3		
SENNET NORTHERN (SPHYRAENA BOREALIS)					1		
SILVERSIDE ATLANTIC (MENIDIA MENIDIA)	161	129	255	243	109	1994	595
SNAKEFISH (TRACHINOCEPHALUS MYOPS)					8		
SQUID LONGFIN (LOLIGO PEALEI)							
STICKLEBACK FOURSPINE (APELTES QUADRACUS)	2	12	85	10	2	1	52
STICKLEBACK THREESPINE (GASTEROSTEUS ACULEATUS)							
TAUTOG (TAUTOGA ONITIS)				3	4	12	108
TOADFISH OYSTER (OPSANUS TAU)		3	13	2			
TOMCOD ATLANTIC (MICROGADUS TOMCOD)					2		5
TRUNKFISH (LACTOPHRYS TRIGONUS)							
WEAKFISH (CYNOSCION REGALIS)							
WINDOWPANE (SCOPHTHALMUS AQUOSUS)							

ASSESSMENT OF RECREATIONALLY IMPORTANT FINFISH STOCKS IN RHODE ISLAND WATERS

NARRAGANSETT BAY JUVENILE FINFISH SURVEY

Jason McNamee
Chief Marine Resource Management

Nichole Ares
Principal Marine Fisheries Biologist

R. I. Division of Fish & Wildlife
Marine Fisheries

Ft. Wetherill Marine Laboratory
3 Ft. Wetherill Road
Jamestown, Rhode Island 02835

2015

PERFORMANCE REPORT

STATE: Rhode Island

PROJECT NUMBER: F-61-R
SEGMENT NUMBER: 22

PROJECT TITLE: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters.

PERIOD COVERED: 1 January 2015 - 31 December 2015

JOB NUMBER AND TITLE: IV - Juvenile Marine Finfish Survey

JOB OBJECTIVE: To monitor the relative abundance and distribution of the juvenile life history stage of winter flounder (*Pseudopleuronectes americanus*), tautog (*Tautoga onitis*), bluefish (*Pomatomus saltatrix*), scup (*Stenotomus crysops*), weakfish (*Cynocion regalis*), black sea bass (*Centropristis striata*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), Atlantic menhaden (*Brevoortia tyrannus*), Atlantic herring (*Clupea harengus),* striped bass (*Morone saxatilis*), and other selected species of commercial and recreational importance in Narragansett Bay. To use these data to evaluate short and long term annual changes in juvenile population dynamics, to provide data for stock assessments, and for the development of Fishery Management Plans. To collect fish community data that is used to continue to identify, characterize, and map essential juvenile finfish habitat in Narragansett Bay.

SUMMARY: Eighteen fixed stations (Figure 1) around Narragansett Bay were sampled once a month from June through October 2015 with the standard 61 x 3.05 m beach seine. Adults and juveniles of approximately eighty species were collected during the 2015 survey. For comparison seventy-four species were collected in 2008, the highest number of species and families collected since the survey began until the 2015 season. For the entire survey time series (1988 – 2015), all individuals of the target species: winter flounder, tautog, bluefish, weakfish, black sea bass, scup, river herring, sea herring, and menhaden were enumerated and measured. With few exceptions (noted) all individuals of these species that were collected in the survey were juveniles. Adult and juveniles of other species collected were not differentiated for data analysis or descriptive purposes prior to 2009. Presence and relative abundance (few, many, abundant) of three forage species: Atlantic silversides (*Menidia menidia*), common mummichog (*Fundulus heteroclitus*) and striped killifish (*Fundulus majalis*) had been noted until 2009. Since 2009 all finfish species caught were enumerated and measured. Invertebrate species were noted and enumerated using the relative abundance scale as noted above. Data on weather, water temperature, salinity, and dissolved oxygen were recorded at each station.

TARGET DATE: December 2015

SIGNIFICANT DEVIATIONS: There were no significant deviations to methodology in 2015, however, a new vessel (22' Sisu) was purchased and used during the 2015 season. It is not anticipated that the vessel change will have an effect on the survey, but this will be confirmed in future years.

RECOMMENDATIONS: Continue standard seine survey at all eighteen stations. Continue to provide comments and recommendations to other resource management and regulatory agencies regarding potential anthropogenic impacts to fisheries resources and habitat. Continue to analyze and provide data for use in fisheries stock assessments. A reassessment and characterization of the habitat at each station should be undertaken to see if any major changes have occurred since the original evaluation. A power analysis of the data specifically for the target species should be undertaken to quantify the adequacy of the sampling protocol.

REMARKS: Abundance trends derived from adult data collected from the RIDFW seasonal trawl survey since 1979 indicate a declining abundance of demersal species and an increasing abundance for pelagic species in Rhode Island waters. It should be noted that the trawl survey samples both adult and juvenile fish and invertebrates. This trend has also been observed in other estuaries along the Atlantic coast. Reasons for these shifts are attributed to a number of factors but may not be limited to these factors. These include the effects of climate change, warming coastal waters, water quality, habitat degradation and loss, overexploitation of some species leading to niche replacement by other species, and trophic level changes and shifts associated with all of these factors. Anthropogenic affects and the synergy between factors have no doubt led to changes in fish communities along the coast (Kennish, 1992).

A non parametric Mann-Kendall test for trend significance can be used to show annual abundance trends for species collected during this juvenile survey. Two iterations of this test were run on a sample of different species. The first was to analyze the entire dataset and then a second iteration of this non parametric trend analysis was done using a shortened time period of 10 years. While no species have any significant long term trend in abundance, striped bass showed significant trends of decreasing abundance during the past 10 years. The other species such as juvenile bluefish, winter flounder, and tautog show no abundance trend for either the full dataset or the past ten years (Table 1a, b). The data in Table 1a all indicate trends or lack thereof for the entire survey data series going back to 1988.

Reductions and annual fluctuations in abundance of many species may be attributed to a number of factors outlined above. Any one or more of these factors and/or the synergy between them may be responsible for inhibiting populations of some species from returning to historic or in some cases sustainable levels. Continued monitoring of juvenile fish populations is necessary to document the abundance and distribution of important species as well as the interactions between species. Further, this data can be analyzed to evaluate the effectiveness of management actions, an example being a spawning closure enacted for tautog in 2006 and then lengthened in 2010. This spawning closure was in part supported by the data derived from this survey. Trends in abundance and shifts in fish community composition can also be evaluated with these data.

While the primary purpose for conducting this survey is to provide data for making informed fisheries management decisions, these data are also used when evaluating the adverse impacts of dredging and water dependent development projects.

METHODS, RESULTS & DISCUSSION: A 61m x 3.05m beach seine, deployed from a 22' boat, was used to sample the juvenile life stage of selected fish species in Narragansett Bay.

Monthly seine collections were completed at the eighteen standard survey stations (Figure 1) from June through October 2015.

Number of individuals and lengths were recorded for all finfish species. While both juveniles and adults were represented in the collections for many species, individuals collected for the target species were predominately young-of-the-year juveniles (YOY). Species and number of individuals (both juveniles and adults) of invertebrate species collected were also recorded with the use of a relative index of abundance (abundant, many, few). Tables 3 - 7 show the species occurrence and number caught at each station for June through October. Table 8 is a summary table for all stations and species collected during the 2015 survey. Tables 9-13 provide the number of fish/seine haul for each station along with the station mean, monthly mean, and annual abundance index for each target species. Figures 2 – 10 show the annual abundance index trends for a number of important species for both the original and standardized indices. It should be noted when interpreting these data, that the survey began in 1986 with fifteen stations. The data represented in the graphs begins in 1988 as the period of time when the survey began using consistent methodology with the 15 stations. Station 16 (Dyer Is.) was added in June 1990, station 17 (Warren R.) was added in July of 1993, and station 18 (Wickford) was added in July of 1995. The addition of the stations is standardized in the analysis, see appendix A.

Table 15 provides bottom temperature, salinity, and dissolved oxygen data for each station by month.

Winter flounder

Juvenile winter flounder (*Pseudopleuronectes americanus*) were present in forty-six percent of the seine hauls for 2015. This is a small increase from 2014 when they were present in forty-four percent of the hauls. A total of 394 fish were collected in 2015 (all fish would be considered young-of-the-year (YOY) according to Table 2 winter flounder maximum size by month). This was an increase from the 229 individuals collected during the 2014 survey. They were present at all but two stations (no presence at stations 10 and 14), and were collected in all months (Table 9).

The 2015 juvenile winter flounder standardized abundance index was 4.38 ± 2.26 S.E. fish/seine haul; this is greater than the 2014 index of 2.57 ±1.00 S.E. fish/seine haul. Figure 2 shows the standardized annual abundance indices since 1988. The Mann-Kendall test showed no significant abundance trend for this species for the full dataset, or in the last 10 years (Table 1a, b).

June had the highest mean monthly abundance of 10.78 ± 5.13 S.E. fish/seine haul. Chepiwonoxet Pt (Sta. 3) and Spectacle Island (Sta. 13) had the highest mean station abundance of 24.80 ± 16.48 and 15.60 ± 9.73 S.E. respectively. Overall upper and mid bay stations continue to have higher abundances than lower bay stations. This is expected since the primary spawning area for this species is believed to be in the Providence River followed by a secondary spawning area in Greenwich Bay where Station 3 is located. Wickford (Sta. 18), located in the lower bay, also has high numbers of juveniles. This station is located just outside Wickford Harbor, an area believed to be an important winter flounder spawning area.

Winter flounder length frequency data from the 2015 survey indicate that all the winter flounder collected were young-of-the-year (YOY). The maximum lengths by month for YOY winter flounder used for this report are supported by growth rates in Rhode Island waters as reported in the literature (Delong et al, 2001; Meng et al, 2000; Meng et al, 2001; Meng et al, 2008). See Table 2 for maximum YOY lengths by month.

Figure 2 shows the 2012 abundance index continues to be lower than most years since 2000, the survey high. The Division of Fish and Wildlife's trawl survey data (sampling both adults and juveniles) saw a small decrease in abundance from 2014 to 2015 during the spring seasonal survey, while the fall trawl survey saw a flat trend in abundance from 2014 to 2015. Over the course of the Narragansett Bay Juvenile Finfish Seine Survey the abundance index rose between 1995 and 2000, but then decreased with variability to 2015. The Mann-Kendall trend analysis shows no trend in the abundance of juvenile winter flounder in Narragansett Bay over the entire time series, and the declining trend indicated for the shortened 10 year time series in the terminal year of 2012 has dissipated in 2015, now showing no trend as we move away from the peak years of the early 2000's. The dramatic abundance fluctuations over the past ten years shown in Figure 2 and the declining trend over the last decade continue to be a concern to resource managers.

Tautog

During the 2015 survey 521 juvenile tautog (*Tautoga onitis*) were collected. This is an increase from the 2014 survey when 319 juveniles were collected. The 2015 abundance index was 5.78 ± 2.26 S.E. fish/seine haul, an increase from the 2014 index 3.63 ± 1.49 S.E. (Figure 3). Based on this survey data, it can be may be inferred that the spawning closure enacted in 2006 and then extended through 2015 may be having a significant impact on the number of juveniles produced during the spring as an increasing trend appears to be occurring. We will continue to monitor this species closely in the coming years.

Juvenile tautog were collected in fifty-four percent of the seine hauls in 2015 (Table 10). This is a slight increase from 2014 when they were present in forty-three percent of the seine hauls. August had the highest mean monthly abundance of 14.11 ± 4.65 fish per seine haul, which corresponds to the majority of the survey time series data which indicates August as being the month with the highest abundance. Patience Island (Sta. 5) had the highest mean station abundance of 29.40 ± 11.82 S.E. followed by Dyer Island (Sta. 16) with a mean station abundance of 13.00 ± 7.64 S.E. fish/seine haul. The Mann-Kendall test showed no long-term or short term abundance trend for juvenile tautog (Table 1a, b). It should be noted that this survey data was used as a young of the year index for the benchmark stock assessment for tautog by the Atlantic States Marine Fisheries Commission.

Our Narragansett Bay spring trawl survey had a flat abundance trend for tautog from 2014 to 2015, while the fall trawl survey saw a slight decrease. There would be a lag in time between when juveniles are caught in the seine survey and when the cohort shows up in the trawl survey, but the trends are worth monitoring.

Bluefish

During the 2015 survey six-hundred seventy-one juvenile bluefish (*Pomatomus saltatrix*) were collected. This is lower than the 1,246 juveniles collected in 2014. Juveniles were present in thirty-three percent of the seine hauls and were collected at seventeen of the eighteen stations (Table 11). They were present in all months, with the higher abundances occurring in August and September. It should be noted that since this survey began only one hundred forty one juvenile bluefish have been collected in October, in seven different years (1990, 1997, 1999, 2005, 2011, 2012, and 2015), and only when water temperatures were 16 – 21° C.

The abundance index for 2015 was 7.46 ± 4.73 S.E. fish/seine haul. This is lower than the 2014 abundance index of 14.597 ± 6.24 S.E fish/seine haul (Figure 4). The Mann-Kendall test showed no long-term or 10 year abundance trend for this species (Table 1a, b).

August had the highest mean monthly abundance of 21.50 ± 17.06 S.E. fish/seine haul (Table 11). July and August are typically the months of highest juvenile abundance for this species. The only exception to this was in 2005 when September had the highest mean monthly abundance. This was probably due to the higher than normal water temperatures during September 2005.

In 2015, Wickford (Sta. 18) had the highest mean station abundance of 64.00± 61.04 S.E. fish/seine haul (Table 11). This was due to a single high catch of bluefish at this station in August.

Length frequency data for 2015 indicates that all juveniles collected were young-of-the-year individuals.

The spatial distribution and abundance of juvenile bluefish in Narragansett Bay is highly variable and is dependent on a number of factors: natural mortality, fishing mortality, size of offshore spawning stocks, spawning success, number of cohorts, success of juvenile immigration into the estuaries, and the availability of appropriate size prey species like Atlantic silversides (*Menidia menidia*) when juveniles enter the bay. The annual abundance indices since 1988 show dramatic fluctuations supporting a synergy of these factors affecting recruitment of this species to Narragansett Bay (Figure 4).

<u>Striped Bass</u>

During the 2015 survey 12 striped bass (*Morone saxatalis*) were collected. This is higher than the 7 fish collected in 2014. Striped bass were present in four percent of the seine hauls and were collected at four of the eighteen stations (Table 14). They were present in June and August.

The abundance index for 2014 was 0.133 ± 0.08 S.E. fish/seine haul. This is higher than in 2014, which had an abundance index of 0.080 ± 0.06 S.E fish/seine haul (Figure 8). The Mann-Kendall test showed no abundance trend for this species for the entire dataset, but indicated a decreasing trend for the truncated 10 year dataset (Table 1a, b).

June had the highest mean monthly abundance of 0.61 ± 0.33 S.E. fish/seine haul (Table 14). September and October are usually the months with the highest abundance for the entire time series.

In 2015, Rose Island (Sta. 10) and Third Beach (Sta. 15) had the highest mean station abundance at 0.80 ± 0.80 S.E. (Table 14). The station with the highest abundance each year is variable, though it does tend to be the lower bay stations in general for the entire time series.

Length frequency data for 2015 indicates that a mix of juveniles and adults were collected. This is normal for the seine survey. The spatial distribution and abundance of striped bass in Narragansett Bay is highly variable and is most likely highly dependent on the availability of appropriate size prey species like Atlantic silversides (*Menidia menidia*) and juvenile menhaden (*Brevoortia tyrannus*) when fish enter the bay. The annual abundance indices since 1988 show fluctuations in abundance from year to year (Figure 8), but generally appears to have had an increasing trend during the late 90s to early 2000s, but now appears to be on a downward trajectory since 2008. The standardized index, which accounts for some of these factors, follows a similar trend year to year as the straight catch per unit effort (CPUE) index.

<u>Clupeidae</u>

Four species of clupeids are routinely collected during the survey. Alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), collectively referred to as river herring, and Atlantic menhaden (*Brevoortia tyrannus*) are most common. Atlantic herring (*Clupea harengus*) have also been collected during the surveys time series but in very small numbers.

<u>*River Herring*</u>

Due to the large numbers of anadromous herring collected, and the difficulty of separating juvenile alewives from juvenile blueback herring without sacrificing them, both species are combined under the single category of river herring. Data collected from this survey and the Division's Anadromous Fish Restoration Project show alewives to be the predominate river herring species collected, although both species are present and have been stocked as part of the Division's restoration efforts.

River herring were present in eighteen percent of the seine hauls and were collected at thirteen of the eighteen stations during 2015. River herring were present in June, July, August, and September in 2015. A total of 5,865 juveniles were collected in 2015, a significant increase from the number collected in 2014 (440 fish).

The highest mean monthly abundance for 2015 occurred during July and was 324.56 ± 245.56 S.E. fish/seine haul. Conimicut Point (Sta. 2) and Kickimuit River (Sta. 11) had the highest mean station abundance of 849.80 ± 849.80 S.E. and 302.80 ± 302.80, respectively (Table 13). Both of these stations experienced a single high catch in July 2015. Single large catches of these species are due to their schooling behavior and is the reason for the high standard error associated with the indices.

The standardized abundance index for 2015 was 65.17± 49.35 S.E. fish/seine haul (Figure 5). The annual abundance indices since 1988 show dramatic fluctuations as is a common occurrence with schooling clupeid species. In 2014, a decreasing trend in abundance was supposed by the 10 year Mann-Kendall test, this trend has dissipated in 2015 now showing no trend (Table 1b) additionally, the Mann-Kendall test showed no long-term abundance trend for river herring

(Table 1a).

Figure 6 shows the estimated spawning stock size of river herring as monitored by our Anadromous Fish Restoration Program at two fishways in Rhode Island. There may be some correlation between increasing numbers of returning adult fish (Figure 6) and the abundance index generated by this survey (Figure 5) as the recent small increases in juvenile abundance in the data corresponds to an increase in returning adults, and vise versa. Due to an extended period of low abundance of river herring in Rhode Island, the taking of either species of river herring is currently prohibited in all state waters.

Menhaden

Seven-thousand, three hundred fifty-six Atlantic menhaden (*Brevoortia tyrannus*) were collected during the 2015 survey, a large increase from 2014. They were present in thirty-seven percent of the seine hauls and were collected at sixteen of the eighteen stations (Table 12). The 2015 abundance is the highest in recent years; the last high abundance was 2007, when eight thousand two hundred fifty three juveniles were collected.

The highest mean monthly abundance for 2015 occurred during September and was 206.39 ± 195.74 S.E. fish/seine haul. Gaspee Pt. (Sta. 1) had the highest mean station abundance of 725.80 ± 701.78 S.E. (Table 13). Single large catches of these species are due to their schooling behavior and is the reason for the high standard error associated with the indices.

The standardized abundance index for 2015 was 81.73 ± 62.80 S.E. fish/seine haul. This is higher than recent years but lower than 2007 (Figure 7). The standardized index indicates an increased abundance during the 2000s. In the most recent years a decreasing abundance is evident. Our Narragansett Bay spring trawl survey had a no changes in the abundance of menhaden form 2014 to 2015, while the fall trawl survey showed a decrease. The trawl survey catches juveniles as well as some age one fish. The Mann-Kendall test showed no long-term or short-term abundance trend for this species (Table 1a, b).

Similar to river herring, juvenile menhaden were also observed in very large schools around Narragansett Bay and as discussed earlier, this behavior often results in single large catches resulting in a high abundance index and large standard error. This schooling behavior also contributes to the variability of their spatial and temporal abundance from year to year. Because of these characteristics it is difficult to develop an abundance index that will accurately reflect the number of juveniles actually observed in the field rather than the number represented in the samples. The standardization techniques used for analysis this year are an effort to take in to account this variability and high percentage of zero catches through the use of a delta lognormal model.

Weakfish

Twenty-five weakfish, *Cynocion regalis,* was collected during the 2015 survey. Station 3 in Greenwich Bay and Station 4 at the mouth of the Potowomut River, immediately south of Greenwich Bay, are the stations where this species is collected most frequently. Station 3, Chepiwanoxet is where the highest abundance was collected in 2015.

The abundance trend over the past several years indicate the juvenile population of this species in Narragansett Bay fluctuates dramatically, a trend also reflected in our trawl survey. The abundance index for 2015 was 0.278 ± 0.216 S.E fish/seine haul. This was higher than the 2014 index of 0.010 ± 0.010 (Figure 9). Possible reasons for this high variability in abundance, other than fishing pressure, may be environmental and anthropogenic factors that affect spawning and nursery habitat. Survival rate at each life history stage may also be influenced by these factors. The literature indicates this species spawns in calm coves within the estuary and juveniles move up the estuary to nursery areas of lower salinity. These are the same areas of the bay where anthropogenic impacts are high, often resulting in hypoxic and/or anoxic events that may increase mortality of the early life history stages of this species.

With the limited and sporadic juvenile data generated by this survey a juvenile population trend analysis is difficult. A nominal index was developed, but due to the sparse nature of the data, the index generated should be viewed with caution.

<u>Black Sea Bass</u>
Seven hundred eighty-three juvenile black sea bass (*Centropristis striata*) were collected in 2015 compared to three hundred and eight collected during the 2012 survey, the last time a high recruitment event occurred in Narragansett Bay. The number of black sea bass has been highly variable from year to year during the time series of this survey, but the 2012 and 2015 numbers stand out as unique. Black sea bass were caught in twenty-eight percent of the seine hauls in 2015.

The highest mean monthly abundance for 2015 occurred during August and was 28.28± 15.88 S.E. fish/seine haul. Conimicut Pt. (Sta. 2) had the highest mean station abundance of 59.60 ± 59.35 S.E. (Table 13), this is due to a single high landing event in August at Conimicut Point of 297 black sea bass. Rose Island (Sta. 10) which had the highest mean station abundance (2.40 ± 1.50 S.E.) in 2014 did not catch a single black sea bass in 2015.

The abundance index for 2015 was 8.70 ± 3.70 S.E. fish/seine haul. This was higher than the 2014 index of 0.298 ± 0.213 S.E (Figure 10). Our Narragansett Bay spring survey had a small decrease in the abundance of black sea bass from 2014 to 2015, however, the abundance was still much greater than it has been since the survey began in 1979. The fall index dropped down from the high values in 2012 and 2013. This recruitment signal in recent years was seen not only in RI waters, but all along the Atlantic coast.

Both the trawl survey and the coastal pond survey seem to be better indicators for local abundances of black sea bass. The Narragansett Bay seine survey does not catch them in any consistent manner leading one to believe that they may be using deeper water and or the coastal ponds as their preferred nursery areas. There are no indications that there are any problems with the local abundance of black sea bass, information that is also corroborated by the coastwide stock assessment for black sea bass, which indicates no overfishing and a rebuilt stock.

<u>Other important species</u>
Juveniles of other commercial or recreationally important species were also collected during the 2015 survey. These juveniles included scup (*Stenotomus chrysops*), Northern kingfish

(*Menticirrhus saxatilis*), and windowpane flounder (*Scophthalmus aquosus*).

Five-hundred seventy-eight juvenile scup were collected in 2015 during July, August, and September. Seven-hundred nineteen Northern kingfish were collected in 2015 with the majority (75%) collected in August. Two windowpane flounder were collected in 2015. Five summer flounder were collected in 2015 in July and September. Three smallmouth flounder were caught in 2015. Relative to the sixty-eight smallmouth flounder that were caught in 2011, and the thirty-three that were caught in 2010, this is a decrease in abundance for 2015. This species will have to be monitored in future years to see if, due to changing habitat conditions or possible vacant niches, it is increasing its residency in the Bay. See Tables 3-8 for additional survey data on these species.

Physical & Chemical Data

Previous to 2010 a YSI 85 was used to collect water temperature, salinity and dissolved oxygen data from the bottom water at all stations on each sampling date. This meter was upgraded in 2010 to a YSI Professional Plus Multiparameter instrument 6050000. The instrument collects the same suite of information as the YSI 85, but is an improved meter with better functionality. The water quality data collected are shown in Table 15. An important note is that the YSI failed towards the end of 2014. Data from water quality data buoys in close proximity to station locations was used to fill in temperature and salinity data once the meter failed, and is represented in the table. A new YSI was purchased and used for the 2015 field season.

Water temperatures during the 2015 survey ranged from a low of 11.0°C at Conimicut Point (Sta. 2) in October to a high of 27.8°C at Chepiwonoxet Pt (Sta. 3) in August.

Salinities ranged from 21.1 *ppt* at Conimicut Pt. (Sta. 2) in June to 29.5 *ppt* at Dutch Island (Sta. 7) in October and Rose Island (Sta. 10) in September.

SUMMARY: In summary, data from the 2015 Juvenile Finfish Survey continue to show that a number of commercial and recreationally important species utilize Narragansett Bay as an important nursery area. Using the Mann Kendall test, winter flounder, tautog, river herring, menhaden, striped bass, and bluefish showed no long-term abundance trends. Striped bass showed a decreasing abundance trend when analyzed over the past 10 years. For some species abundance trends from this survey agree with those from our coastal pond survey and/or trawl survey, in some instances they do not. This outcome is probably influenced by the species specific use of habitat and looking at appropriate data lags between the juvenile life stages and the adult stages. Hopefully, juvenile survey abundance indices will be reflected later in the abundance of adults in the trawl survey, but this is not always the case.

Eighty species, both vertebrates and invertebrates, were collected in 2015. This is higher than, the survey mean for the past twenty-five years of sixty species. An initial audit of the earlier time series and information contained on the field logs was undertaken to determine if some of the species diversity was missing from the earlier time series. Some issues were resolved from this analysis, however there are still some unresolved issues contained in the historical field logs. These final issues will be addressed over the coming year.

During 2015 two tropical and subtropical species were collected during the survey. While tropical and subtropical species are collected during this survey every year, the number of species and individuals is dependent upon the course of the Gulf Stream, the number of streamers and warm core rings it generates, and the proximity of these features to southern New England.

The survival and recruitment of juvenile finfish to the Rhode Island fishery is controlled by many factors: over-fishing of adult stocks, spawning and nursery habitat degradation and loss, water quality changes, and ecosystem changes that effect fish community structure. Any one of these factors, or a combination of them, may adversely impact juvenile survival and/or recruitment in any given year.

An ongoing effort to increase populations of important species must embrace a comprehensive approach that takes into account the above factors, their synergy and the changing fish community in the Bay. A continued effort to identify and protect essential fish habitat (EFH) and improve water quality is essential to this effort. The Division through our permit review program does represent the interests of fish and habitat preservation and protection. As well, properly informed management decisions are tantamount to preserving spawning stock biomass in order to create and maintain sustainable populations. This survey's dataset is used to inform the statistical catch at age models for both a regional tautog assessment as well as the coastwide menhaden assessment. In addition to the direct usage of the data in fisheries models, the other information collected by the survey helps to identify ancillary information such as abundances of forage species and habitat parameters, all important information for making good informed management decisions. These activities will all continue to be an important component of this project.

References

DeLong. A.K., Collie, J.S., Meise, C.J., and Powell, J.C. 2001. Estimating growth and mortality of juvenile Winter Flounder, *Pseudopleuronectes americanus* with a length-based model. Canadian Journal of Fisheries and Aquatic Sciences. 58: 2233-2346.

Lo, N.C., Jacobson, L.D., and Squire, J.L. 1992. Indices of relative abundance from fish spotter data based on delta-lognormal models. Canadian Journal of Fisheries and Aquatic Sciences. 49: 2515-2526.

Meng, L., Taylor, D.L., Serbst, J., and Powell, J.C. 2008. Assessing habitat quality of Mount Hope Bay and Narragansett Bay using growth, RNA:DNA, and feeding habits of caged juvenile winter flounder (Pseudopleuronectes americanus Walbaum). Northeast Naturalist. 15(1): 35 – 56.

Meng, L., Powell, J.C., and Taplin, B. 2001. Using Winter Flounder growth rates to assess habitat quality across an anthropogenic gradient in Narragansett Bay, Rhode Island. Estuaries. 24:576-584.

Meng, L., Gray, C., Taplin, B., and Kupcha, E. 2000. Using Winter Flounder growth rates to assess habitat quality in Rhode Island's coastal lagoons. Marine Ecology Progress Series. 201:287-299.

Kennish, M.J. 1992. Ecology of Estuaries: Anthropogenic Effects. CRC Press. 495 pp.

Zuur, AF, Ieno, EN, Walker, NJ, Saveliev, AA, Smith, GM. 2009. Mixed effects models and extensions in ecology with R. Springer Science and Business Media. 596 pp.

FIGURES

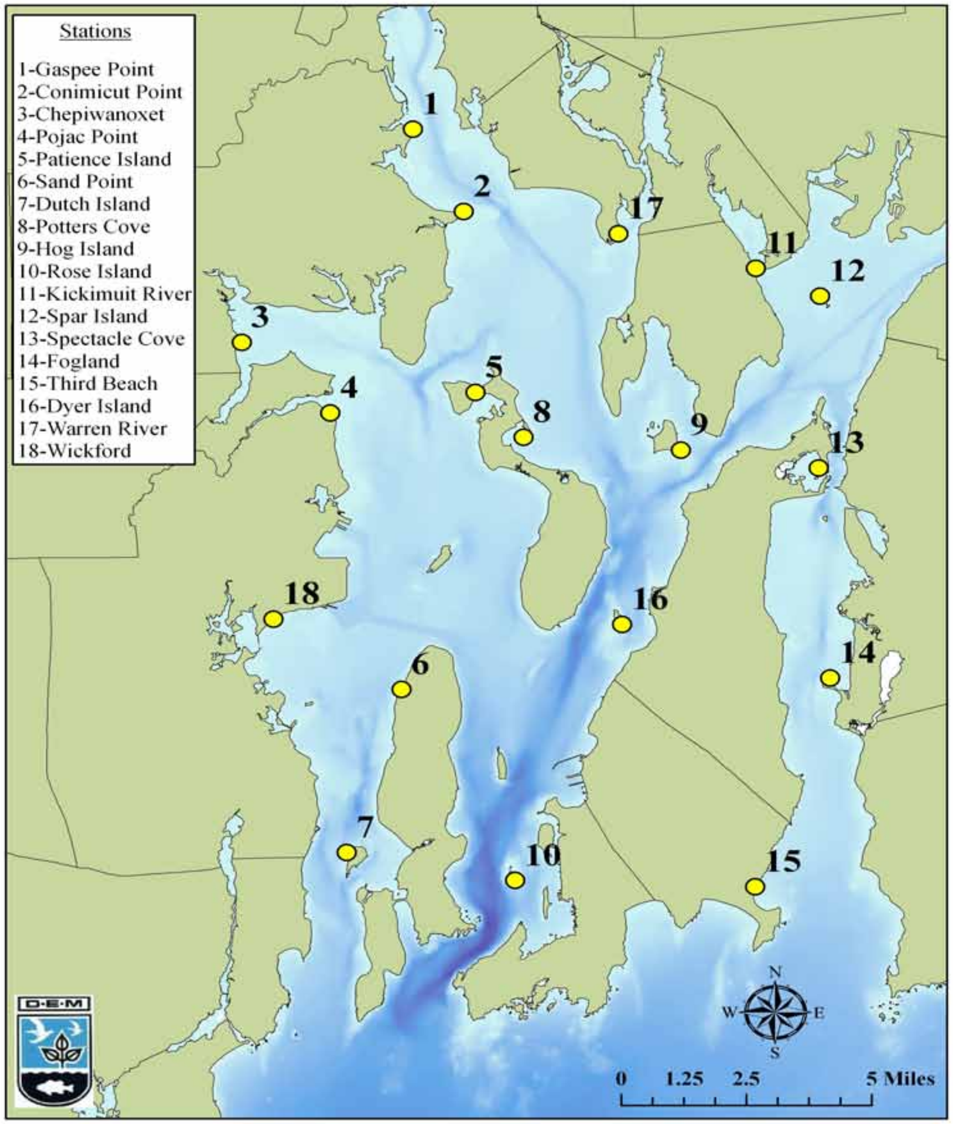


Figure 1. Survey station location map.

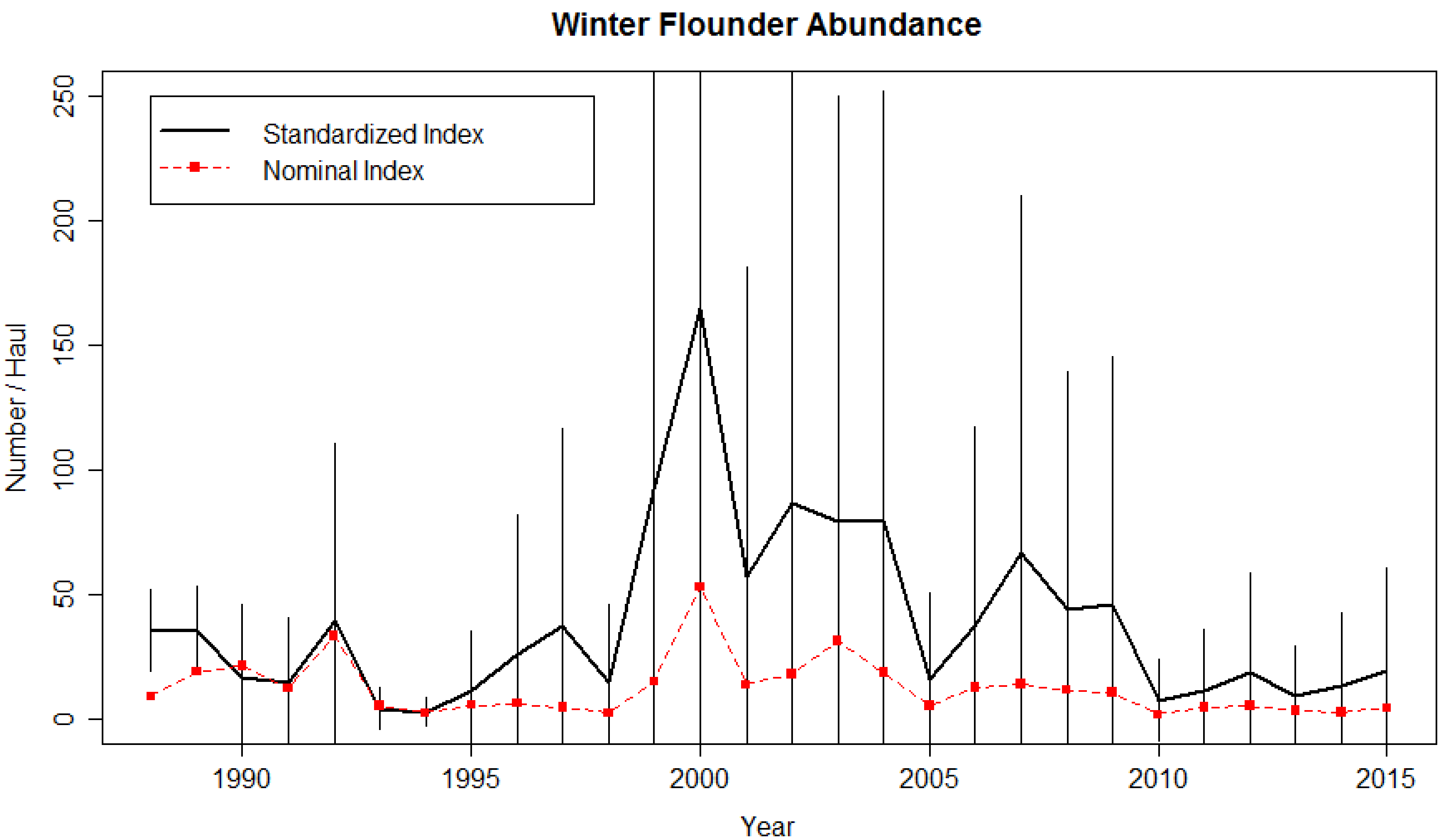


Figure 2. Juvenile winter flounder standardized abundance index 1988 – 2015 (see appendix A for standardization methodology).

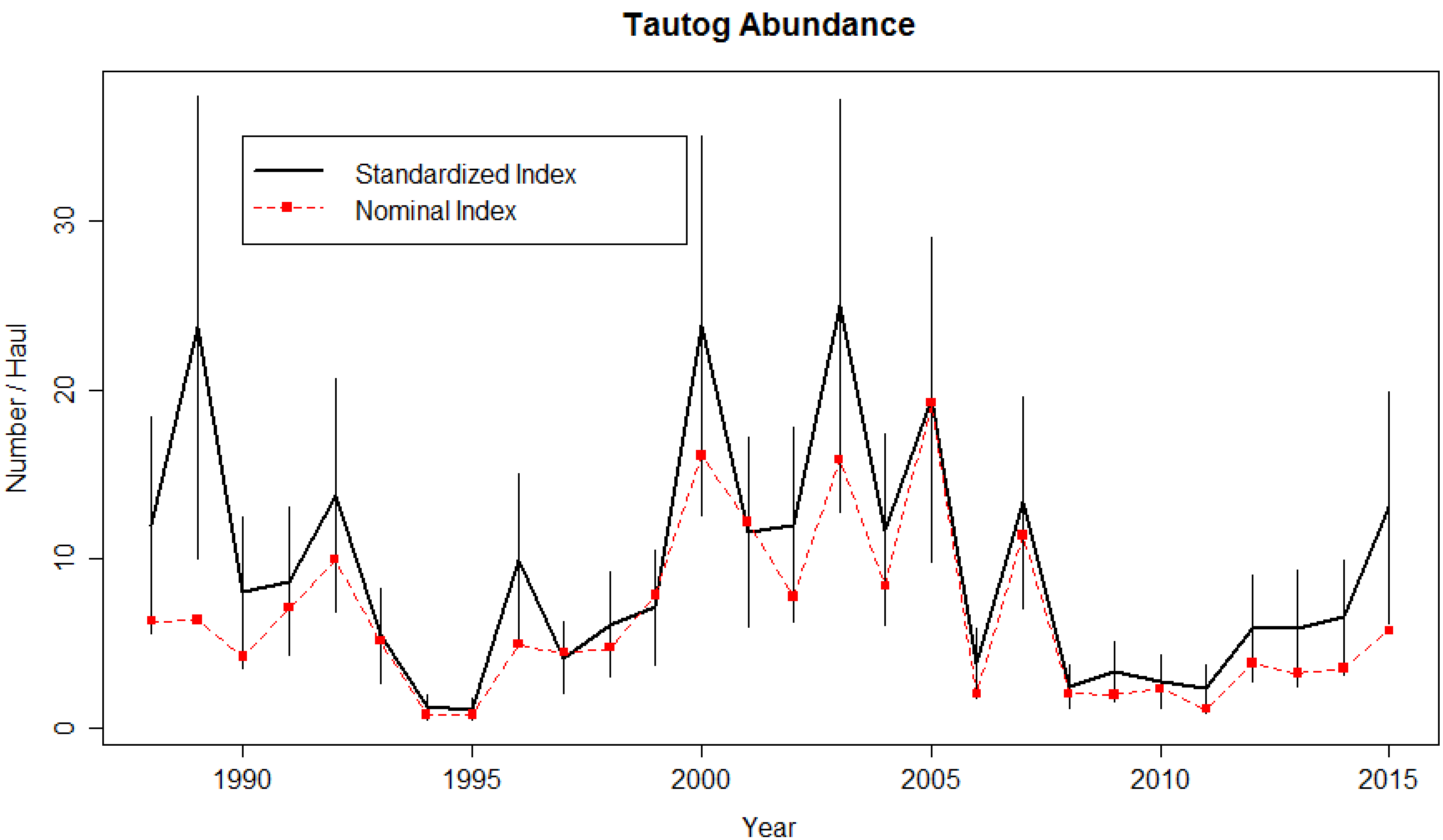


Figure 3. Juvenile tautog standardized annual abundance index 1988 – 2015 (see appendix A for standardization methodology).

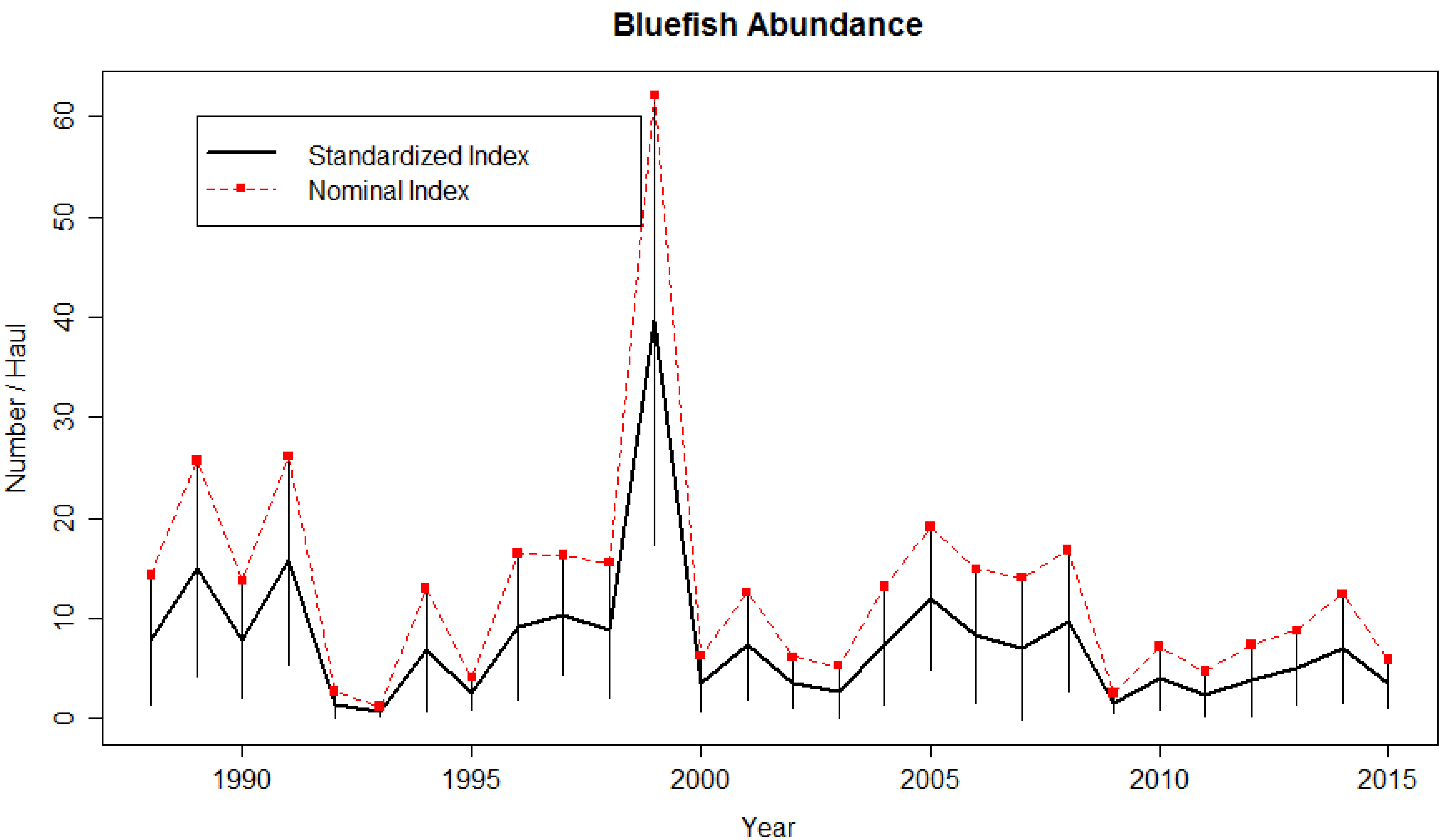


Figure 4. Juvenile bluefish standardized annual abundance index 1988 – 2015 (see appendix A for standardization methodology).

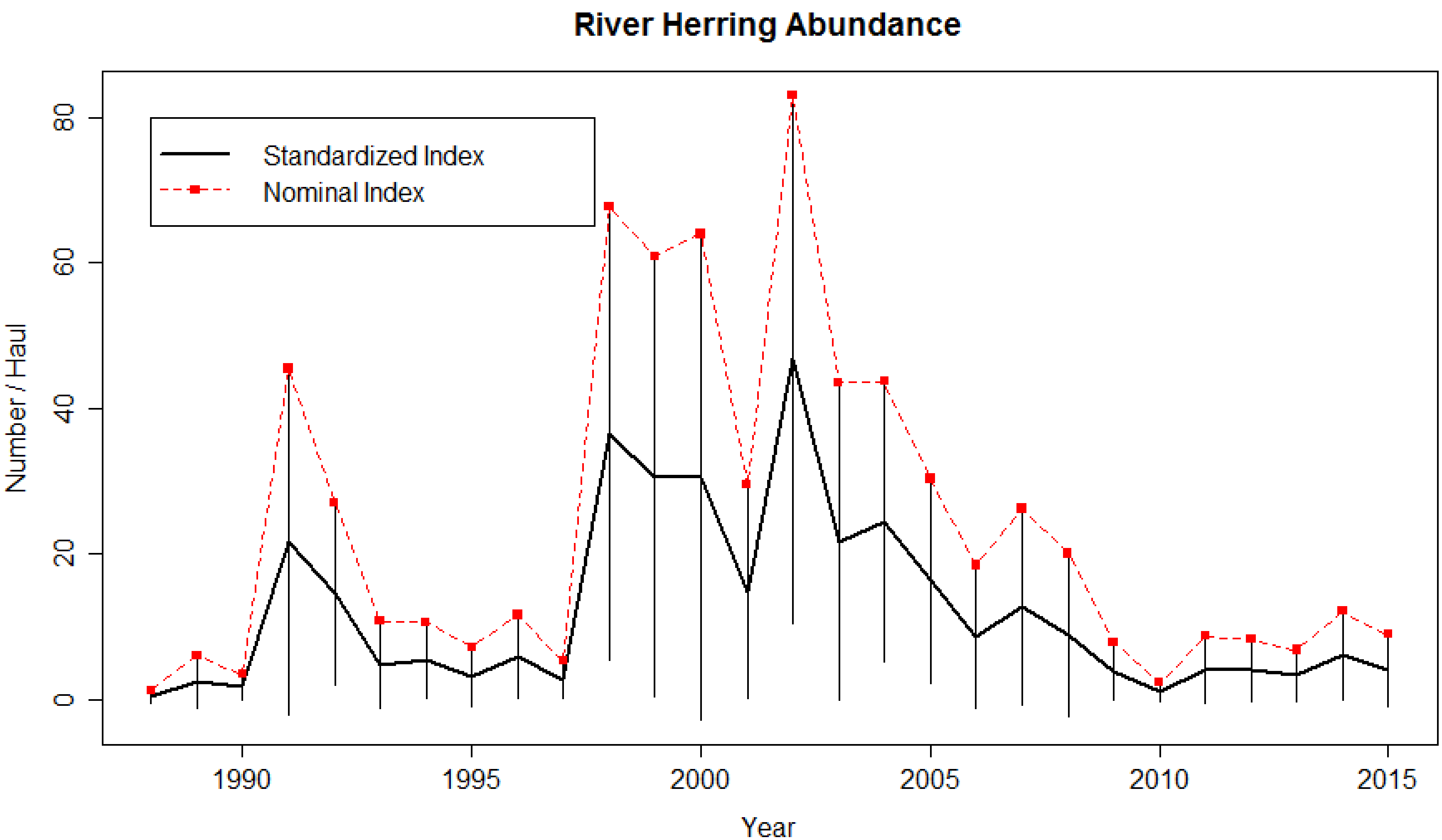
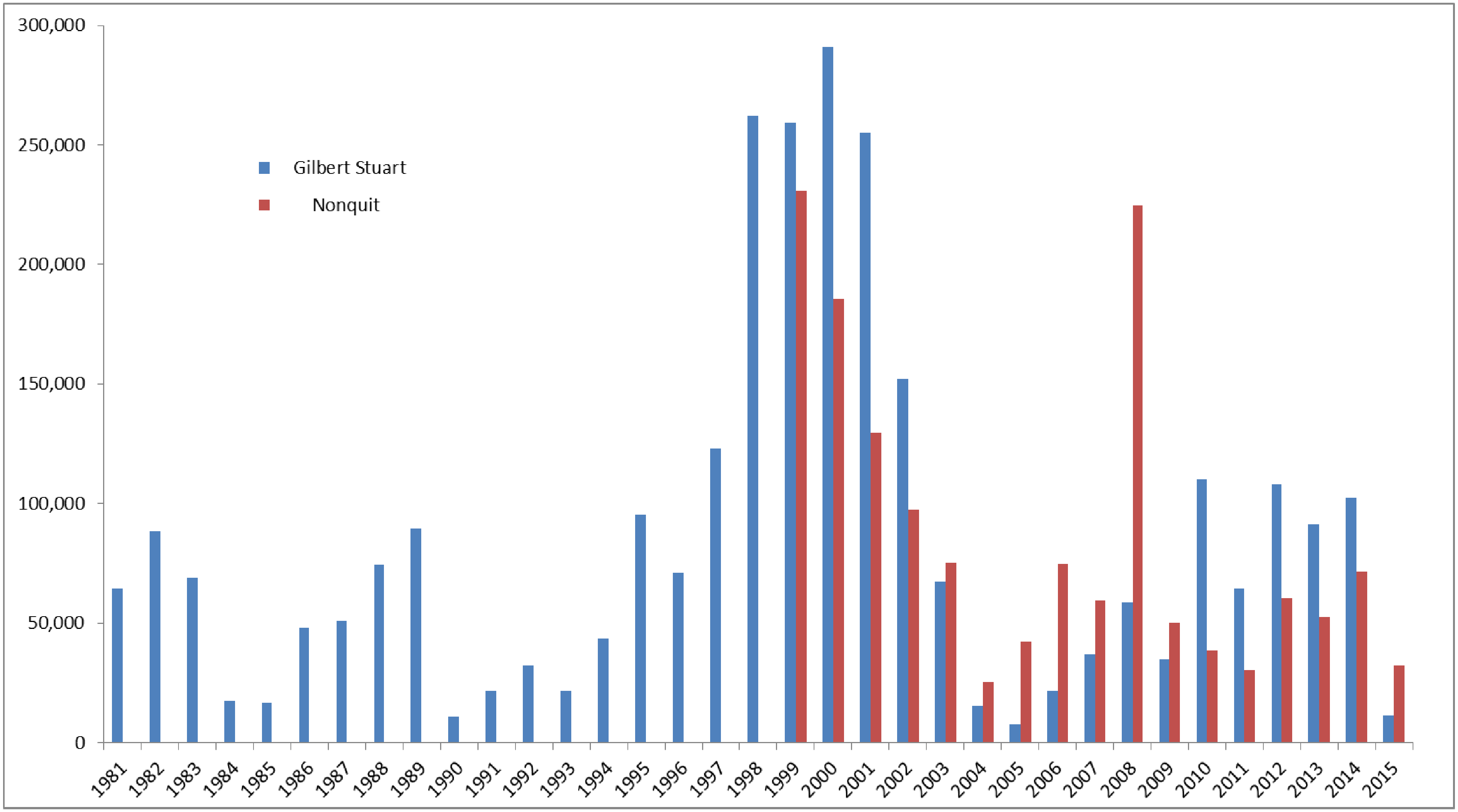


Figure 5. Juvenile river herring standardized annual abundance index 1988 – 2015 (see appendix A for standardization methodology).



Courtesy - Phil Edwards, RIF&W Anadromous Fish Restoration Program

Figure 6. River herring spawning stock size from monitoring at two locations 1999 – 2015.

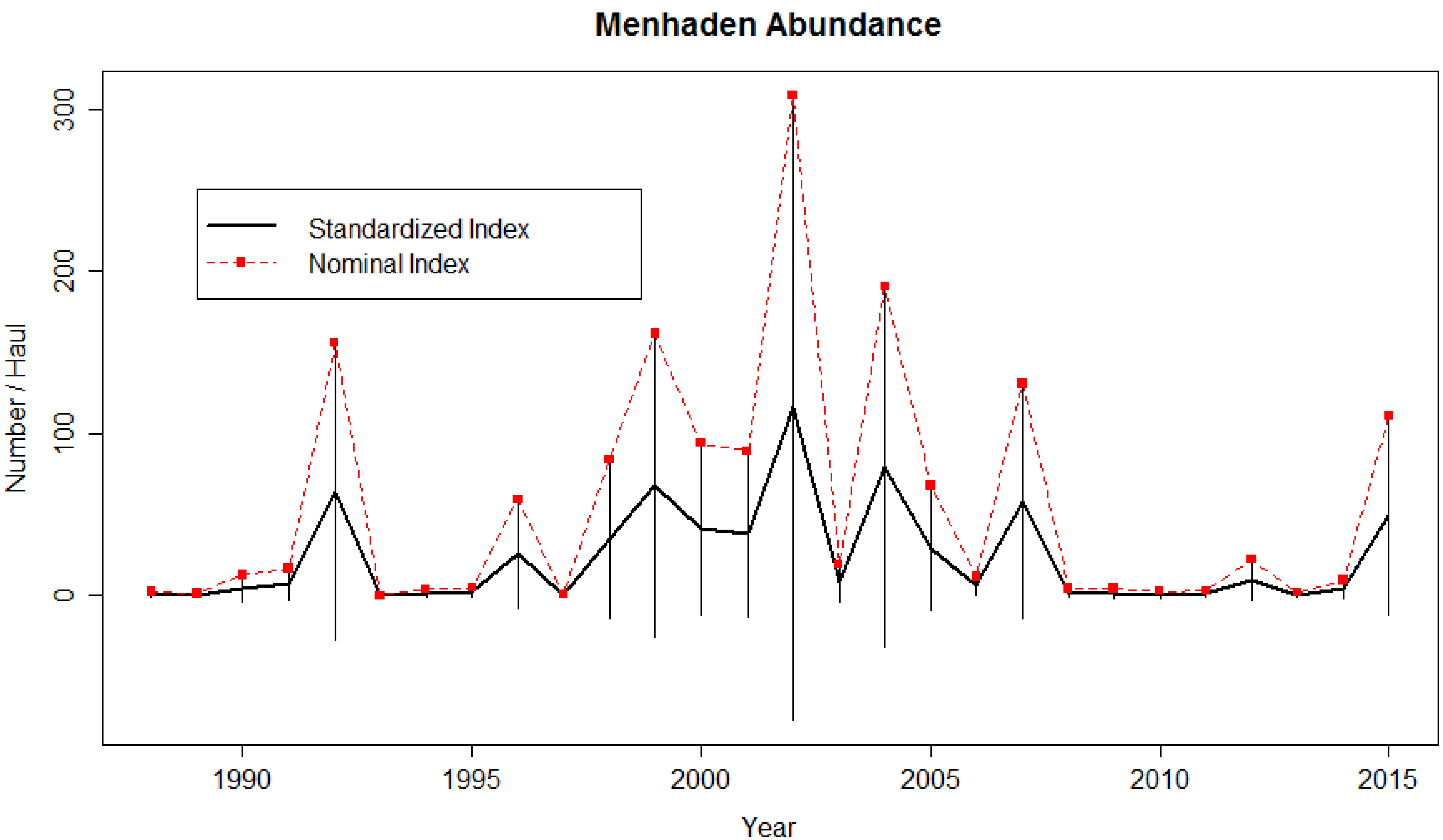


Figure 7. Juvenile menhaden standardized annual abundance index 1988 – 2015 (see appendix A for standardization methodology).

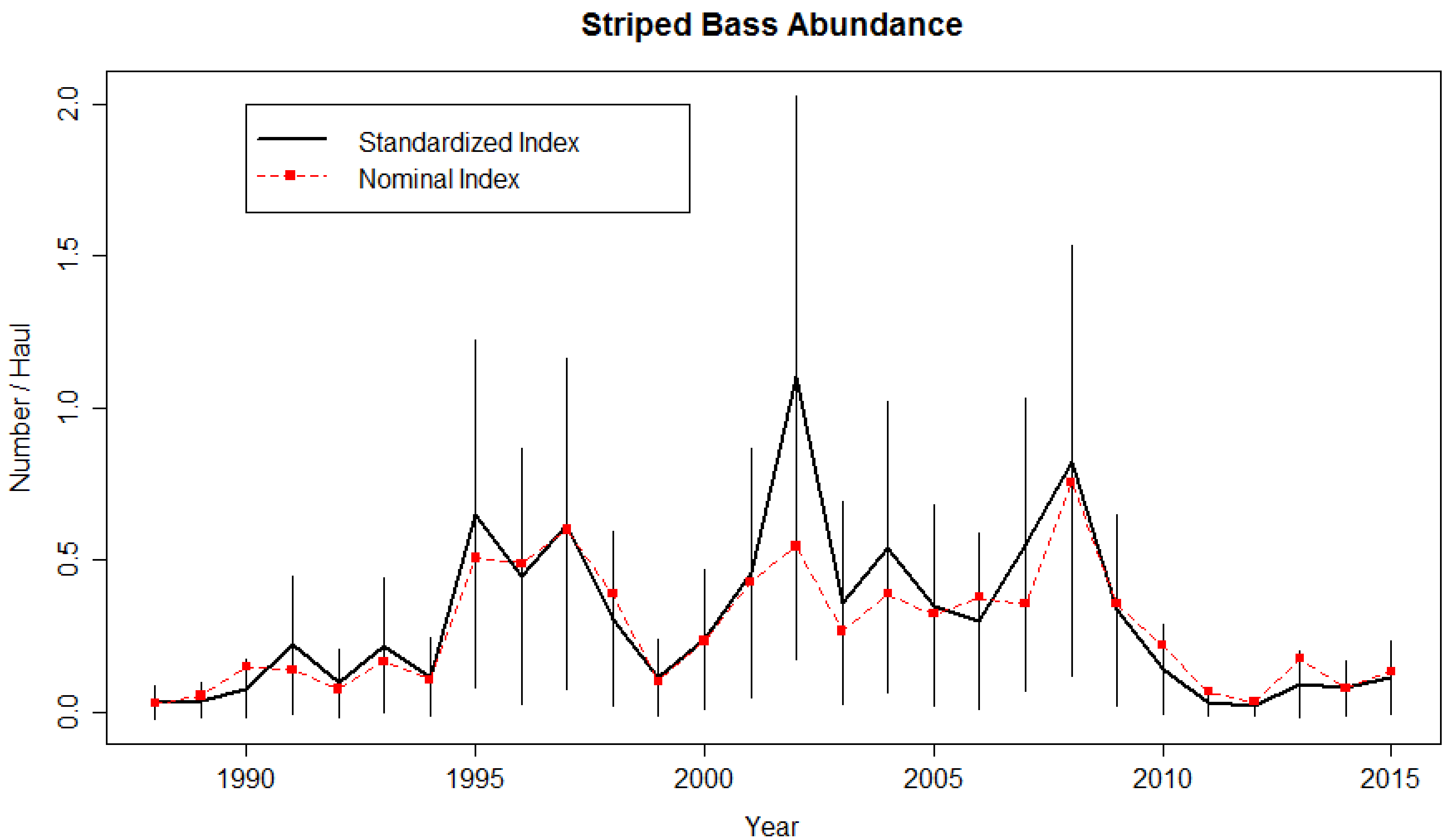


Figure 8. Striped bass standardized annual abundance index 1988 – 2015 (see appendix A for standardization methodology).

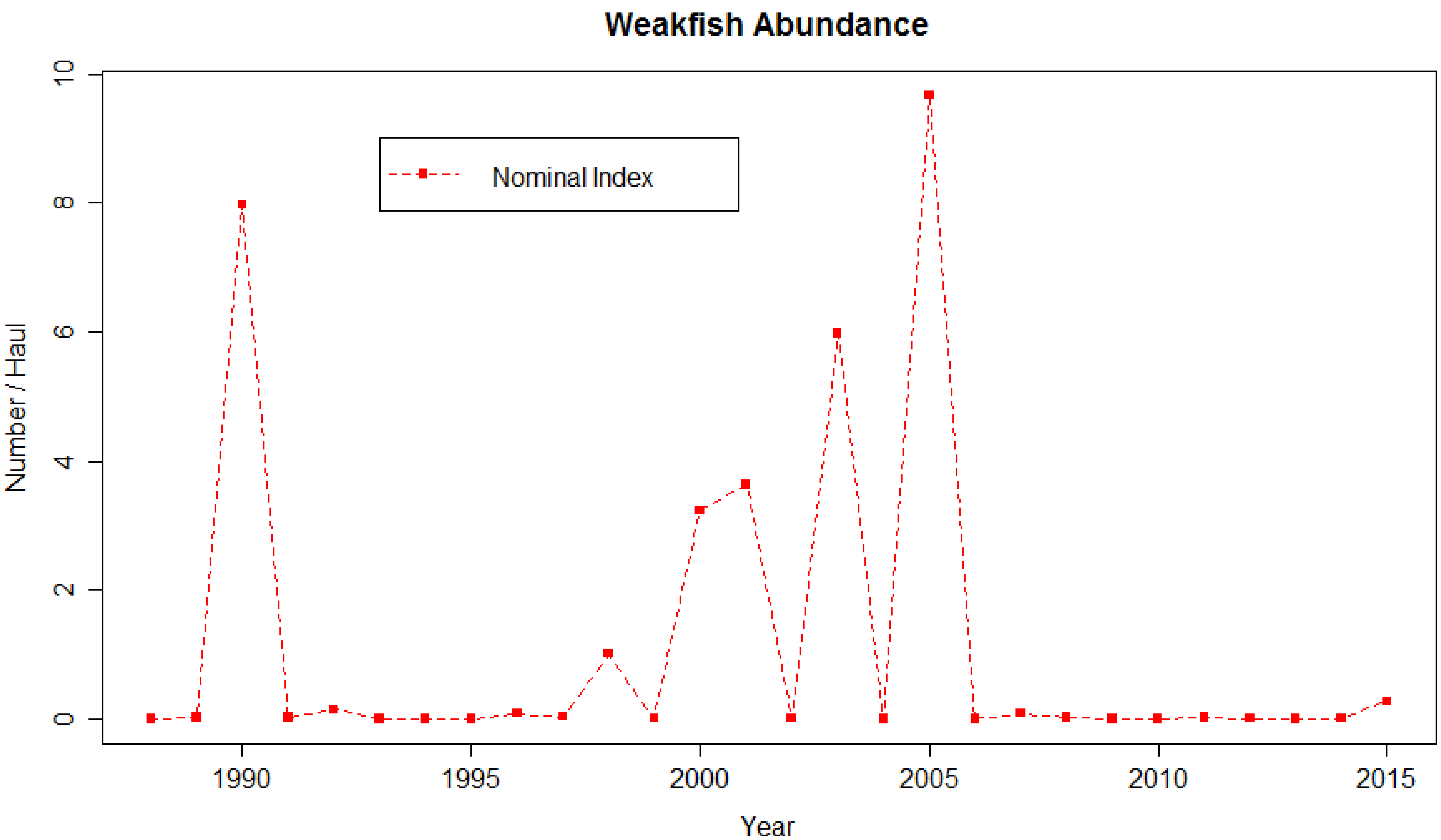


Figure 9. Weakfish annual abundance index 1988 – 2015.

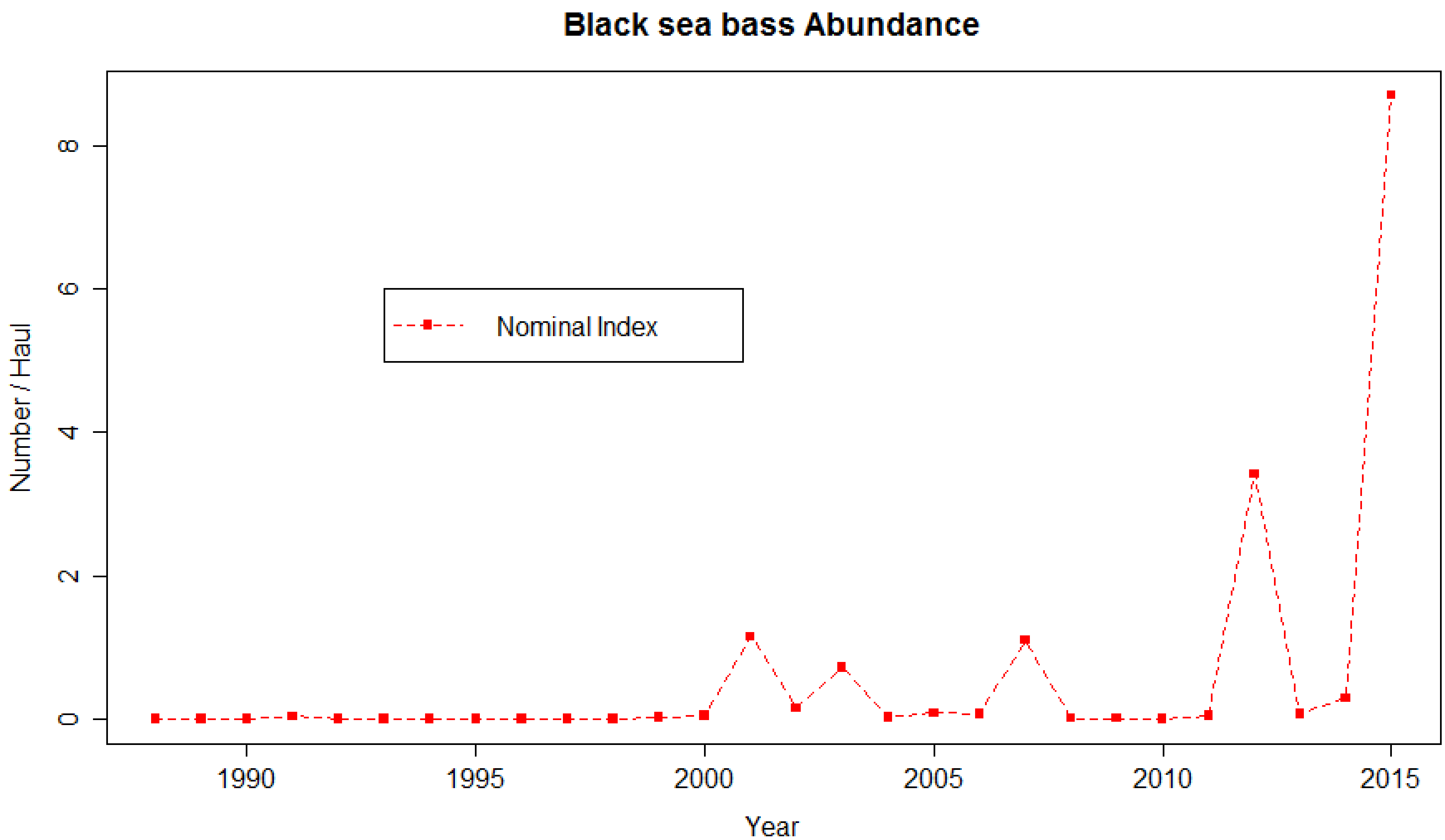


Figure 10. Black sea bass annual abundance index 1988 – 2015.

TABLES

Table 1a. Mann-Kendall test for target species abundance trend analysis (Full dataset; 1988 - 2015).

Mann-Kendall test	Winter Flounder	Tautog	Bluefish	River Herring	Menhaden	Striped Bass
S	-8	-38	-62	-6	22	14
n Observations	28	28	28	28	28	28
Variance	2562	2562	2562	2562	2562	2562
Tau	-0.0212	-0.101	-0.164	-0.156	0.058	0.037
2-sided p value	0.890	0.465	0.228	0.921	0.678	0.797
α	0.05	0.05	0.05	0.05	0.05	0.05
Significant Trend	No	No	No	No	No	No

Table 1b. Mann-Kendall test for target species abundance trend analysis (2004-2014).

Mann-Kendall test	Winter Flounder	Tautog	Bluefish	River Herring	Menhaden	Striped Bass
S	-13	13	-9	-15	-5	-21
n Observations	10	10	10	10	10	10
Variance	125	125	125	125	125	125
Tau	-0.289	0.289	-0.200	-0.333	-0.111	-0.467
2-sided p value	0.283	0.283	0.474	0.211	0.721	0.074
α	0.05	0.05	0.05	0.05	0.05	0.05
Significant Trend	No	No	No	No	No	Borderline↓

Table 2. Young-of-the-Year (YOY) winter flounder - maximum total length for each month.*

Month	July	August	September	October
Max. YOY length (TL)	100 mm	107 mm	109 mm	115 mm

* data provided by L. Buckley, National Marine Fisheries Service, Narragansett Laboratory, Narragansett, R.I.

Table 3. Species presence by station for June 2015.

	Station																	
Scientific Name	**1**	**2**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Grand Total**
Alosa aestivalis &/or pseudoharengus	1													1				**2**
Amphipoda order				1														**1**
Anchoa mitchilli		1				1												**2**
Anguilla rostrata						1												**1**
Apeltes quadracus										1								**1**
Busycotypus canaliculatus														1				**1**
Calinectes sapidus										1								**1**
Carcinus maenus		1		1			1	1		1		1	1		1			**8**
Clupea harengus					1		1			1	1					1	1	**6**
Clupeidae family										1								**1**
Crangon septemspinosa			1	1			1	1		1		1			1	1	1	**9**
Crepidula fornicata								1										**1**
Ctenophora phylum																	1	**1**
Emerita talpoida														1				**1**
Etropus microstomus														1				**1**
Fundulus heteroclitus	1	1	1	1				1		1		1						**7**
Fundulus majalis										1		1				1		**3**
Gasterosteus aculeatus	1									1								**2**
Gobiosoma bosc											1							**1**
Hemigrapsus sanguineus							1											**1**
Isopoda order									1				1	1				**3**
Libinia emarginata				1			1			1		1				1	1	**6**
Limulus polyphemus													1			1		**2**
Loligo pealei						1												**1**
Lunatia heros														1				**1**
Melanogrammus aeglefinus						1												**1**
Menidia menidia	1	1	1	1	1		1	1		1		1				1	1	**11**
Menticirrhus saxatilis										1								**1**
Microgadus tomcod		1		1		1		1			1	1	1		1			**8**
Morone saxatilis									1					1		1		**3**
Myoxocephalus aenaeus	1			1		1	1	1		1	1	1			1	1		**10**
Nassarius obsoletus		1	1	1	1			1		1	1	1						**8**
Ovalipes ocellatus										1								**1**
Pagurus spp		1	1	1	1		1	1	1	1							1	**9**
Palaemonetes vulgaris		1	1		1	1		1		1	1	1			1	1	1	**11**
Panopeus spp			1	1			1	1		1		1			1			**7**
Pollachius virens											1							**1**
Pomatomus saltatrix					1													**1**
Prionotus evolans														1			1	**2**
Pseudopleuronectes americanus	1	1	1	1	1		1	1		1	1	1				1	1	**12**
Scophthalmus aquosus														1				**1**
Syngnathus fuscus		1						1		1	1				1			**5**
Tautoga onitis						1			1		1				1			**4**
Tautogolabrus adspersus						1												**1**
Urophycis chuss						1												**1**
Urophycis regia				1		1		1			1			1	1			**6**
Urophycis tenuis				1		1												**2**
Grand Total	**6**	**10**	**8**	**14**	**7**	**12**	**10**	**14**	**4**	**20**	**11**	**12**	**4**	**10**	**9**	**10**	**9**	**170**

Table 4. Species presence by station for July 2015.

	Station																		
Scientific Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Grand Total**
Alosa aestivalis &/or pseudoharengus	1	1		1	1	1	1	1	1		1		1	1	1			1	**13**
Apeltes quadracus											1								**1**
Brevoortia tyrannus	1	1	1	1															**4**
Busycon carica												1							**1**
Calinectes sapidus	1		1																**2**
Carcinus maenus			1					1	1		1		1						**5**
Crangon septemspinosa			1	1					1				1		1			1	**6**
Crepidula fornicata														1					**1**
Cynoscion regalis			1	1															**2**
Cyprinodon variegatus														1		1			**2**
Fundulus heteroclitus	1		1		1			1	1		1		1	1			1		**9**
Fundulus majalis	1	1	1	1		1		1	1		1		1	1		1	1	1	**13**
Gasterosteus aculeatus	1		1																**2**
Hemigrapsus sanguineus												1		1					**2**
Isopoda order										1					1				**2**
Libinia emarginata	1		1	1	1			1	1		1						1	1	**9**
Limulus polyphemus		1																	**1**
Littorina littorea						1							1	1					**3**
Loligo pealei								1											**1**
Lucania parva	1		1																**2**
Menidia menidia	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	**17**
Menticirrhus saxatilis	1	1	1	1									1		1			1	**7**
Microgadus tomcod					1							1	1						**3**
Myoxocephalus aenaeus					1				1		1			1			1		**5**
Mytilus edulis										1									**1**
Nassarius obsoletus	1			1					1			1	1						**5**
Nassarius trivittatus							1					1							**2**
Ovalipes ocellatus			1	1											1			1	**4**
Pagurus spp	1		1			1		1	1	1	1	1	1					1	**10**
Palaemonetes vulgaris	1			1							1		1	1			1	1	**7**
Panopeus spp				1	1	1		1										1	**5**
Paralichthys dentatus	1																1	1	**3**
Pomatomus saltatrix	1	1	1	1															**4**
Prionotus evolans	1	1	1	1														1	**5**
Pseudopleuronectes americanus	1		1	1	1						1	1				1	1	1	**9**
Salpidae family									1							1			**2**
Scophthalmus aquosus									1										**1**
Sphoeroides maculatus				1		1		1	1			1			1		1		**7**
Sphyraena borealis													1	1					**2**
Stenotomus chrysops			1	1								1		1					**4**
Syngnathus fuscus					1				1				1						**3**
Synodus foetens				1														1	**2**
Tautoga onitis	1		1	1	1	1	1				1	1		1			1		**10**
Tautogolabrus adspersus				1	1		1												**3**
Grand Total	**18**	**8**	**19**	**20**	**11**	**8**	**5**	**10**	**14**	**3**	**12**	**11**	**14**	**13**	**7**	**5**	**10**	**14**	**202**

Table 5. Species presence by station for August 2015.

	Station																		
Scientific Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Grand Total**
Albula vulpes																		1	**1**
Alosa aestivalis &/or pseudoharengus																	1		**1**
Anchoa mitchilli										1									**1**
Brevoortia tyrannus	1	1	1	1	1	1	1	1		1			1	1	1	1	1	1	**15**
Busycotypus canaliculatus												1							**1**
Calinectes sapidus	1	1											1			1	1		**5**
Carcinus maenus								1	1			1		1		1	1		**6**
Centropristus striata	1	1		1	1	1			1			1	1		1		1	1	**11**
Clupea harengus		1	1																**2**
Crangon septemspinosa			1		1											1			**3**
Crepidula fornicata					1														**1**
Cynoscion regalis																		1	**1**
Fundulus heteroclitus	1	1	1	1	1	1		1	1		1		1	1		1	1	1	**14**
Fundulus majalis	1	1	1	1	1	1		1	1		1		1	1	1	1	1	1	**15**
Gobiosoma bosc									1										**1**
Isopoda order										1									**1**
Leiostomus xanthurus																		1	**1**
Libinia emarginata		1	1	1	1			1	1								1		**7**
Limulus polyphemus		1																1	**2**
Littorina littorea		1					1							1		1			**4**
Loligo pealei								1											**1**
Menidia menidia	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**17**
Menticirrhus saxatilis	1	1	1	1	1			1	1		1	1	1		1	1	1	1	**14**
Morone saxatilis					1														**1**
Mugil curema									1										**1**
Myoxocephalus aenaeus					1				1				1				1		**4**
Nassarius obsoletus	1			1							1		1				1		**5**
Opsanus tau									1										**1**
Ovalipes ocellatus		1	1												1		1		**4**
Pagurus spp	1	1	1	1			1	1	1	1		1		1	1	1	1		**13**
Palaemonetes vulgaris	1								1		1		1				1		**5**
Panopeus spp	1	1	1	1	1					1				1		1			**8**
Pomatomus saltatrix		1		1	1	1	1	1										1	**7**
Prionotus evolans	1	1	1	1		1			1							1	1	1	**9**
Pseudopleuronectes americanus		1	1	1		1	1		1				1		1		1	1	**10**
Salpidae family										1									**1**
Sphoeroides maculatus	1	1		1		1			1		1	1		1	1	1	1		**11**
Squilla empusa				1															**1**
Stenotomus chrysops	1	1	1	1	1		1		1						1		1	1	**10**
Strongylura marina													1						**1**
Syngnathus fuscus			1						1	1						1	1		**5**
Synodus foetens	1			1								1							**3**
Tautoga onitis	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	1	**16**
Tautogolabrus adspersus	1				1		1		1	1						1	1		**7**
Trachinotus falcatus															1				**1**
Urosalpinx cinerea								1											**1**
Grand Total	**17**	**20**	**15**	**18**	**16**	**10**	**9**	**11**	**20**	**10**	**7**	**9**	**13**	**10**	**12**	**16**	**22**	**15**	**250**

Table 6. Species presence by station for September 2015.

	Station																		
Scientific Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Grand Total**
Cliona celata												1							**1**
Alosa aestivalis &/or pseudoharengus							1							1	1				**3**
Anchoa mitchilli								1											**1**
Anguilla rostrata					1														**1**
Apeltes quadracus			1																**1**
Brevoortia tyrannus	1		1		1	1							1	1	1				**7**
Busycon carica												1							**1**
Calinectes sapidus				1															**1**
Carangidae family															1				**1**
Carcinus maenus		1		1	1	1		1	1				1	1					**8**
Centropristus striata	1	1			1			1	1		1	1	1	1				1	**10**
Crangon septemspinosa			1	1						1									**3**
Ctenophora phylum										1				1	1				**3**
Etropus microstomus																		1	**1**
Fundulus heteroclitus	1	1	1	1		1		1	1		1	1	1	1		1	1		**13**
Fundulus majalis	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	**17**
Gobiosoma bosc					1														**1**
Libinia emarginata		1		1					1								1		**4**
Limulus polyphemus																	1		**1**
Littorina littorea			1			1										1			**3**
Menidia menidia	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**17**
Menticirrhus saxatilis	1				1						1	1	1	1	1			1	**8**
Mercenaria mercenaria		1																	**1**
Mugil curema									1										**1**
Mya arenaria		1																	**1**
Myoxocephalus aenaeus					1				1										**2**
Myoxocephalus octodecemspinos										1									**1**
Nassarius obsoletus													1						**1**
Ovalipes ocellatus		1	1	1															**3**
Pagurus spp		1	1	1	1			1			1							1	**7**
Palaemonetes vulgaris			1						1		1		1						**4**
Panopeus spp			1	1	1	1		1	1		1		1				1		**9**
Paralichthys dentatus															1				**1**
Pomatomus saltatrix	1	1		1	1	1	1	1	1		1	1	1	1	1	1	1	1	**16**
Prionotus carolinus	1																		**1**
Prionotus evolans									1									1	**2**
Pseudopleuronectes americanus				1	1				1				1						**4**
Sphoeroides maculatus						1			1										**2**
Squilla empusa											1								**1**
Stenotomus chrysops							1		1		1		1	1	1			1	**7**
Syngnathus fuscus				1	1				1	1								1	**5**
Tautoga onitis		1		1	1	1	1		1	1		1	1	1		1	1		**12**
Tautogolabrus adspersus	1				1	1			1	1		1				1		1	**8**
Grand Total	**9**	**11**	**11**	**14**	**16**	**11**	**5**	**9**	**18**	**8**	**11**	**10**	**14**	**12**	**10**	**7**	**8**	**11**	**195**

Table 7. Species presence by station for October 2015.

	Station																		
Scientific Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Grand Total**
Brevoortia tyrannus	1	1		1	1			1	1								1		**7**
Busycon carica												1							**1**
Cancer irroratus																1	1		**2**
Carcinus maenus	1	1			1	1	1	1	1				1				1		**9**
Centropristus striata					1			1	1			1			1				**5**
Crangon septemspinosa					1							1							**2**
Crepidula fornicata									1								1		**2**
Ctenophora phylum						1	1		1	1		1	1		1			1	**8**
Cyanea capillata										1									**1**
Cynoscion regalis									1										**1**
Farfantepenaeus aztecus				1	1														**2**
Fundulus heteroclitus			1			1		1	1		1		1	1		1	1		**9**
Fundulus majalis	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	**17**
Gobiosoma bosc					1								1						**2**
Hemigrapsus sanguineus				1		1													**2**
Leucoraja erinacea															1				**1**
Libinia emarginata						1		1	1								1		**4**
Littorina littorea					1	1													**2**
Menidia menidia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**18**
Mya arenaria	1	1																	**2**
Myoxocephalus aenaeus									1										**1**
Nassarius obsoletus												1	1						**2**
Ovalipes ocellatus		1	1	1			1										1	1	**6**
Pagurus spp				1					1	1		1	1			1	1		**7**
Palaemonetes vulgaris	1	1	1		1										1				**5**
Panopeus spp					1	1				1						1			**4**
Pomatomus saltatrix									1								1		**2**
Pseudopleuronectes americanus	1			1	1		1								1	1			**6**
Syngnathus fuscus															1				**1**
Tautoga onitis	1	1			1				1	1		1		1	1				**8**
Tautogolabrus adspersus					1				1										**2**
Grand Total	**8**	**8**	**5**	**8**	**14**	**9**	**6**	**7**	**15**	**7**	**2**	**9**	**8**	**4**	**9**	**7**	**11**	**4**	**141**

Table 8. Summary of species occurrence by station in 2015.

	Station																		
Scientific Name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**Grand Total**
Cliona celata												1							**1**
Albula vulpes																		1	**1**
Alosa aestivalis &/or pseudoharengus	1	1		1	1	1	1	1	1		1		1	1	1		1	1	**14**
Amphipoda order					1														**1**
Anchoa mitchilli		1					1	1		1									**4**
Anguilla rostrata					1		1												**2**
Apeltes quadracus			1								1								**2**
Brevoortia tyrannus	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	**16**
Busycon carica												1							**1**
Busycotypus canaliculatus												1			1				**2**
Calinectes sapidus	1	1	1	1							1		1			1	1		**8**
Cancer irroratus																1	1		**2**
Carangidae family															1				**1**
Carcinus maenus	1	1	1	1	1	1	1	1	1		1	1	1	1		1	1		**15**
Centropristus striata	1	1		1	1	1		1	1		1	1	1	1	1		1	1	**14**
Clupea harengus		1	1			1		1			1	1					1	1	**8**
Clupeidae family											1								**1**
Crangon septemspinosa			1	1	1			1	1	1	1	1	1		1	1	1	1	**13**
Crepidula fornicata					1				1					1			1		**4**
Ctenophora phylum						1	1		1	1		1	1	1	1			1	**9**
Cyanea capillata										1									**1**
Cynoscion regalis			1	1					1									1	**4**
Cyprinodon variegatus														1		1			**2**
Emerita talpoida															1				**1**
Etropus microstomus															1			1	**2**
Farfantepenaeus aztecus				1	1														**2**
Fundulus heteroclitus	1	1	1	1	1	1		1	1		1	1	1	1		1	1	1	**15**
Fundulus majalis	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**18**
Gasterosteus aculeatus	1		1								1								**3**
Gobiosoma bosc					1				1			1	1						**4**
Hemigrapsus sanguineus				1		1		1				1		1					**5**
Isopoda order										1				1	1				**3**
Leiostomus xanthurus																		1	**1**
Leucoraja erinacea															1				**1**
Libinia emarginata	1	1	1	1	1	1		1	1		1		1				1	1	**12**
Limulus polyphemus		1												1			1	1	**4**
Littorina littorea		1	1		1	1	1						1	1		1			**8**
Loligo pealei							1	1											**2**
Lucania parva	1		1																**2**
Lunatia heros															1				**1**
Melanogrammus aeglefinus							1												**1**
Menidia menidia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**18**
Menticirrhus saxatilis	1	1	1	1	1			1	1		1	1	1	1	1	1	1	1	**15**
Mercenaria mercenaria		1																	**1**
Microgadus tomcod		1			1		1		1			1	1	1		1			**8**
Morone saxatilis					1					1					1		1		**4**
Mugil curema									1										**1**
Mya arenaria	1	1																	**2**
Myoxocephalus aenaeus	1				1		1	1	1		1	1	1	1		1	1		**11**
Myoxocephalus octodecemspinos										1									**1**
Mytilus edulis										1									**1**
Nassarius obsoletus	1	1		1	1	1			1		1	1	1				1		**10**
Nassarius trivittatus							1					1							**2**
Opsanus tau									1										**1**
Ovalipes ocellatus		1	1	1			1				1				1		1	1	**8**
Pagurus spp	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**18**
Palaemonetes vulgaris	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	**16**
Panopeus spp	1	1	1	1	1	1		1	1	1	1		1	1		1	1	1	**15**
Paralichthys dentatus	1														1		1	1	**4**
Pollachius virens												1							**1**
Pomatomus saltatrix	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	**17**
Prionotus carolinus	1																		**1**
Prionotus evolans	1	1	1	1		1			1						1	1	1	1	**10**
Pseudopleuronectes americanus	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1	1	**16**
Salpidae family									1	1						1			**3**
Scophthalmus aquosus									1						1				**2**
Sphoeroides maculatus	1	1		1		1		1	1		1	1		1	1	1	1		**12**
Sphyraena borealis													1	1					**2**
Squilla empusa				1							1								**2**
Stenotomus chrysops	1	1	1	1	1		1		1		1	1	1	1	1		1	1	**14**
Strongylura marina													1						**1**
Syngnathus fuscus		1	1	1	1				1	1	1	1	1		1	1	1	1	**13**
Synodus foetens	1			1								1						1	**4**
Tautoga onitis	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	**17**
Tautogolabrus adspersus	1			1	1	1	1		1	1		1				1	1	1	**11**
Trachinotus falcatus															1				**1**
Urophycis chuss							1												**1**
Urophycis regia					1		1		1			1			1	1			**6**
Urophycis tenuis					1		1												**2**
Urosalpinx cinerea								1											**1**
Grand Total	**28**	**29**	**25**	**29**	**31**	**22**	**25**	**21**	**33**	**17**	**27**	**30**	**27**	**25**	**30**	**25**	**31**	**29**	**484**

* The units are number of times present at each station (maximum would be 18 times present for a species at all stations for the year).

Table 9. Numbers of juvenile winter flounder per seine haul in 2015.

	Station																				
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	Mean	St Dev	SE
JUN	6	11	86	2	1	2	0	2	5	0	12	4	47	0	0	0	3	13	10.78	21.76	5.13
JUL	2	0	33	6	1	0	0	0	0	0	11	2	0	0	0	1	1	4	3.39	7.92	1.87
AUG	0	5	5	1	0	3	1	0	39	0	0	0	30	0	3	0	1	2	5.00	10.97	2.59
SEP	0	0	0	1	25	0	0	0	14	0	0	0	1	0	0	0	0	0	2.28	6.55	1.54
OCT	1	0	0	1	1	0	3	0	0	0	0	0	0	0	1	1	0	0	0.44	0.78	0.18
Mean	1.80	3.20	24.80	2.20	5.60	1.00	0.80	0.40	11.60	0.00	4.60	1.20	15.60	0.00	0.80	0.40	1.00	3.80			
St Dev	2.49	4.87	36.86	2.17	10.85	1.41	1.30	0.89	16.35	0.00	6.31	1.79	21.76	0.00	1.30	0.55	1.22	5.40		Total Fish	
SE	1.11	2.18	16.48	0.97	4.85	0.63	0.58	0.40	7.31	0.00	2.82	0.80	9.73	0.00	0.58	0.24	0.55	2.42		394	
Number	9	16	124	11	28	5	4	2	58	0	23	6	78	0	4	2	5	19			

Table 10. Numbers of juvenile tautog per seine haul in 2015.

	Station																				
Row Labels	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	Mean	St Dev	SE
JUN	0	0	0	0	0	0	24	0	0	2	0	6	0	0	0	2	0	0	1.89	5.72	1.35
JUL	2	0	6	1	12	3	0	0	0	0	5	1	0	8	0	0	4	0	2.33	3.45	0.81
AUG	7	56	2	9	69	11	16	0	1	4	0	1	16	4	1	35	15	7	14.11	19.72	4.65
SEP	0	1	0	1	29	27	2	0	16	7	0	11	7	5	0	28	1	0	7.50	10.43	2.46
OCT	2	1	0	0	37	0	0	0	4	2	0	6	0	3	1	0	0	0	3.11	8.63	2.03
Mean	2.20	11.60	1.60	2.20	29.40	8.20	8.40	0.00	4.20	3.00	1.00	5.00	4.60	4.00	0.40	13.00	4.00	1.40			
St Dev	2.86	24.83	2.61	3.83	26.43	11.43	10.99	0.00	6.80	2.65	2.24	4.18	7.06	2.92	0.55	17.09	6.36	3.13		Total Fish	
SE	1.28	11.10	1.17	1.71	11.82	5.11	4.92	0.00	3.04	1.18	1.00	1.87	3.16	1.30	0.24	7.64	2.85	1.40		521	
Number	11	58	8	11	147	41	42	0	21	15	5	25	23	20	2	65	20	7			

Table 11. Numbers of juvenile bluefish per seine haul in 2015.

	Station																				
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	Mean	St Dev	SE
JUN	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.24	0.06
JUL	13	27	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.67	6.88	1.62
AUG	0	46	0	2	9	2	2	18	0	0	0	0	0	0	0	0	0	308	21.50	72.39	17.06
SEP	17	1	0	2	2	5	12	6	87	0	17	11	1	1	15	10	33	12	12.89	20.37	4.80
OCT	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0.17	0.51	0.12
Mean	6.00	14.80	0.60	1.80	2.20	1.60	2.80	4.80	17.60	0.00	3.40	2.20	0.20	0.20	3.00	2.00	7.00	64.00			
St Dev	8.34	20.92	1.34	2.05	3.90	2.07	5.22	7.82	38.80	0.00	7.60	4.92	0.45	0.45	6.71	4.47	14.56	136.50		Total Fish	
SE	3.73	9.36	0.60	0.92	1.74	0.93	2.33	3.50	17.35	0.00	3.40	2.20	0.20	0.20	3.00	2.00	6.51	61.04		671	
Number	30	74	3	9	11	8	14	24	88	0	17	11	1	1	15	10	35	320			

Table 12. Numbers of juvenile menhaden per seine haul in 2015.

	Station																				
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	Mean	St Dev	SE
JUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
JUL	94	116	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.78	34.13	8.04
AUG	2	5	1906	74	145	43	4	105	0	32	0	0	7	9	763	3	3	319	190.00	467.00	110.07
SEP	3532	0	70	0	103	6	0	0	0	0	0	0	2	1	1	0	0	0	206.39	830.44	195.74
OCT	1	1	0	1	2	0	0	1	2	0	0	0	0	0	0	0	1	0	0.50	0.71	0.17
Mean	725.80	24.40	395.40	15.20	50.00	9.80	0.80	21.20	0.40	6.40	0.00	0.00	1.80	2.00	152.80	0.60	0.80	63.80			
St Dev	1569.23	51.25	844.99	32.87	69.17	18.74	1.79	46.85	0.89	14.31	0.00	0.00	3.03	3.94	341.11	1.34	1.30	142.66		Total Fish	
SE	701.78	22.92	377.89	14.70	30.93	8.38	0.80	20.95	0.40	6.40	0.00	0.00	1.36	1.76	152.55	0.60	0.58	63.80		7356	
Number	3629	122	1977	76	250	49	4	106	2	32	0	0	9	10	764	3	4	319			

Table 13. Numbers of juvenile river herring per seine haul in 2015.

	Station																				
Row Labels	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	Mean	St Dev	SE
JUN	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0.33	1.19	0.28
JUL	0	4249	0	0	9	9	1	11	27	0	1514	0	1	16	1	0	0	4	324.56	1041.81	245.56
AUG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.06	0.24	0.06
SEP	0	0	0	0	0	0	1	0	0	0	0	0	0	0	15	0	0	0	0.89	3.53	0.83
OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
Mean	0.20	849.80	0.00	0.00	1.80	1.80	0.40	2.20	5.40	0.00	302.80	0.00	0.20	3.20	4.20	0.00	0.20	0.80			
St Dev	0.45	1900.21	0.00	0.00	4.02	4.02	0.55	4.92	12.07	0.00	677.08	0.00	0.45	7.16	6.38	0.00	0.45	1.79		Total Fish	
SE	0.20	849.80	0.00	0.00	1.80	1.80	0.24	2.20	5.40	0.00	302.80	0.00	0.20	3.20	2.85	0.00	0.20	0.80		5865	
Number	1	4249	0	0	9	9	2	11	27	0	1514	0	1	16	21	0	1	4			

Table 14. Numbers of striped bass per seine haul in 2015.

	Station																				
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	Mean	St Dev	SE
JUN	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4	0	3	0	0.61	1.42	0.33
JUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
AUG	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.24	0.06
SEP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
Mean	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.80	0.00	0.60	0.00			
St Dev	0.00	0.00	0.00	0.00	0.45	0.00	0.00	0.00	0.00	1.79	0.00	0.00	0.00	0.00	1.79	0.00	1.34	0.00		Total Fish	
SE	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.80	0.00	0.60	0.00		12	
Number	0	0	0	0	1	0	0	0	0	4	0	0	0	0	4	0	3	0			

Table 15. Temperature and salinity (dissolved oxygen not available in 2015) by station and month – 2014 (NA indicates a day where batteries failed on YSI).

Station		Month JUN	JUL	AUG	SEP	OCT	Grand Total
1	Average of Salinity	20.6	22.3	25.2	27.3	25.8	24.24
	Average of Temp (C)	22.9	25.7	26.7	21.2	13.1	21.92
2	Average of Salinity	21.1	23.3	26.3	25.4	26.7	24.56
	Average of Temp (C)	22.4	26.1	26.4	15.9	11	20.36
3	Average of Salinity		25.9	27	26.5	27.6	26.75
	Average of Temp (C)		25.7	27.8	15.6	12.8	20.48
4	Average of Salinity	26.7	25.4	27.5	26.5	27.8	26.78
	Average of Temp (C)	20.5	24.7	26.3	17.1	12	20.12
5	Average of Salinity	26.8	26.5	27.6	28.3	28.2	27.48
	Average of Temp (C)	20.6	24.8	23.9	22.5	13.2	21.00
6	Average of Salinity	27.7	27.6	28.3	28.5	28.8	28.18
	Average of Temp (C)	19	24	25.5	22	16.3	21.36
7	Average of Salinity	28.4	28.1	28.4	29.1	29.5	28.70
	Average of Temp (C)	18.5	22.8	23	19.6	14.3	19.64
8	Average of Salinity	26.9	26.7	27.1	28.1	28.5	27.46
	Average of Temp (C)	17.3	23.8	22.9	20.7	16.9	20.32
9	Average of Salinity	27.1	26.9	27.4	28.1	28.5	27.60
	Average of Temp (C)	16.7	23	23	22.4	16.6	20.34
10	Average of Salinity	29	28.5	28.6	29.5	29.4	29.00
	Average of Temp (C)	17.1	20.7	20.4	16.9	16.3	18.28
11	Average of Salinity	25.75	25.3	26.7	27.5	26.6	26.37
	Average of Temp (C)	19.9	25	26.5	21	12.7	21.02
12	Average of Salinity	25.5	26.1	26.7	27.5		26.45
	Average of Temp (C)	19.1	23.8	25.8	21.1		22.45
13	Average of Salinity	27.6	27.3	27.6	28.5	28	27.80
	Average of Temp (C)	19.1	25.3	26.9	21.7	14.4	21.48
14	Average of Salinity	27.7	27.7	28.1	29	28.5	28.20
	Average of Temp (C)	18.5	24.2	25.2	20.6	14.3	20.56
15	Average of Salinity	29	28.3	28.4	29.3	29.4	28.88
	Average of Temp (C)	17.3	23	23.3	20	14.9	19.70
16	Average of Salinity	27.8	27.6	28	28.5	28.9	28.16
	Average of Temp (C)	15.9	21.7	21.7	22	16.8	19.62
17	Average of Salinity	25.6	25.7	27.1	28	27.6	26.80
	Average of Temp (C)	17.7	24.7	23.2	21.5	17	20.82
18	Average of Salinity	27.5	27.7	28	28.4	28.8	28.08
	Average of Temp (C)	19.9	24.5	26.3	19.8	12.6	20.62
	Total Average Salinity	26.51	26.53	27.47	28.09	28.19	27.36
	Total Average Temp (C)	18.96	23.99	24.53	20.35	14.53	20.47

APPENDIX A

Standardized Index Development – Delta Lognormal

Menhaden, Bluefish, River Herring

The standardized indices for 2 of the main target species of the survey considered five factors as possible influences on the indices of abundance, which are summarized below:

Factor	Levels	Value
Year	25	1988-2015
Month	5	June - October
Temperature (°C)	Continuous	
Salinity (ppt)	Continuous	
Station	18	18 fixed stations throughout bay

The delta lognormal model approach (Lo et al., 1992) was used to develop standardized indices of abundance for the seine survey data. This method combines separate generalized linear model (GLM) analyses of the proportion of successful hauls (i.e. hauls that caught winter flounder) and the catch rates on successful hauls to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure in the R statistical software package (dglm function see: http://www.sefsc.noaa.gov/sedar/download/SEDAR17-RD16%20User%20Guide%20Delta-GLM%20function%20for%20R%20languageenvironment%20(Ver.%201.7.2,%2007-06-2006).pdf?id=DOCUMENT).

For each GLM procedure of proportion positive trips, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion successful trips. During the analysis of catch rates on successful trips, a model assuming lognormal error distribution was examined.

The final models for the analysis of catch rates on successful trips, in all cases were:

Ln(catch) = Year + Month + Station + Temperature + Salinity

The final models for the analysis of the proportion of successful hauls, in all cases including menhaden, were:

Success = Year + Month + Station + Temperature + Salinity

Standardized Index Development – Negative Binomial Generalized Linear Model

Winter Flounder, Tautog, Striped Bass

The standardized indices for 3 of the main target species of the survey considered up to six factors as possible influences on the indices of abundance, which are summarized below:

Species	Factor	Levels	Value
Winter Flounder	Year	27	1988-2015
	Station Periods	4	Stations were added to the survey on 3 separate occasions (station 16 added June 1990, station 17 added July 1993, station 18 added July 1995)
	Temperature (°C)	Continuous	
	Salinity (ppt)	Continuous	
	Station	18	18 fixed stations throughout bay
Tautog	Year	27	1988-2015
	Station Periods	4	Stations were added to the survey on 3 separate occasions (station 16 added June 1990, station 17 added July 1993, station 18 added July 1995)
	Station	18	18 fixed stations throughout bay
Striped Bass	Year	27	1988-2015
	Station Periods	4	Stations were added to the survey on 3 separate occasions (station 16 added June 1990, station 17 added July 1993, station 18 added July 1995)
	Temperature (°C)	Continuous	
	Salinity (ppt)	Continuous	
	Station	18	18 fixed stations throughout bay
	Month	5	June - October

The negative binomial generalized linear model approach was used to develop standardized indices of abundance for the seine survey data. This method produces a generalized linear model (GLM) for the catch rates on all hauls to construct a single standardized CPUE index. Parameterization of each model was accomplished using a GLM procedure in the R statistical software package, the code of which was modified from Nelson and Coreia of the Northeast Fishery Science Center (personal communication).

During the analysis of catch rates on hauls, a model assuming a negative binomial error distribution was examined. The linking function selected was "log", and the response variable was abundance (count) for each individual haul where one of the three species was caught.

A stepwise approach was used to quantify the relative importance of the factors. First a GLM model was fit on year. These results reflect the distribution of the nominal data. Next, each potential factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ($p<0.05$). This model then became the base model, and the process was repeated, adding factors individually until no factor met the criteria for incorporation into the final model.

The final models for the analysis of catch rates were:

Winter Flounder: Abundance = Year + Temperature + Station + Station Periods
Tautog: Abundance = Year + Temperature + Station + Salinity
Striped Bass: Abundance = Year + Station

Assessment of Recreationally Important Finfish
Stocks in Rhode Island Coastal Waters

2015 Annual Performance Report for Job VI, Part A:

Assessment, Protection, and Enhancement of Fish Habitat to Sustain Coastal and Marine Ecosystems and Healthy Stocks of Recreationally Important Finfish:

Assessing, Monitoring, and Minimizing Impacts to Marine Habitat

By
Christopher Deacutis
& Eric Schneider
Principal Marine Fisheries Biologist
& Sup. Environmental Scientist

Rhode Island Department of Environmental Management
Division of Fish and Wildlife
Fort Wetherill Marine Fisheries Laboratory
3 Fort Wetherill Road
Jamestown, RI 02835

Federal Aid in Sportfish Restoration
F-61-R

2015 Performance Report for Job VI, Part A March 31, 2016

PERFORMANCE REPORT

STATE: Rhode Island

PROJECT NUMBER: F-61-R
SEGMENT NUMBER: 22

PROJECT TITLE: Assessing, Monitoring, and Minimizing Impacts to Marine Habitat

PERIOD COVERED: January 1, 2015 - December 31, 2015

JOB NUMBER AND TITLE: VI, Part A: Assessment, Protection, and Enhancement of Fish Habitat to Sustain Coastal and Marine Ecosystems and Healthy Stocks of Recreationally Important Finfish

STAFF: Eric Schneider (Principal Marine Fisheries Biologist) and Chris Deacutis, PhD (Supervising Environmental Scientist)

JOB OBJECTIVE: The goal of this project is to assess, protect, enhance, and restore important marine habitat to support healthy marine ecosystems and stocks of recreationally important finfish. We will obtain this goal by addressing the following objectives:

(1) Identify, assess, and monitor sensitive and important marine habitat in Rhode Island (RI) waters in concert with developing a RI Marine Habitat Management and Restoration Plan through a regional approach, starting at the Head of Narragansett Bay.
(2) Provide a comprehensive review of permit applications for projects that occur in Rhode Island waters and may directly or indirectly impact coastal and marine resources and their habitat, including economic development projects, such as energy, infrastructure, dredging, and dredge spoil disposal projects, as well as aquaculture and habitat restoration projects.
(3) Respond to major fish kills and assess habitat conditions, and in the event of a significant environmental incident: coordinate hazard mitigation, assessment of natural resource damages, and resulting habitat restoration.

SUMMARY: This report summarizes all work conducted for this project between January 1 and December 31, 2015. During this period we focused on aspects related to the three aforementioned objectives.

To address Objective 1 we have initiated a collaborative project with The Nature Conservancy (TNC) to assess fish habitat in the Providence-Seekonk tidal Rivers in upper Narragansett Bay (Head of the Bay). We have updated available data that could be used to identify, assess and quantify fish habitat in this area of Narragansett Bay, including two old datasets: one from a year-long study by RIDEM F&W in 1989 and a benthic juvenile fish study in summer 2002-2003 by the US EPA AED laboratory (Narragansett, RI) using a special benthic sled with net and video camera. We have designed a study plan to use the same benthic sled system used by USEPA (on loan to us from USEPA) to repeat sampling a subset of the EPA stations in summer 2016. We are investigating side scan data available for the area as well.

We have been also been meeting with a group of scientists at the US EPA Atlantic Ecology division (AED) Laboratory (Narragansett, RI) who are attempting to apply the "Biological Condition Gradient" technique to various National Estuary Programs (including the Narragansett Bay Estuary program (nbep)) for assessment of present water quality conditions in relation to past conditions, with a goal towards identifying achievable improvements in water quality through management decisions. This process uses various historical and recent data sets , including historical benthic community data sets, qualitative metadata from historical documents (e.g., state fishery commission reports), and Sediment Profile Imaging (SPI) techniques to assess marine habitat conditions in relation to water quality gradients (e.g., eutrophication and/or toxics impact levels). We will be looking for collaborative opportunities with the nbep to use SPI in the Providence – Seekonk area for benthic habitat assessments in that area of the Bay.

To address Objective 2 Division of Fish and Wildlife (DFW) staff reviewed 68 projects and applications as part of its Environmental Review program during the 2015 calendar year. Verbal comment was provided on all general permit reviews through the monthly general permit meeting at the RI CRMC with the US Army Corps. We reviewed and responded to all dredging projects and provided dredge windows for all projects. Applications for residential dock permits were mainly new requests, with the majority located in the coastal ponds, but did not encroach on known eelgrass beds.

To address Objective 3, the RI DFW responded to 1 clam kill, 1 reported blue crab kill (unverified) and 6 menhaden kills and provided reports to the Director, the Division of Water Resources, and the RIDEM Emergency Response section. Summer 2015 was a particularly bad year for severe hypoxia in areas with poor flushing, likely due to the very low river flows. As part of this objective, we participated in a mock oil spill at the Univ. RI Coastal Institute, and assisted NOAA in their process to update the Environmental Sensitivity Index maps for Rhode Island.

TARGET DATE: Completed December 31, 2015

DEVIATIONS: There were no significant deviations from the timeline proposed in the current grant. We revised the original job VI Part A.1. in June 2015 to shift from a comprehensive synoptic 5 yr Restoration Plan covering all marine waters to a regional approach due to the significant data needs that were uncovered in the 2014-15 efforts to develop a state-wide Plan. We are now addressing this need in a geographically segmented process, starting with the Head of the Bay (Providence-Seekonk tidal Rivers areas), where significant water quality improvements are thought to have positively shifted the quality of habitat, potentially opening up greater collaborative opportunities with TNC for fish habitat enhancement and restoration.

RECOMMENDATIONS: We recommend working closely with TNC through the ongoing cooperative agreement to assess the Providence – Seekonk tidal rivers at the head of Narragansett Bay in summer 2016, characterize the habitat conditions in this formerly highly polluted area, and highlight areas that may be conducive to habitat restoration or enhancement opportunities. We also recommend continuing to collaborate with Dr. Emily Shumchenia on work that is presently funded by USEPA under Biological

Condition Gradient efforts with local Nat'l Estuary Programs, including the Narragansett Bay Estuary Program based on the supposition that the nbep may be interested in a collaborative effort to complete a SPI survey of the upper Bay areas.

INTRODUCTION

Healthy and resilient coastal and marine ecosystems depend on the careful stewardship of both the living marine resources and the habitats upon which they depend. The importance of fish habitat to the sustainability of healthy fisheries was formally recognized with the advent of the Essential Fish Habitat (EFH) component of the Sustainable Fisheries Act (1996). Site specific baseline information detailing the condition of the habitat (water column environment, submerged aquatic vegetation (SAV), and the benthic structural habitat and epifauna) is required for several important fishery management tasks, including identifying areas of important habitat that should be protected, documenting the spatial distribution and condition of habitat in case of an environmental disaster, assessing changes over time due to impacts from climate change or other anthropogenic factors, as well as minimizing impacts from development activities.

In Rhode Island (RI) most of the habitat-related survey work is conducted via collaborative projects that are often coordinated by non-regulatory partners and do not have consistent funding sources. Although the information collected by these projects is usually beneficial to managers, there is not an overarching plan or vision regarding how RI's marine habitat should be assessed, monitored, and managed. Thus, there is a clear need for a Marine Habitat Management and Restoration Plan that provides guidance for current (on-going) projects and establishes priorities for future work. This type of plan would also be a vital resource when establishing goals and objectives of cooperative projects and when seeking funds via a competitive grant process. Because such a plan will require extensive filling of data gaps, we will be taking a regional approach to developing a statewide habitat plan, starting with the Providence-Seekonk tidal rivers (Head of Narragansett Bay) over the next two years (2016-17).

APPROACH

The anticipated approach for each objective is described separately below.

Approach - Objective 1

Overall, fish populations and habitat in these areas have been rarely investigated, but the few research studies available suggest that the populations in these areas may be significant for important recreational species like winter flounder (juveniles) due to the high primary production found here. Over the next 2 years (2016-2017) we will concentrate efforts on assessment of the fish assemblages and present conditions of fish habitat at the Head of Narragansett Bay. Work will include gathering information on present fish habitat, including water quality conditions which will lead to the development of a fish habitat restoration and enhancement action plan for this area. Future grant years will entail implementing components of the plan that are feasible with the funds available, as well as applying for additional funds through grant opportunities that are pertinent to fish habitat restoration.

We will use gear and equipment typically used for shallow estuarine waters, including water quality sampling equipment (Eureka Manta 2) and fish sampling gear that duplicates the USEPA survey completed in summer 2002-2003 as well as seine net surveys. We have approached USEPA and been given permission to borrow the benthic sled and net system they used. We plan on using video camera techniques as well as the net to characterize the area and compare results with the EPA study completed ~ 15 yrs ago. We will also use a seine net survey (and possibly fish pots) to better characterize near-shore pelagic fish species utilizing the area. This effort will address current data gaps and provide detailed information to support site-specific assessments with partners and other collaborators who are conducting habitat-related work in the upper Bay.

Approach - Objective 2

To address Objective 2, the Division provides a comprehensive review of any project or activity, including economic development projects (e.g. energy and infrastructure), dredging and dredge spoil disposal projects, as well as other activities (e.g. recreational and commercial fishing, aquaculture, habitat restoration, etc.) that are proposed for Rhode Island waters and could pose potential direct or indirect impacts to coastal and marine resources and their habitat. Reviews include all available data and provided important information to permitting agencies to allow for more informed permitting decisions.

As part of this effort, RI DFW attends a monthly meeting of upcoming General Permit activities with the Army Corps and the RI CRMC every first Thursday of the month. During that meeting, applications for pier expansions, new piers, dredging projects, as well as aquaculture leases and any concerns over natural resource impacts were discussed by the agencies.

Due to the loss of a staff member, and as part of this Objective, we coordinated all responses and drafted DEM F&W official response letters related to fish habitat impacts from new and expanded aquaculture lease applications for RI DFW starting in October 2015-December 2015.

Depending on the size, scope, and location of the proposed project or activity the review process sometimes involved determining the living and non-living resources present at or near the project site and evaluating the potential direct and indirect adverse effects of the proposed project or activity on fishery resources and marine habitat. More specifically, this process often requires a site visit and a review of fishery resource data and marine habitat data, including EFH, that were collected at or near the project site or in similar habitat conditions. These data may include data collected by RI F&W finfish surveys funded by the USFWS Sport Fish Restoration Program (e.g. Narragansett Bay Monthly and Seasonal Fishery Resource Assessment, Winter Flounder Spawning Stock Biomass Survey, Young of the Year Survey of Selected RI Coastal Ponds and Embayments, and the Juvenile Marine Finfish Survey) and surveys related to finfish, shellfish, and ichthyoplankton conducted by RI F&W pursuant to other funding sources or other originations and institutions (e.g. MA DMF, NEMAP, NEFSC, URI GSO, etc.). Habitat data, including EFH data, may require leveraging data collected previously by RI F&W or other organizations and institutions.

In cases where site-specific habitat and marine resource data is limited, dated, or absent new data may be collected, analyzed, and summarized. When possible, this work takes advantage of collaborative efforts with other agencies. Collection of marine habitat and resource (finfish) data has required use of a vehicle, boat, research vessel, field equipment including but not limited to habitat surveying tools, such as submersible high-resolution digital cameras (video and still-shot), bottom samplers (benthic dredge/sled), water quality data sondes, meters, and associated equipment, and marine resource survey tools, including nets (bongo, seine), measuring boards, and foul weather gear. Data is assimilated and analyzed using statistical software, databases, imaging processing software, and GIS mapping and processing technologies where applicable. Where necessary, RI DFW staff testify at RI CRMC hearings for permits where there is a significant objection by the Division.

Approach - Objective 3

The Division has the duty to provide available scientific information on sudden mass-die-off events such as fish kills in marine waters, and identify important recreational fish habitat and pre-impact conditions in the event of a significant environmental incident classified as a Category 3 major environmental disaster incident (e.g., > 10,000 gal oil spill or wide coastal environmental impact likely). In addition, the Division provides a staff member with recreational fishery habitat expertise for coordination of Division responses related to assisting the Office of Emergency Response Incident Command in assessing any significant environmental impacts of a major oil spill or incident on recreational habitat and biota in Rhode Island marine waters. For moderate incidents such as fish kills, the staff will follow the "Bay Response Team" (BART) protocols. We have been responding to all moderate and large kills and investigating habitat conditions to ascertain the role of severe hypoxia/anoxia in fish kills (the typical cause in summer months) in RI marine habitats.

Results

Results - Objective 1 (aspects of work plan regional assessment of urban Head of Bay waters as part of development of a Comprehensive Marine Habitat Management and Restoration Plan)

The purpose and scope of this objective is to focus on a regional approach to developing a Habitat Management and Restoration Plan by filling in serious habitat data gaps for critical marine areas that are data poor, but also needed to produce a robust plan. We realized while compiling the data currently available to guide the Habitat Management and Restoration Plan that there were significant data gaps, especially in areas that appear to have the greatest potential for positive fishery responses from enhancement practices. We are taking a regional approach to adequately fill in data gaps in areas where very little recent habitat data is available. This approach will allow us to evaluate and develop recommendations for restoration and enhancement techniques that can be rapidly deployed as part of a state-wide plan. It also allows us to more immediately and positively improve fishery habitat and hopefully fishery resources while we increase the knowledge base for the state-wide plan. We will concentrate in the next 4-5 years on the urban marine waters where substantial water quality improvements have been recorded.

Given the extensive positive water quality changes to the areas in the upper Bay due to toxics pretreatment and nutrient treatment requirements in major WWTF permits, we are initiating work to assess an area of the Bay that was "written off" as poor habitat in the past due to what seemed in the past to be intractable pollution sources. These areas were once some of the most productive areas of the Bay (Oviatt et al. 2003). In a number of cases, productivity is still high for certain species such as juvenile winter flounder, *Pseudopleuronectes americanus,* in these urban parts of the estuary (Meng et al. 2005). This program will assess habitat conditions in these once "severely degraded" areas of the Bay, and investigate potential opportunities to restore or enhance recreational fish habitat. Specifically, our efforts will focus on the Providence-Seekonk tidal river mesohaline waters at the Head of Narragansett Bay, which includes tidal marine locations in Providence, East Providence, Pawtucket, Cranston, and Warwick RI. This work is being conducted in collaboration with The Nature Conservancy (TNC) under a multi-year cooperative agreement between TNC and the RIDEM DFW. The agreement will address the following tasks:

> **Task I. Identifying and studying locations of degraded coastal habitat in Rhode Island estuaries that have the greatest potential to benefit from shoreline and sub-tidal restoration techniques and improve fish production.**
>
> **Task II. Identify relevant and cost effective coastal fishery habitat enhancement practices that have potential to make the greatest improvements to the degraded fish habitat sites that are selected for the study.**
>
> **Task III. Design pilot studies and obtain permitting necessary to begin evaluating fish habitat restoration techniques.**
>
> **Task IV. Implement and/or construct fish habitat improvement techniques.**

The initial work for this revised objective was initiated in June 2015, with a search for data available for the Providence-Seekonk tidal rivers. We located a year-long study performed by RIDEM F&W in 1989 and a benthic juvenile fish study in summer 2002-2003 by the US EPA AED laboratory (Narragansett, RI) using a special benthic sled with benthic net and video camera. We have obtained the datasets for both studies, and are examining them. We have also acquired a rugosity coverage of Narragansett Bay bottom at 2 m resolution completed by Dr. John King and his graduate students in 2015, as well as side scan maps for the Seekonk River. We will be using these coverages for the Providence-Seekonk work with TNC in 2016.

We have received agreement from the USEPA to borrow the benthic net-sled equipment and plan to repeat a subset of their stations sampled in 2002-03 in summer 2016 with TNC in order to compare results and see if any species changes have occurred in response to improved WQ conditions as well as climate change (warming water temperatures). We also expect to complete shore seines with TNC at selected habitats in this mesohaline zone of the Bay in 2016.

In addition, as part of this objective, we attended and actively participated in two all-day meetings on the Providence River "Capstone" Project (August 8 and December 14, 2015), originally led by the RI Coordination Team, and now led by the Narragansett Bay Estuary Program. This project is examining opportunities to further improve the urban Bay area by providing improved ecosystem filtering functions / processing of excess nutrients using wetlands restoration and mariculture techniques. This project is very interested in our work with TNC in the Providence-Seekonk system.

Also as part of this effort, we have been meeting ~ bi-monthly in 2015 with a group of scientists at the Atlantic Ecology division (AED) Laboratory in Narragansett, RI who are initiating an EPA project to apply the "Biological Condition Gradient" technique to various National Estuary Programs (including Narragansett Bay) for assessment of present water quality conditions in relation to past conditions, with a goal towards identifying achievable improvements in water quality through management decisions. This process uses various historical and recent data sets , including historical benthic community data sets, qualitative metadata from historical documents (e.g., state fishery commission reports), and Sediment Profile Imaging (SPI) techniques to assess marine habitat conditions in relation to water quality gradients (e.g., eutrophication and/or toxics impact levels). We are considering using some BCG techniques such as Sediment Profile Imaging (SPI) in the Providence-Seekonk Rivers area to understand present conditions in the benthos in this region of the Bay. We may have an opportunity to coordinate such efforts with the EPA group in 2016.

Results - Objective 2 (comprehensive review of permit applications for projects that occur in Rhode Island waters and may directly or indirectly impact coastal and marine resources and their habitat)

RIDFW coordinated responses for 16 public noticed lease applications and 6 preliminary determination meetings, and coordinated 2 RIMFC Advisory Panel meetings for the RIMFC in 2015. Aquaculture leases have increased significantly over the last ten years (see Fig VI.A.1). We expect a new staff member will be on board early in 2016 to assist with coordination of aquaculture leases, while we continue to review new and expansion applications.

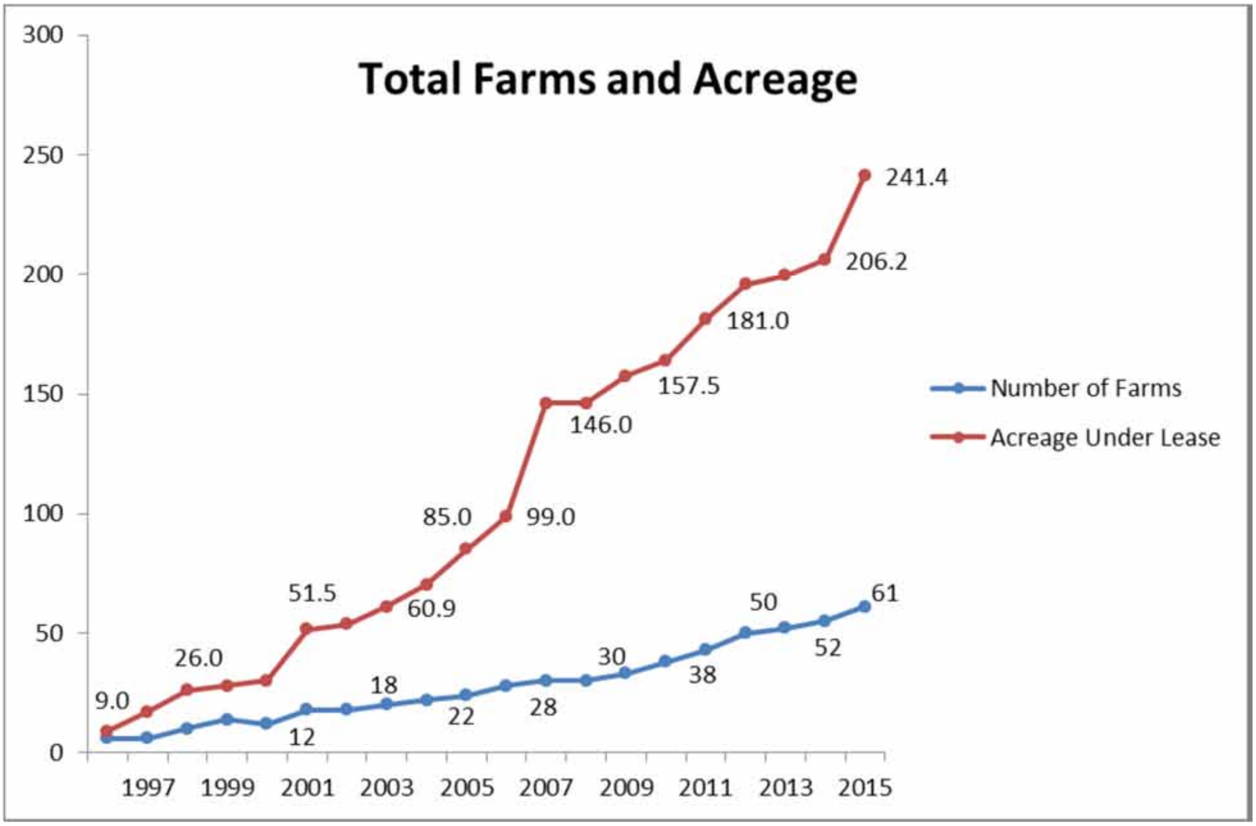


Fig. VI A.1. Number of Aquaculture Farms and acreage in RI waters (source, RICRMC 2015 Annual Status Report on Aquaculture in Rhode Island).

Division of Fish and Wildlife (DFW) staff reviewed 68 dredging projects and dock permit applications as part of its Environmental Review program during the 2015 calendar year. All permit reviews are detailed in Table VI A.1. Verbal comment was provided on all general permit reviews through the monthly general permit meeting at the RI CRMC with the US Army Corps. Most residential dock permits were new requests and were located in the coastal ponds, but most did not encroach on known eelgrass beds. RIDFW staff were also involved in site visits to the Ninigret marsh Thin Layer Deposition project as well as a multi-agency (NOAA , USEPA, RIDEM, RICRMC) visit to the Goddard State Park ramp rebuild + shore habitat restoration site. Staff are directly involved in the fish habitat enhancement reefs in Ninigret and the EQIP projects in Bissel Cove and Ninigret Pond (see F61 VI. B section).

Results - Objective 3 (response to a significant environmental incident)

We investigated a clam kill (hard shell clams) in the Seekonk early in the year (4/15/15). We found small numbers of dead clams and sent samples to Roger Williams University histopathology lab. Results did not indicate any evidence of disease causes. We suspect the harsh spring 2015 cold temperatures may have been the cause. We investigated a reported blue crab kill in the upper Kickamuit River, but could find no evidence. Bottom oxygen levels were normal and did not indicate hypoxia.

RI DFWstaff responded to a large number of moderate to large fish kills of Menhaden (several hundred to thousands) in the (tidal) Seekonk River and other marine waters starting in May 2015. We surveyed the areas, took oxygen profiles, and documented the kill with fish counts and digital photography. All menhaden kills (6 dates) were associated with low oxygen events. All fish kill reports are available from RIDEM DFW (C. Deacutis) upon request. Summer 2015 was a particularly bad year for hypoxia in the Seekonk River and other poorly flushed areas, while the Providence River and main Bay actually had a moderate to low amount of hypoxia (data provided by URI). We suspect the main problem this summer was the lack of rainfall / river flow (see Fig VI.A.2). This minimized the estuarine circulation and flushing of the deep waters (>4') in the Seekonk as well as other areas, and sustained low oxygen levels in the channel along with warm temperatures in this area over a period of months. The large numbers of menhaden entering the Bay in 2015 and moving up to the head of the Bay exacerbated the problem, often replacing a menhaden school that had suffered severe losses from the extended hypoxia within days of the event. This often led to a second or third kill in the area. It is unclear what management efforts can be taken to guarantee such situations do not continue, since the lack of river flow may have been a significant factor in setting up the hypoxia. The decrease in nitrogen load from WWTFs has reached an over 60% drop in the region as of mid-2015 (A.Liberti, RIDEM DWR, personal communication), and the Providence River and upper Bay seem to be responding positively to this management effort in dry summers, while wet summers seem to exacerbate hypoxia through both added nutrient pulse loads and increased stratification (H. Stoffel, URI, personal communication). Although further nitrogen loading decreases from the WWTFs in the Seekonk and Blackstone and Ten Mile rivers and vicinity may assist this area, we expect poor flushing in drought summers will continue to exacerbate low oxygen conditions in the upper part of the Seekonk river system.

As part of this Objective, staff attended an all-day event hosted by the URI Coastal Institute and NOAA concerning an ongoing updating process for Environmental Sensitivity Index Maps for Rhode Island being undertaken by NOAA's consultant AECOM on Nov 5, 2015, and provided input on issues related to fish habitat during discussions of the update process for RI. We will continue to provide input to NOAA through their consultant as they update Environmental Sensitivity Index (ESI) maps for RI (last updated 2001).

In addition to responses to kill events, DFW staff attended a "practice" mock oil spill training at the annual Scientific Support for Environmental Emergency Response (SSEER) Workshop on Sept. 2, 2015 at the URI Coastal Institute. The NOAA spill response scientific staff as well as a number of URI research scientists and RIDEM and RICRMC technical staff attended the workshop. We went through a mock oil spill incident response, and were able to ascertain available technical capabilities as well as first response state agency capabilities through this exercise.

The RIDEM DFW hosted the Chief of the RIDEM Emergency Response Division on Oct. 5, 2015 and provided him with a tour of the Fort Wetherill facility as well as vessels potentially available for response to an emergency marine waters incident such as a major oil spill.

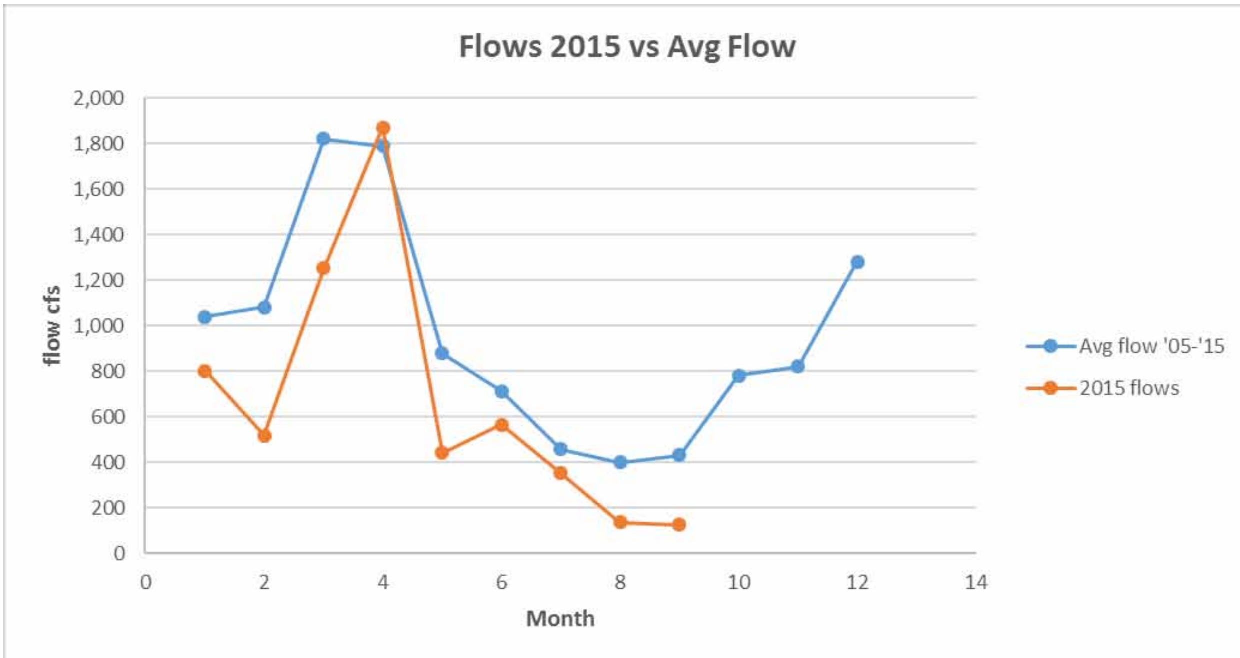


Fig VI A1.2. Blackstone River Monthly Flows 2015 vs Mean Monthly flows.

Discussion

The DFW's ability to protect marine resources and their habitat from adverse anthropogenic impact is largely dependent upon the quality and extent of the data available. Therefore, the DFW strives to use high quality, quantitative information to develop science-based recommendations for regulations and permits. There were several major permit issues dealt with in 2015, requiring substantial time and technical analysis by DEMF&W staff. The number of activities and types reviewed are listed in Table VI A1.1., while greater details are provided below for specific permits that were responded to in the permit review process:

• The US FWS Narrow River Coastal Resiliency Project has continued an ongoing, complex project involving support of NRPA Water Quality; a monitoring program; installation of two BMP's in high priority areas; enhanced flushing in upper Petasquamscutt Cove as well as other high priority refuge needs for the US FWS. This work was funded by the Hurricane Sandy Coastal Resiliency Program under the Disaster Relief Appropriations Act 0f 2013. This project involves saltmarsh habitat enhancement and resiliency at the John H. Chafee NWR – Narrow River. The project is targeting 68 acres of saltmarsh to restore surface drainage and treat adjacent marsh migration areas to enhance saltmarsh migration. The response of the system is being followed by US FWS using robust monitoring protocols including nekton response.

Excavation of some tidal flats was undertaken in 2015 to enhance cool-water refugia for winter flounder; provide foraging habitat for striped bass; and enhance eel grass habitat. A side benefit provides boat navigation away from saltmarsh shorelines, decreasing that erosion energy source. Dredged sediments were dewatered and stockpiled away from the site, and were later used on experimental plots as beneficial reuse by applying thin layer deposition techniques to specific areas of the marsh showing sea level rise impacts such as new salt pan generation and loss of *Spartina alterniflora* in order to elevate these zones, providing some short-term resilience to sea level rise.

We provided DFW comments for all dredge applications that require a WQ Certification, and reviewed and verbally commented on a number of dredging projects:

- One in Pawtuxet cove (new 6 slip marina for new condo complex). Staff checked on quahog densities and agreed the area was low density and would not interfere with fish or shellfish interests.
- One just north of Pawtuxet Cove. We indicated that the deeper dredging would cause an anoxic basin to form in this part of the already hypoxic Providence River, potentially impacting fish habitat. The applicant eventually agreed to have this maintenance dredging depth stay at the present maximum depth (6').
- One dredge project review (August and Sept 2015) ended up involving staff in a site visit. The approved dredge permit requirements were violated by the subcontractor, and evidence provided by staff showing dredge spoils not dewatered and not stored in the approved manner, along with dredge volumes exceeding the original permit volume. Both agencies (RIDEM and RICRMC) have sent an NOV to the marina involved.

- The Manchester Street Power Station (MSS), owned by Dominion Resource Services, is a gas-fired power plant located at the top of Narragansett Bay, along the Providence River behind the ACOE Hurricane Barrier. Like most power plants, this plant requires water to generate stream, and subsequently turn the turbines to create electricity, as well as to cool equipment at the plant. A significant volume of cooling water is withdrawn from and then discharged back to the Providence River, requiring a Rhode Island Pollutant Discharge Elimination System (RIPDES) permit from DEM. The DFW has continued to assist the RIPDES program with their 316 a&b permit modification, responding to issues associated with recreationally important fish species.

- In 2015, we reiterated the evidence we provided the RIDEM Office of Water Resources (state Water Quality permitting division) from a substantial review of the 316a demonstration report as well as all station fish impingement and entrainment (I&E) data, and a graphic analyses of fish losses due to these I&E impacts. We continue to argue potentially substantial I&E impact losses from this plant to the local winter flounder population, *Pseudopleuronectes americanus*, as well as concerning levels of impact to tautog, *Tautoga onitis*, and the American eel, *Anguilla rostrata* .

- Dominion has indicated they will complete 11 technical tasks providing additional technical details by July 2016, including further review of entrainment and impingement data and conceptual examination of a possible barrier on the bottom of the intake canal area to minimize juvenile winter flounder entrainment. We expect to continue RIDFW involvement in reviews and meetings with Dominion on this power plant permit when these technical reports are provided in 2016.

Conclusion

The DFW's ability to protect marine resources and their habitat from adverse anthropogenic impact is largely dependent upon the quality and extent of the data available. Therefore, the DFW strives to use high quality, quantitative information to develop science-based recommendations for regulations and permits. We will continue to improve data collection and the review process in order to protect the important recreational fishery resources of the state.

Table VI.A.1.1. General Permit Reviews performed in 2015 by RI DFW

2015 permit Reviews		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Potential Impacts to SAV or Benthic Habitat							cancelled							
SaltMarsh Restoration		1[a]		1[d]				2[f,g]	1[d]					
Eelgrass Restoration														
Coastal Restoration (other)														
Maintenance Dredging		1							1[i]	1[l]	2[l,n]	1[q]	2[r,s]	
New Dredging										1[m]				
New Marina			1[b]	1[c]										
Marina Expansion or Reconfiguration					1[e]									
Restoration of Tidal Flow to Coastal Pond														
Residential Docks (new)			2	1	5	3			1	2	1	2	3	
Residential Docks (modification)		1											1	
Commercial and muni Piers or Docks						1				1	1[l]			
Salt Marsh or Coastal Wetland Impacts														
Beach Nourishment or Coastal Feature Restoration														
Waterfront Bulkhead/Riprap												1[q]		
Waterfront Development														
Aquaculture (acres)	(potential shellfish or rec use conflicts)		1 (2 ac)					2 (16 ac)		4 (7.5 ac)	3 (5 ac)	2 (7 ac)	3 (11 ac)	
Aquaculture expansion (+*x* acres)	(potential shellfish or rec use conflicts)		3 (+ 6 ac)							1 (2.6 ac)		1 (add kelp)		
Public Works or Utility														
Fish Passage														
Potential Shellfish Impacts														
Channel Maintenance														
Boat Ramp (New or Repair)								1[h]						
Oyster Restoration										2[j,k]	2[o,p]			
Conflict with Recreational Use														
Impacts from Discharge														
- Total Number of Activities and Potential Impacts Identified		3	7	3	6	4		8	3	12	9		13	
a RICC-Marsh Restoration though ditch maintenance and runnel creation														68

b 6 slip marina + 1325 CY dredge - Pawtuxet by the Sea - Pawtuxet Cove Warwick
c Melville Marina - discussion of application status-application not yet received for 887 slip marina incl dredging + filling for condos
d Ninigret Marsh Restoration project RIDEM/RICRMC/SaveTheBay parnership using dredged materials from breachway for Thin Layer Deposition to raise some marsh drowned pans - incl. site visit to the area
e Clark Boat Yd, Jamestown RI - reconfigure dock to permanent fltg (problm with eelgrass there now) + moorings - will convert several conservation moorings
f Ninigret Marsh Restoration project RIDEM/RICRMC/SaveTheBay parnership
g USFWS Maidford Salt Marsh Restoration
h install new ramp + restore shoreline habitat - Goddard State park, East Greenwich RI
i Silver Spring Marina upper Pt Judith Pond - maint dredge 726 CY
j install sculpture forms for oyster restore-filter function - Providence Rvr India Point URI/RISD/SeaGrant
k establish 4 cultch reefs Ninigret (RIDEM F&W
l Navy Pier dredge modification - significant dredge project-Pier 1-2 Coddington Cove, Newport, RI
m J. Goodson Co - Quonset QDC 8100CY - install 2 15'X 160' travel piers for boat repair business upland disposal
n Wickford YC Maintenance Dredging 450 CY
o oyster cultch + seeding - Bissel Cove North Kingstown EQIP
p oyster cultch + seeding Ninigret Pond EQIP
q Repair Block Island East Breakwater (damaged in Hurr Sandy) + Maintenance Dredging request 550 CY for Old Harbor Block Island -disposal on Town Beach - Std Dredge window (Oct15-Jan31)
r Bela Vista Marina Warwick Cove 930 CY
s RIYC Providence River 16,400 CY (deepen basin) disposal to CAD

Assessment of Recreationally Important Finfish
Stocks in Rhode Island Coastal Waters

<u>2015 Annual Performance Report for Job VI, Part B:</u>

Assessment, Protection, and Enhancement of Fish Habitat to Sustain Coastal and Marine Ecosystems and Healthy Stocks of Recreationally Important Finfish:

Investigating techniques to enhance degraded marine habitats to improve recreational fisheries

By

Eric Schneider and Will Helt
Rhode Island Department of Environmental Management
Division of Fish and Wildlife
Fort Wetherill Marine Fisheries Laboratory
3 Fort Wetherill Road
Jamestown, RI 02835

&

Sara Coleman
The Nature Conservancy
159 Waterman Street
Providence, Rhode Island

Federal Aid in Sportfish Restoration
F-61-R

2015 Performance Report for Job VI, Part B March 30, 2016

PERFORMANCE REPORT

STATE: Rhode Island

PROJECT NUMBER: F-61-R
SEGMENT NUMBER: 22

PROJECT TITLE: Investigating techniques to enhance degraded marine habitats to improve recreational fisheries

PERIOD COVERED: January 1, 2015 - December 31, 2015

JOB NUMBER AND TITLE: VI, Part B: Assessment, Protection, and Enhancement of Fish Habitat to Sustain Coastal and Marine Ecosystems and Healthy Stocks of Recreationally Important Finfish

STAFF: Eric Schneider (Principal Marine Fisheries Biologist; RI DEM, Div. of Fish and Wildlife) Will Helt (Fisheries Specialist, RI DEM, Div. of Fish and Wildlife); and Sara Coleman (Coastal Restoration Scientist, The Nature Conservancy Rhode Island Chapter)

JOB OBJECTIVE: This project aims to positively affect local fish populations by improving degraded marine habitat. Specifically, the goal is to determine if oyster reef construction can be used to improve growth and survival (i.e., productivity) of early-life stages of recreationally important fishes such as black sea bass (*Centropristis striata*), tautog (*Tautoga onitis*), scup (*Stenotomus chrysops)*, summer flounder (*Paralichthys dentatus*), and winter flounder (*Pseudopleuronectes americanus*).

This goal will be addressed with the following objectives:
(1) Determine the appropriate location for reef establishment, considering oyster suitability modeling, present habitat quality and value, and connectivity to adjacent fish habitat;
(2) Create and establish oyster reefs in selected coastal ponds; and
(3) Conduct post-enhancement evaluation of study sites and controls to establish baselines and determine if there are changes in fish productivity, such as changes in recruitment and survival of early life stages of recreationally important fish.

SUMMARY: This report summarizes all work conducted for this project between January 1 and December 31, 2015. During this period we finalized the experimental design, identified reef locations in Ninigret Pond, conducted pre-treatment assessment and baseline monitoring, prepared shell and seed on shell, and then constructed the habitat enhancement reefs. We also evaluated locations for the second of four fish habitat enhancement (FHE) sites to be constructed prior to 2018, considering oyster suitability modeling, present habitat quality and value, and connectivity to adjacent fish habitat. It appears Quonochontaug Pond offers the best opportunity for success in 2016 given the logistical strengths, results from assessment of previous restoration work, and the amount of ongoing research occurring at multiple sites within this coastal pond.

TARGET DATE: December 2015

SIGNIFICANT DEVIATIONS: Although there were no significant deviations from the timeline proposed in the current grant, some tasks were not completed within the anticipated timeline. Deviations are shown in Table 1. Overall, the project is still on track.

RECOMMENDATIONS: The lack of information regarding the current status of oyster reefs in the coastal pond system is a major impediment in our ability to link the TNC oyster habitat suitability model outputs and potential long-term reef sustainability. We are currently addressing this data gap by coordinating resource assessment and data sharing with the Natural Resource Conservation Service (NRCS) funded oyster monitoring project that is surveying all former NRCS funded oyster restoration sites and natural oyster reefs sites during 2015 & 2016. During 2015 we submitted an application for funds from the Rhode Island Coastal and Estuary Habitat Restoration Fund administered by CRMC . These funds would help support the oyster monitoring and site assessment work, with the goal of ensuring that high quality sites are identified, prioritized relative to other restoration and enhancement practices, and the DFW management (APA) process initiated to establish the appropriate protections, as needed. Furthermore, the TNC oyster habitat suitability model lacks adequate resolution for the salinity of water in areas with suitable substrate for oyster reef restoration. We will address the paucity of salinity data by purchasing submersible dataloggers to place at potential restoration locations and then update the suitability model to reflect the data collected.

Introduction

Alteration and loss of coastal habitats, such as saltmarshes, eelgrass, and oyster reefs, is believed to be one of the most important factors contributing to declines in populations of marine finfish (Deegan & Bucshbaum, 2005). For example, more than 70% of Rhode Island's recreationally and commercially important finfish spend part of their lives in coastal waters, usually when they are young (Meng & Powell, 1999). The shallow water, salt marshes, sea grasses, and oyster reefs provide excellent foraging and feeding areas as well as protection from larger, open-water predators. Juvenile finfish show a high degree of site fidelity, rarely moving far from shallow-water nursery habitats until either water cools in the late fall or resources are insufficient (Saucerman and Deegan, 1991). Habitats known to be important to early life stages of finfish include unvegetated soft sediments or tidal flats, submerged aquatic vegetation, and complex shellfish and oyster reefs (ASMFC 2007). It is broadly accepted that habitat restoration and enhancement improves coastal ecosystems; however, it remains unclear if coastal habitat restoration practices conducted here in RI would benefit the survival and growth of early life stages of finfish as in the mid-Atlantic.

In Rhode Island, complex shellfish reefs formed by oysters (*Crassostrea virginica*) and ribbed mussels (*Geukensia demissa*) are found in intertidal and shallow subtidal waters of coastal ponds and bays. Recent decades have witnessed declines in this habitat. For example, Beck *et al.* (2011) estimated that shellfish reefs are at less than 10% of their prior abundance and that ~85% of reefs have been lost globally. The decrease in oyster reef extent and condition has coincided with decreases in water quality and clarity, and loss of important nursery habitat for finfish and crustaceans (zu Ermgassen et al., 2013).

Numerous studies completed in the mid-Atlantic have identified shellfish reefs as essential fish habitat (EFH) for resident and transient finfish (Breitburg, 1999; Coen et al., 1999). Similarly, Wells (1961) collected 303 different species of marine life that utilized oyster reef habitat. Reef-dwelling organisms are then consumed by transient finfish of recreational and commercial importance (Grabowski *et al.,* 2005; Grabowski and Peterson, 2007). Harding and Mann (2001) suggested that oyster reefs may provide a higher diversity and availability of food or a greater amount of higher quality food compared to other marine habitats. Grabowski et al. (2005) found that oyster reefs constructed in soft sediments increased the growth and survival of juveniles fishes such as the black sea bass *Centropristis striata*.

The growing recognition of the ecological and economic importance of complex benthic habitat has led to an increase in the efforts to construct oyster reefs (Coen and Luckenback, 2000; Brumbaugh et al., 2006). In North Carolina, recreational fisherman value constructed oyster reefs as a place to find a large number and variety of fish. Grabowski and Peterson (2007) estimated that an acre of oyster reef sanctuary will result in ~$40,000 in additional value of commercial finfish and crustacean fisheries. Note that Grabowski and Peterson (2007) suggested that the recreational sector, like the commercial sector, would be positively affected by an oyster reef sanctuary; however, there was not a clear and convenient value metric for the recreational sector for assessment (i.e., value of landings for commercial species was used to assess commercial value).

Approach

Under a cooperative agreement between the Division of Fish and Wildlife and The Nature Conservancy (TNC), we will collaborate to examine the practice of establishing oyster reefs in shallow coastal waters as a tool to improve populations of recreationally important fishes. The project is broken into four components described in Table 1. In general, we will construct up to 4 acres of oyster reef habitat (1 acre per pond per year starting in 2015) to evaluate reef habitat function and services related to local fish populations. The project will be completed in four stages: (1) identify optimal project locations, and if not already in place promulgate regulatory protections for the "to be created" resource, and submit permit applications; (2) construct oyster reefs; (3) monitor reefs and evaluate fish use and productivity; and (4) develop public outreach materials and reports.

Significant Stage-1 work has been completed, including finalizing the location of the first fish habitat enhancement (FHE) reef, finalizing the experimental design of the project, and submitting the required permit applications. This project will be completed in the coastal ponds of South County, Rhode Island (Figure 1). The coastal pond ecosystems provide refuge and spawning areas for numerous estuarine and marine finfish and are popular fishing areas for recreational anglers. A thorough analysis of oyster and finfish habitat suitability will be completed prior to reef construction. This will be done at the pond and sanctuary scale to identify areas with appropriate physical and biological characteristics. We will use TNC's oyster restoration suitability model along with DEM's juvenile fisheries data (Figure 1) to evaluate not only suitability but the likelihood of recruitment of juvenile fishes. Geospatial data developed in our suitability analysis will greatly inform this project and future fish habitat restoration projects in coastal pond ecosystems.

Reef construction will take place in state-designated Shellfish Management Areas, which encompass all of the coastal ponds. Within a given Shellfish Management Area the Division of Fish and Wildlife (DFW) has authority to conserve and enhance shellfish resources with appropriate management strategies including transplanting, area closures, establishment of spawner sanctuaries, and daily possession limits. If needed, the DFW will promulgate regulations to protect the "to be created" resource prior to placing shell in the water for reef creation. These rules and regulations are promulgated pursuant to Chapter 42-17.1, §20-1-4, §§20-2.1 and Public Laws Chapter 02-047, in accordance with §42-35 of the Rhode Island General Laws of 1956, as amended.

Results

This report summarizes all work conducted for this project between January 1 and December 31, 2015. During this period we (1) determined the locations and experimental design of reef habitats to be constructed in Ninigret Pond, (2) prepared seed-on shell for reef construction, (3) conducted a pre-treatment assessment for baseline fish data at the Ninigret Pond sites, (4) constructed the planned reef habitats, (5) and evaluated and planned aspects of work for 2016.

<u>*Site selection and experimental design for the first fish habitat enhancement (FHE) reef*</u>

Ninigret Pond in Charlestown, RI was chosen as the first coastal lagoon to construct reef habitat. Taking into account depth, subaqueous soil type, benthic geologic habitat, orthophotography, ease of access, and user conflicts within the Spawner sanctuary, four sites were chosen, two in the northern portion of the Spawner Sanctuary and two in the southern portion (Figures 2,3). Study Plots 1 and 2 are located in the northern-end of the Shellfish Spawner Sanctuary (Figure 2) adjacent to a large boulder field and not in areas that are navigable or have moorings. This area has suitable habitat for oyster restoration is are uniquely located adjacent to habitat that could be high quality fish habitat. However, based on preliminary observations, this area appears to be underutilized by targeted fish species. The sediment at these sites consists of Napatree sand (i.e. loamy marine and estuarine deposits over till). Study Plots 3 and 4 are located in the southern-end of the Shellfish Spawner Sanctuary (Figure 3) in the same general area as previous oyster reefs. This area is also not typically used for navigation. The bottom type consists of Nagunt sand (i.e. sandy marine and sandy estuarine deposits). Similar substrate compositions will be sought in Quonochontaug Pond when determining 2016 sites.

Discussion with Dr. Jonathan Grabowski (Marine Science Center, Northeastern University) and consideration of past restoration practices led to a block design. At each of the four sites, three sub-sites were identified and assigned one of three treatments; a reef that would receive seed-on-shell, an unseeded reef, or a bare control plot. The three treatments will test the potential for natural recruitment of oysters and whether oyster density effects fish production. Furthermore, this design allows for the greatest statistical power and allows us to make links between living oyster biomass and ecosystem services in restoration work.

Seed on shell preparation

In early Spring 2015, 200 oyster shell bags were filled with recycled oyster shell. These bags were transported to the Aquaculture Research Corporation (ARC) in Dennis, Massachusetts. There the bags were placed in tanks with oyster larvae to collect seed. On July 7, staff retrieved the oyster shell bags from ARC and delivered them to Jim Arnoux, an aquaculturist in Ninigret Pond with whom a contract had been written to grow out the spat. Mr. Arnoux kept the oysters on his lease in the pond until after the construction had taken place.

Pre-treatment assessment

Over the summer of 2015, we collected baseline fish data at the Ninigret Pond sites. Using eel pots, minnow pots, and gill nets, a monthly monitoring protocol was developed. Traps were set for 6 hours during the day and gillnets were deployed at sunset and left to soak for 12 hours. Each site received 2 eel pots and 3 minnow pots connected on a trot line. We used a 30m long, 1.2m single panel, monofilament gillnet with 7.6cm stretch mesh. Underwater video monitoring was considered, but preliminary attempts were not successful due to high turbidity and low visibility in the pond during the summer months. All animals collected were identified to species, measured, and enumerated. Weights were obtained when possible. Table 2 shows the diversity of species caught by each sampling method. Raw data for species abundance is contained in Tables 3-5). Data regarding the length and weight will be analyzed and summarized in the Spring 2016.

We assessed whether abundance of fish differed by gear type and between study sites. Using a Welch's Two Sample T-Test we determined that the abundance of catch in gillnets was about 600% greater in the southern sites (3 & 4) compared to the northern sites (1 & 2) in the month of August, which was the only month that all four sites were monitored ($p = 0.01857$; Figure 4). Welch's Two Sample T-Test revealed marginal significance between the abundance of catch in gillnets in August and September at southern sites (3 & 4), which were the only sites sampled in both August and September ($p=0.05333$, Figure 5). About 180% more individuals were caught in August than September; however, the small sample size affects the statistical power limiting the ability to detect a significant difference. Welch's Two Sample T-Test revealed significance between the abundance of catch in minnow pots in June between site location ($p=0.01585$, Figure 9). About 500% more finfish were caught in southern sites (3 & 4) than northern sites (1 & 2).

Baseline benthic samples were collected from each of the selected reef and control sites in October and November 2015. Samples were collected using a 2.4 liter Ponar grab sampler, with three replicate samples taken at each of the reef and control sites. Using filtered seawater (63µm) and a 500 µm sieve the collected samples were sieved to remove fine sediment and then fixed in a 10% buffered formalin solution. Rose Bengal stain was added to the fixed samples approximately two weeks before sample picking began. Fixed samples were washed of formalin, picked and sorted into broad taxonomic groupings for further identification and quantification at a later date. Sorted samples were stored in a 70% ethanol solution for later use. To date, 11 of 36 Ponar samples have been picked and sorted.

Reef construction

A total of 131 tons of steamed surf clam shell and recycled oyster shell were used to create eight experimental reefs of about 269ft^2 (18.5ft x 18.5ft) with a reef height of about 2.5ft before subsidence over a period of four days (October 19 to October 22, 2015). Prior to construction, staff used GPS points to mark each reef plot with labeled buoys. Having a clear location to place shell allowed for greater accuracy when deploying from a barge. The work was completed with staff from TNC and RIDEM Division of Fish and Wildlife, as well as many dedicated volunteers. Students from the University of Rhode Island assisted on the second day. The materials were staged at Ninigret Landing Marina and two barges were used from Specialty Divers. East Coast Construction transported seasoned oyster shell from the Great Swamp Management Area to the marina, where a front end loader was used to move shell from one large pile into fish totes. Loading shell using totes enabled the staff to evenly divide deployment of shell across reefs. Using gravity conveyors and fish hooks, staff and volunteers pulled totes full of shell along the dock to be loaded on barges. After one barge was loaded and departed for project sites, the second barge was loaded. This resulted in little down time and made construction very efficient.

Post reef construction nine 0.5m by 0.5m Vexar bags filled with shell or seed on shell (depending on treatment) were placed on each reef to assess reef succession. The bags will be retrieved every 6 months as part of reef monitoring in order to determine invertebrate community composition, oyster survival, and oyster recruitment.

Discussion

Aspects of work for 2016 and thereafter

We assessed both logistical and biological attributes to determine the best potential coastal pond to create the second FHE reef in during 2016. In short, logistical aspects considered were the location for storage of equipment and cultch during reef construction, how site aspects could affect the deployment of shell and construction of the reef, familiarity with potential sites and other current restoration or oyster research in a given coastal pond, and presence of a DEM Shellfish Spawner Sanctuary or Oyster Restoration Area. Biological aspects considered included the suitability of a site for oyster restoration work, including the substrate, water quality, salinity, status of previous oyster restoration work, knowledge of the current marine resources present, as well as the general quality of and type of fish habitat present, and connectivity to other habitats.

Quonochontaug Pond seems to have many of the logistical pieces in place to support this type of work, including locations to stage equipment, substantial fish sampling from other research projects, and two DEM Spawner Sanctuaries. Biological attributes also provide support for Quonochontaug Pond. Oyster habitat suitably modeling conducted by TNC shows that in general locations within Quonochontaug Pond have moderate potential for oyster restoration. In this area we plan to conduct field surveys to delineate the exact transition between suitable and unsuitable substrate and get preliminary data on site conditions including bottom type, presence/absence of structure or rocks, and preliminary assessment of fish habitat type and quality. Field survey techniques will include snorkel surveys, sediment cores, and probing the settlement to determine general firmness of the substrate. We will refine our suitability maps to reflect the acquired knowledge.

We will begin post-construction monitoring in May 2016 at the reefs and control sites in Ninigret Pond, continuing the established methods to sample fish community. In May 2016 we will also assess the first 24 shell bags that were placed on the reef. Oyster monitoring will be conducted in the spring and fall.

Location for the second fish habitat enhancement (FHE) reef

Further analyses of both the physical and fishery data is planned for early 2016. We plan to solicit feedback from the RI Shellfish Restoration Working Group on preliminary sites in early 2016.

Conclusion

During 2015 we finalized the experimental design, identified reef locations in Ninigret Pond, conducted pre-treatment assessment and baseline monitoring, prepared shell and seed on shell, and then constructed the habitat enhancement reefs. We also evaluated locations for the second of four fish habitat enhancement (FHE) sites to be constructed prior to 2018, considering oyster suitability modeling, present habitat quality and value, and connectivity to adjacent fish habitat. It appears Quonochontaug Pond offers the best opportunity for success in 2016 given the logistical strengths, results from assessment of previous restoration work, and the amount of ongoing research occurring at multiple sites within this coastal pond. Although several key aspects need to be resolved in early 2016 we believe we're in a strong position to move forward and keep on schedule. Coordinating all of the field work required to obtain the information needed to move forward in other coastal ponds will be both essential and challenging.

Literature Cited

Atlantic States Marine Fisheries Commission (ASMFC). 2007. The Importance of Habitat Created by Molluscan Shellfish to Managed Species along the Atlantic Coast of the United States: Habitat Management Series #8. Atlantic States Marine Fisheries Commission, Washington, D.C.

Beck, MW., RD. Brumbaugh, L. Airoldi, A. Carranza, LD. Coen, C. Crawford, O. Defeo, G.Edgar, B. Hancock, M. Kay, H. Lenihan, M. Luckenbach, C. Toropova, G. Zhang and X. Guo. 2011. Oyster reefs at risk and recommendations for conservation, restoration, and management. BioScience 61(2): 107–116.

Breitburg DL. 1999. Are three-dimensional structure and healthy oyster populations the keys to an ecologically interesting and important fish community? In: Lucken-bach M, Mann R, Wesson J (eds) Oyster reef habitat restoration: a synopsis of approaches. Virginia Institute of Marine Science Press, Williamsburg, Virginia, p 239–250.

Brumbaugh RD, Beck MW, Coen LD, Craig L, and Hicks P. 2006. A practitioner's guide to the design and monitoring of shellfish restoration projects: an ecosystem services approach. The Nature Conservancy

Coen LD, Luckenbach MW, and Breitburg DL. 1999. The role of oyster reefs as essential fish habitat: A review of current knowledge and some new per- spectives. Pages 438–454 in Benaka LR, ed. Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society. Symposium no. 22.

Coen, LD and Luckenbach, MW. 2000. Developing success criteria and goals for evaluating oyster reef restoration: ecological function or resource exploitation? Ecol Eng 15:323–343

Deegan, L.A., and Buchsbaum R. 2005. The effect of habitat loss and degradation on fisheries. *The Decline of Fisheries Resources in New England*, *67*.

Grabowski, JH, Hughes AR, Kimbro DL, and Dolan MA. 2005. How habitat setting influences restored oyster reef communities. Ecology 86: 1926–1935.

Grabowski, JH, and CH Peterson. 2007. Restoring oyster reefs to recover ecosystem services. In: Cuddington K, Byers JE, Wilson WG, Hastings A (eds) Ecosystem engineers: concepts, theory and applications. Elsevier-Academic Press, Amsterdam, p 281–298

Harding, JM & R Mann. 2001. Oyster reef habitat use by estuarine fishes: Optimal or essential fish habitat? Journal of Shellfish Research. 20(3): 951-959.

Meng, L., & Powell, J. C. 1999. Linking juvenile fish and their habitats: An example from Narragansett Bay, Rhode Island. *Estuaries*, *22*(4), 905-916.

Saucerman, S. E., & Deegan, L. A. 1991. Lateral and cross-channel movement of young-of-the-year winter flounder (Pseudopleuronectes americanus) in Waquoit Bay, Massachusetts. *Estuaries*, *14*(4), 440-446.

Wells, HW 1961. The Fauna of Oyster Beds, with Special Reference to the Salinity Factor. Ecological Monographs 31:239–266.

zu Ermgassen, P. S., Spalding, M. D., Grizzle, R. E., & Brumbaugh, R. D. 2013. Quantifying the loss of a marine ecosystem service: filtration by the eastern oyster in US estuaries. *Estuaries and Coasts*, *36*(1), 36-43.

Table 1. Timeline of project activities.

Component	Activity	Timeline		Status
		Proposed (in original grant)	Current Track	
I. Site Identification & Permits	Evaluate pond & sanctuary suitability	May-14	December-15	Reef 1 (Ninigret Pond) completed. More data is needed to assess sites in all ponds. This will be collected and analyzed during 2015.
	Incorporate fisheries data into suitability models	June-14	December-15	Evaluating approach
	Identify reef & control sites	June-14	March-15 (Reef 1), Dec-15 (Reef 2), Annually in December (Reef 3, 4)	Ninigret Site (Reef 1) near complete. Other ponds pending.
	Complete baseline surveys	Annually, June	Annually, May - August	On target
	Submit permit applications	Annually, July	Annually, January	Quonnie Site (Reef 2) will be submitted in April-10
II. Oyster Reef Construction	Host volunteer workdays to bag shell	Annually, May	-	-
	Secure contracts for reef construction	Annually, May	June	-
	Deliver shell bags to hatchery	Annually, July	May	-
	Grow seed in cages prior to deployment	Annually, July to September	-	-
	Delineate, construct & seed reefs	Annually, October	-	-
III. Monitoring, Evaluation, & Analysis	Post-construction bathymetry & elevation	Annually, *post-construction*	-	-
	Evaluate reef stability & succession	Seasonally, post-construction	-	-
	Evaluate fish & invert community structure	Seasonally, post-construction	-	-
IV. Submit Reports	Analyze data & submit reports	December 2014 - 2018	-	-

Table 2. Species caught during pre-treatment assessment sampling in Ninigret Pond during 2015, by gear type.

Gillnet	Eel pot	Minnow pot
Atlantic menhaden (B*revoorita tyrannus*)	Oyster toadfish (*Opsanus tau*)	Grass shrimp (*Palaemonetes* sp)
Striped searobin (*Prionotus evolans*)	American eel (*Anguilla rostrada*)	Striped killifish (*Fundulus majalis*)
Pinfish (*Lagodon rhomboides*)		Rainwater killifish (*Lucania parva*)
Bluefish (*Pomatomus saltatrix*)		Four spine stickleback (*Apeltes quadracus*)
Blue crab (*Callinectes sapidus*)		Mummichog (*Fundulus heteroclitus*)
Spider crab (*Libinia emarginata*)		Northern pipefish (*Syngnathus fucus*)

Table 3. Water quality data from fish sampling days in Ninigret Pond during 2015.

Date	Site	Salinity	DO (mg/L)	Temperature (^oC)	pH
6/24/2015	1	30	8.65	26.4	8.1
6/24/2015	2	30.18	9.32	26.7	8.32
6/26/2015	3	30.46	8.35	25.1	8.44
6/26/2015	4	30.6	7.85	25.3	8.26
8/26/2015	2	30.3	4.5	27.8	8.2
8/26/2015	1	30.3	4.2	27.8	7.97

Table 4. Soak times for gear used to catch fish in Ninigret Pond during 2015.

Date	Site	Method	Trap number	In	Out	Soak
6/24/2015	1C	Minnow	1	10:00	16:06	6:06
6/24/2015	1C	Minnow	3	10:00	16:04	6:04
6/24/2015	1C	Minnow	2	10:00	16:03	6:03
6/24/2015	1S	Minnow	2	10:15	16:19	6:04
6/24/2015	1S	Minnow	3	10:15	16:20	6:05
6/24/2015	1U	Minnow	1	9:55	15:55	6:00
6/24/2015	1U	Minnow	3	9:55	15:55	6:00
6/24/2015	1U	Minnow	2	9:55	15:55	6:00
6/24/2015	2U	Minnow	1	10:30	16:50	5:20
6/24/2015	2U	Minnow	2	10:30	16:52	5:22
6/24/2015	2S	Minnow	1	10:20	16:35	6:15
6/24/2015	2S	Minnow	2	10:20	16:37	6:17
6/24/2015	2S	Minnow	3	10:20	16:38	6:18
6/26/2015	4U	Minnow	3	10:15	15:40	5:25
6/26/2015	4U	Minnow	2	10:15	15:40	5:25
6/26/2015	4U	Minnow	1	10:15	15:40	5:25
6/26/2015	4S	Minnow	3	10:15	15:50	5:35
6/26/2015	4S	Eel pot	2	10:15	15:50	5:35
6/26/2015	4S	Eel pot	1	10:15	15:50	5:35
6/26/2015	2U	Minnow	3	10:30	16:54	5:24
6/26/2015	4U	Eel pot	2	10:15	15:40	5:25
6/26/2015	4U	Eel pot	1	10:15	15:40	5:25
6/26/2014	4C	Eel pot	1	10:10	16:00	5:50
6/26/2014	4C	Eel pot	2	10:10	16:00	5:50
6/26/2014	4C	Minnow	2	10:10	16:00	5:50
6/26/2014	4C	Minnow	3	10:10	16:00	5:50
6/26/2015	3U	Eel pot	1	10:00	16:45	6:45
6/26/2015	3U	Eel pot	2	10:00	16:45	6:45
6/26/2015	3U	Minnow	1	10:00	16:45	6:45
6/26/2015	3U	Minnow	2	10:00	16:45	6:45
6/26/2015	3U	Minnow	3	10:00	16:45	6:45
6/26/2015	3S	Eel pot	1	10:00	17:10	7:10
6/26/2015	3S	Eel pot	2	10:00	17:10	7:10
6/26/2015	3S	Minnow	1	10:00	17:10	7:10
6/26/2015	3S	Minnow	2	10:00	17:10	7:10
6/26/2015	3S	Minnow	3	10:00	17:10	7:10
6/26/2015	3C	Eel pot	1	10:00	17:15	7:15
6/26/2015	3C	Eel pot	2	10:00	17:15	7:15
6/26/2015	3C	Minnow	1	10:00	17:15	7:15
6/26/2015	3C	Minnow	2	10:00	17:15	7:15
6/26/2015	3C	Minnow	3	10:00	17:15	7:15

Table 5. Continued… Lengths and weights of individuals caught.

Date	Site	Method	Trap	Species	Weight	Number	Lengths												
6/24/2015	1C	Minnow trap	1	Grass shrimp	0.5	1	26												
6/24/2015	1C	Minnow trap	3	Grass shrimp	0.5	1	24												
6/24/2015	1C	Minnow trap	2	Grass shrimp	1	2	29	29											
6/24/2015	1S	Minnow trap	2	Grass shrimp	1	2	29	24											
6/24/2015	1S	Minnow trap	3	Grass shrimp	1.5	3	40	33	31										
6/24/2015	1S	Minnow trap	3	striped killifish	3	1	65												
6/24/2015	1U	Minnow trap	1	Grass shrimp	0.5	1	25												
6/24/2015	1U	Minnow trap	3	Grass shrimp	0.5	1	23												
6/24/2015	1U	Minnow trap	2	Grass shrimp	1	2	28	25											
6/24/2015	2U	Minnow trap	1	Grass shrimp	3	6	26	27	32	34	29	26							
6/24/2015	2U	Minnow trap	1	Rainwater killifish	1	1	45												
6/24/2015	2U	Minnow trap	2	Grass shrimp	2	4	40	26	42	30									
6/24/2015	2S	Minnow trap	1	Mummichog	27	1	111												
6/24/2015	2S	Minnow trap	1	Grass shrimp	0.5	1	26												
6/24/2015	2S	Minnow trap	2	Grass shrimp	1	2	24	38											
6/24/2015	2S	Minnow trap	3	Grass shrimp	1.5	3	21	33	32										
6/26/2015	4U	Minnow trap	3	Grass shrimp	0.5	1	32												
6/26/2015	4U	Minnow trap	2	Pipe fish	10	1	267												
6/26/2015	4U	Minnow trap	1	Grass shrimp	0.5	1	34												
6/26/2015	4U	Minnow trap	1	Rainwater killifish	1	1	40												
6/26/2015	4S	Minnow trap	3	Grass shrimp	1	3	27	25	23										
6/26/2015	4S	Minnow trap	2	Three spine stickleback	1	1	46												
6/26/2015	4S	Eel pot	2	Grass shrimp	0.5	1	35												
6/26/2015	4S	Eel pot	1	Spider crab	1	1	14												
6/26/2015	2U	Minnow trap	3	no catch															
6/26/2015	4U	Eel pot	2	no catch															
6/26/2015	4U	Eel pot	1	no catch															
6/26/2015	4C	Eel pot	1	no catch															
6/26/2015	4C	Eel pot	2	no catch															
6/26/2015	4C	Minnow trap	1	Rainwater killifish	1	1	37												
6/26/2015	4C	Minnow trap	1	Three spine stickleback	2	2	53	50											
6/26/2015	4C	Minnow trap	2	Grass shrimp	1	2	28	25											
6/26/2015	4C	Minnow trap	3	Grass shrimp	0.5	1	30												
6/26/2015	3U	Eel pot	1	Grass shrimp	0.5	1	23												

Table 5. Continued… Lengths and weights of individuals caught.

6/26/2015	3U	Eel pot	2	no catch															
6/26/2015	3U	Minnow trap	2	Three spine stickleback	0.5	1	46												
6/26/2015	3U	Minnow trap	2	Grass shrimp	0.5	1	35												
6/26/2015	3U	Minnow trap	1	Grass shrimp	1.5	4	21	25	22	29									
6/26/2015	3U	Minnow trap	1	Three spine stickleback	2	2	45	34											
6/26/2015	3U	Minnow trap	1	Rainwater killifish	1	1	39												
6/26/2015	3U	Minnow trap	3	Rainwater killifish	2.5	5	41	40	40	44	44								
6/26/2015	3U	Minnow trap	3	Three spine stickleback	1	1	46												
6/26/2015	3U	Minnow trap	3	Grass shrimp	3	13	31	26	25	26	25	29	35	31	24	25	24	30	25
6/26/2015	3S	Eel pot	1	no catch															
6/26/2015	3S	Eel pot	2	no catch															
6/26/2015	3S	Minnow trap	1	no catch															
6/26/2015	3S	Minnow trap	2	Three spine stickleback	1	1	49												
6/26/2015	3S	Minnow trap	2	Grass shrimp	0.5	1	31												
6/26/2015	3S	Minnow trap	3	Rainwater killifish	2	2	43	45											
6/26/2015	3S	Minnow trap	3	Three spine stickleback	1	1	55												
6/26/2015	3C	Eel pot	1	no catch															
6/26/2015	3C	Eel pot	2	no catch															
6/26/2015	3C	Minnow trap	1	Grass shrimp	0.5	2	32	38											
6/26/2015	3C	Minnow trap	1	Three spine stickleback	0.5	1	34												
6/26/2015	3C	Minnow trap	2	no catch															
6/26/2015	3C	Minnow trap	3	Three spine stickleback	1.5	1	54												
6/26/2015	3C	Minnow trap	3	Grass shrimp	0.5	2	34	29											
8/13/2015	3C	Eel pot	1	no catch															
8/13/2015	3C	Eel pot	2	no catch															
8/13/2015	3C	Gillnet	sm mesh	Blue crab	220	1	133												
8/13/2015	3C	Gillnet	lg mesh	Blue crab	240	1	140												
8/13/2015	3C	Gillnet	sm mesh	Bluefish	60	1	195												
8/13/2015	3C	Gillnet	lg mesh	Menhaden	390	1	320												
8/13/2015	3S	Eel pot	1	no catch															
8/13/2015	3S	Eel pot	2	Americal eel	51	1	261												
8/13/2015	3S	Gillnet	sm mesh	Blue crab	100	1	105												
8/13/2015	3S	Gillnet	sm mesh	Bluefish	300	4	190	194	190	n/a									
8/13/2015	3S	Gillnet	sm mesh	Menhaden	850	2	345	335											
8/13/2015	3S	Gillnet	lg mesh	Menhaden	490	2	365	n/a											

Table 5. Continued… Lengths and weights of individuals caught.

8/13/2015	3S	Gillnet	sm mesh	Pinfish	30	1	118												
8/13/2015	3U	Eel pot	1	no catch															
8/13/2015	3U	Eel pot	2	no catch															
8/13/2015	3U	Gillnet	sm mesh	Bluefish	350	4	n/a	232	192	210									
8/13/2015	3U	Gillnet	lg mesh	Menhaden	910	2	339	342											
8/13/2015	4C	Eel pot	1	no catch															
8/13/2015	4C	Eel pot	2	Americal eel	91	1	370												
8/13/2015	4C	Gillnet	sm mesh	Blue crab	500	4	115	133	129	181									
8/13/2015	4C	Gillnet	lg mesh	Blue crab	255	1	145												
8/13/2015	4C	Gillnet	sm mesh	Bluefish	n/a	1	n/a												
8/13/2015	4C	Gillnet	lg mesh	Menhaden	1525	4	360	335	370	n/a									
8/13/2015	4C	Gillnet	sm mesh	Spider crab	230	1	80												
8/13/2015	4S	Eel pot	1	no catch															
8/13/2015	4S	Eel pot	2	no catch															
8/13/2015	4S	Gillnet	lg mesh	Blue crab	540	4	139	102	121	80									
8/13/2015	4S	Gillnet	lg mesh	Bluefish	207	1	110												
8/13/2015	4S	Gillnet	sm mesh	Bluefish	200	3	175	194	n/a										
8/13/2015	4S	Gillnet	lg mesh	Menhaden	3120	7	327	356	330	354	333	342	326						
8/13/2015	4S	Gillnet	sm mesh	Menhaden	780	2	331	352											
8/13/2015	4U	Eel pot	1	no catch															
8/13/2015	4U	Eel pot	2	no catch															
8/13/2015	4U	Gillnet		Menhaden	890	2	325	350											
8/13/2015	4U	Gillnet		Spider crab	140	1	65												
8/26/2015	1C	Eel pot	1	no catch															
8/26/2015	1C	Eel pot	2	no catch															
8/26/2015	1C	Gillnet		no catch															
8/26/2015	1S	Eel pot	1	Americal eel	143	1	464												
8/26/2015	1S	Eel pot	2	no catch															
8/26/2015	1S	Gillnet		no catch															
8/26/2015	1U	Eel pot	1	no catch															
8/26/2015	1U	Eel pot	2	no catch															
8/26/2015	1U	Gillnet		no catch															
8/26/2015	2C	Eel pot	1	Toadfish	50	1	153												
8/26/2015	2S	Eel pot	2	no catch															
8/26/2015	2S	Eel pot	1	no catch															

Table 5. Continued… Lengths and weights of individuals caught.

8/26/2015	2S	Gillnet		Menhaden	996	6	349	330	365	330	348	n/a							
8/26/2015	2U	Eel pot	1	no catch															
8/26/2015	2U	Eel pot	2	no catch															
8/26/2015	2U	Gillnet		no catch															
9/10/2015	3C	Eel pot	1	no catch															
9/10/2015	3C	Eel pot	2	no catch															
9/10/2015	3C	Gillnet		Striped Sea Robin	156.6	1	216												
9/10/2015	3S	Eel pot	1	no catch															
9/10/2015	3S	Eel pot	2	no catch															
9/10/2015	3S	Gillnet		Blue crab	162.1	3	138	140	57										
9/10/2015	3U	Eel pot	1	American eel	68.5	1	444												
9/10/2015	3U	Eel pot	2	Blue crab		1													
9/10/2015	3U	Gillnet		no catch															
9/10/2015	4C	Eel pot	1	no catch															
9/10/2015	4C	Eel pot	2	Toadfish	56.6	1	186												
9/10/2015	4C	Gillnet		Blue crab	98.7	1	150												
9/10/2015	4C	Gillnet		Menhaden	n/a damaged	1	293												
9/10/2015	4S	Eel pot	1	no catch															
9/10/2015	4S	Eel pot	2	no catch															
9/10/2015	4S	Gillnet		Menhaden	1879.5	6	290	280	260	266	270	285							
9/10/2015	4S	Gillnet		Striped Sea Robin	142.6	1	210												
9/10/2015	4U	Eel pot	1	Toadfish	63.5	2	167	155											
9/10/2015	4U	Eel pot	2	no catch															
9/10/2015	4U	Gillnet		Blue crab	265.4	3	154	118	157										
9/10/2015	4U	Gillnet		Striped Sea Robin	76.8	2	220	n/a											

Table 6. Counts of individuals caught.

Date	Site	Gear	Rep.	*Anguilla rostrada*	*Brevoortia tyrannus*	*Lagodon rhomboides*	*Pomatomus saltatrix*	*Callinectes sapidus*	*Libinia emarginata*	*Opsanus tau*	*Prionotus evolans*	*Paleomonetes*	*Fundulus majalis*	*Lucania parva*	*Fundulus heteroclitus*	*Apeltes quadracus*	*Sygnathus fucus*	*Gasterosteus aculeatus*
6/24/2015	1C	Minnow trap	1									1						
6/24/2015	1C	Minnow trap	3									1						
6/24/2015	1C	Minnow trap	2									2						
6/24/2015	1S	Minnow trap	2									2						
6/24/2015	1S	Minnow trap	3									3	1					
6/24/2015	1U	Minnow trap	1									1						
6/24/2015	1U	Minnow trap	3									1						
6/24/2015	1U	Minnow trap	2									2						
6/24/2015	2U	Minnow trap	1									6		1				
6/24/2015	2U	Minnow trap	2									4						
6/24/2015	2S	Minnow trap	1									1			1			
6/24/2015	2S	Minnow trap	2									2						
6/24/2015	2S	Minnow trap	3									3						
6/24/2015	2U	Minnow trap	3															
6/26/2015	4U	Minnow trap	3									1						
6/26/2015	4U	Minnow trap	2														1	
6/26/2015	4U	Minnow trap	1									1		1				
6/26/2015	4S	Minnow trap	3									3						
6/26/2015	4S	Minnow trap	2															1
6/26/2015	4S	Eel pot	2									1						
6/26/2015	4S	Eel pot	1						1									
6/26/2015	4U	Eel pot	2															
6/26/2015	4U	Eel pot	1															
6/26/2015	4C	Eel pot	1															
6/26/2015	4C	Eel pot	2															
6/26/2015	4C	Minnow trap	1											1				2
6/26/2015	4C	Minnow trap	2									2						
6/26/2015	4C	Minnow trap	3									1						
6/26/2015	3U	Eel pot	1									1						

Table 6. Continued… Counts of individuals caught.

6/26/2015	3U	Eel pot	2															
6/26/2015	3U	Minnow trap	2									1						1
6/26/2015	3U	Minnow trap	1									4		1				2
6/26/2015	3U	Minnow trap	3									13		5				1
6/26/2015	3S	Eel pot	1															
6/26/2015	3S	Eel pot	2															
6/26/2015	3S	Minnow trap	1															
6/26/2015	3S	Minnow trap	2									1						1
6/26/2015	3S	Minnow trap	3											2				1
6/26/2015	3C	Eel pot	1															
6/26/2015	3C	Eel pot	2															
6/26/2015	3C	Minnow trap	1									2						1
6/26/2015	3C	Minnow trap	2															
6/26/2015	3C	Minnow trap	3									2						1
8/13/2015	4U	Gillnet	1		2				1									
8/13/2015	4S	Gillnet	1		9		4	4										
8/13/2015	4C	Gillnet	1		4		1	5	1									
8/13/2015	3C	Gillnet	1		1		1	2										
8/13/2015	3U	Gillnet	1		2		4											
8/13/2015	3S	Gillnet	1		4	1	4	1										
8/13/2015	3U	Eel pot	1															
8/13/2015	3U	Eel pot	2															
8/13/2015	4C	Eel pot	1															
8/13/2015	4C	Eel pot	2	1														
8/13/2015	4U	Eel pot	1															
8/13/2015	4U	Eel pot	2															
8/13/2015	4S	Eel pot	1															
8/13/2015	4S	Eel pot	2															
8/13/2015	3C	Eel pot	1															
8/13/2015	3C	Eel pot	2															
8/13/2015	3S	Eel pot	1															
8/13/2015	3S	Eel pot	2	1														

Table 6. Continued… Counts of individuals caught.

8/26/2015	2U	Gillnet	1															
8/26/2015	2U	Eel pot	1															
8/26/2015	2U	Eel pot	2															
8/26/2015	2C	Eel pot	1							1								
8/26/2015	1C	Gillnet	1															
8/26/2015	1C	Eel pot	1															
8/26/2015	1C	Eel pot	2															
8/26/2015	1U	Gillnet	1															
8/26/2015	1U	Eel pot	1															
8/26/2015	1U	Eel pot	2															
8/26/2015	2S	Gillnet	1		6													
8/26/2015	2S	Eel pot	1															
8/26/2015	2S	Eel pot	2															
8/26/2015	1S	Gillnet	1															
8/26/2015	1S	Eel pot	1	1														
8/26/2015	1S	Eel pot	2															
9/10/2015	4U	Eel pot	1							2								
9/10/2015	4U	Eel pot	2															
9/10/2015	4U	Gillnet	1					3			2							
9/10/2015	4C	Gillnet	1		1			1										
9/10/2015	4C	Eel pot	1															
9/10/2015	4C	Eel pot	2							1								
9/10/2015	3S	Eel pot	1															
9/10/2015	3S	Eel pot	2															
9/10/2015	3S	Gillnet	1					3										
9/10/2015	3U	Eel pot	1	1														
9/10/2015	3U	Eel pot	2					1										
9/10/2015	3U	Gillnet	1															
9/10/2015	3C	Gillnet	1								1							
9/10/2015	3C	Eel pot	1															
9/10/2015	3C	Eel pot	2															
9/10/2015	4S	Gillnet	1		6						1							
9/10/2015	4S	Eel pot	1															
9/10/2015	4S	Eel pot	2															

Figure 1. Coastal ponds located in Southern Rhode Island, as well as the Lower Pawcatuck River system. Red circles indicate sites sampled by the RI DEM Division of Fish and Wildlife Coastal Pond Juvenile Finfish Survey. The coastal ponds, which excludes the Lower Pawcatuck River, present potential areas for Fish Habitat Enhancement work under this project.

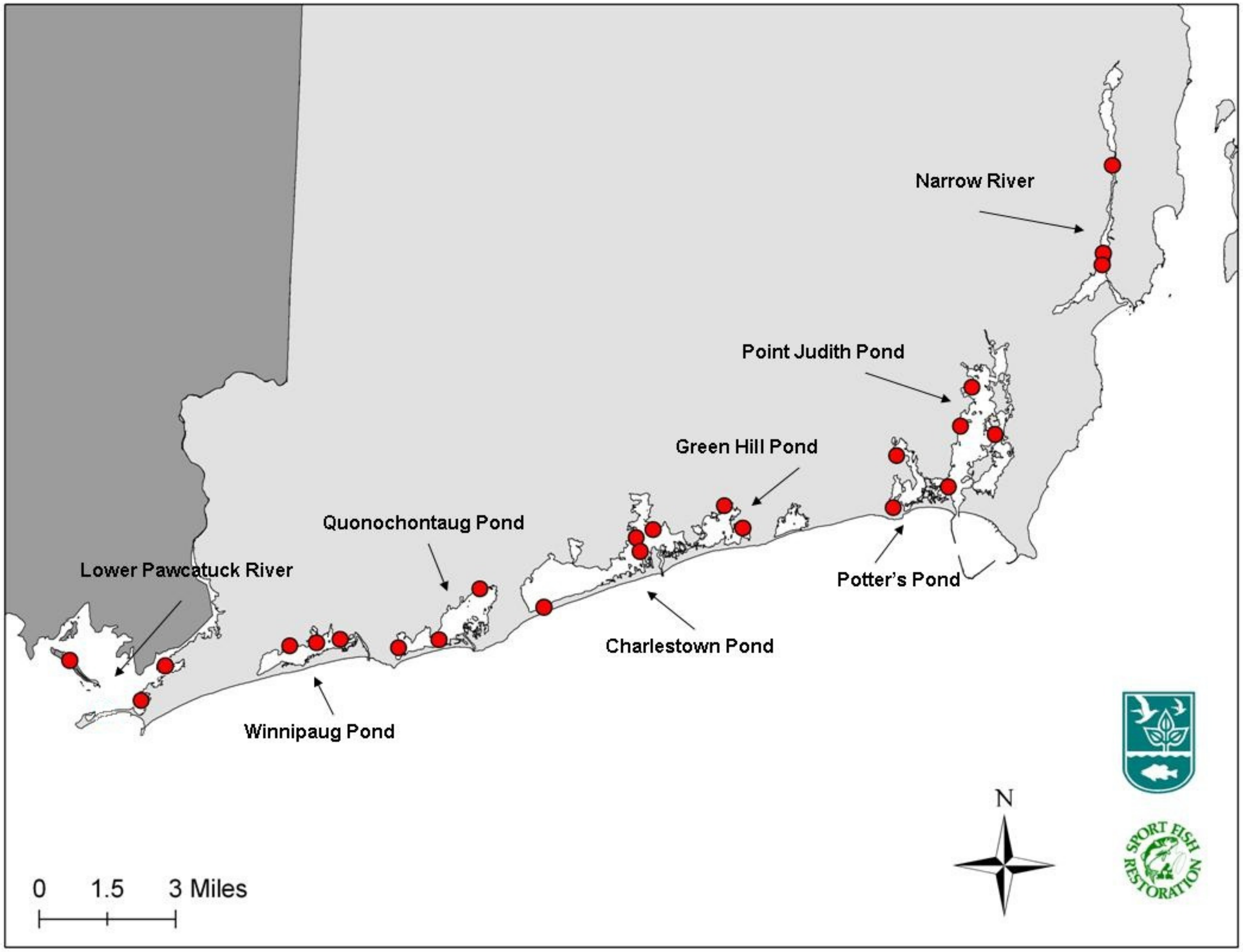
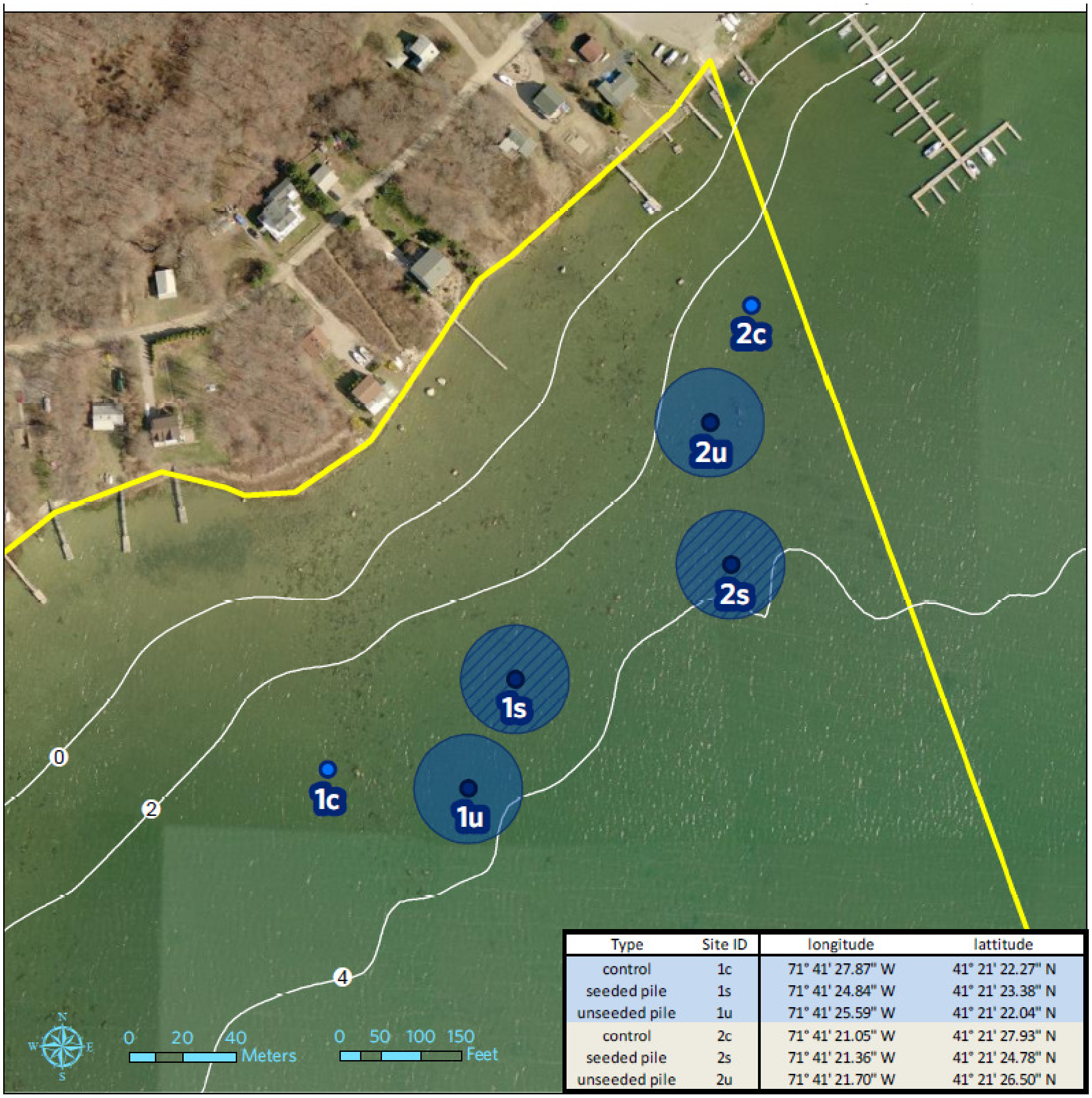
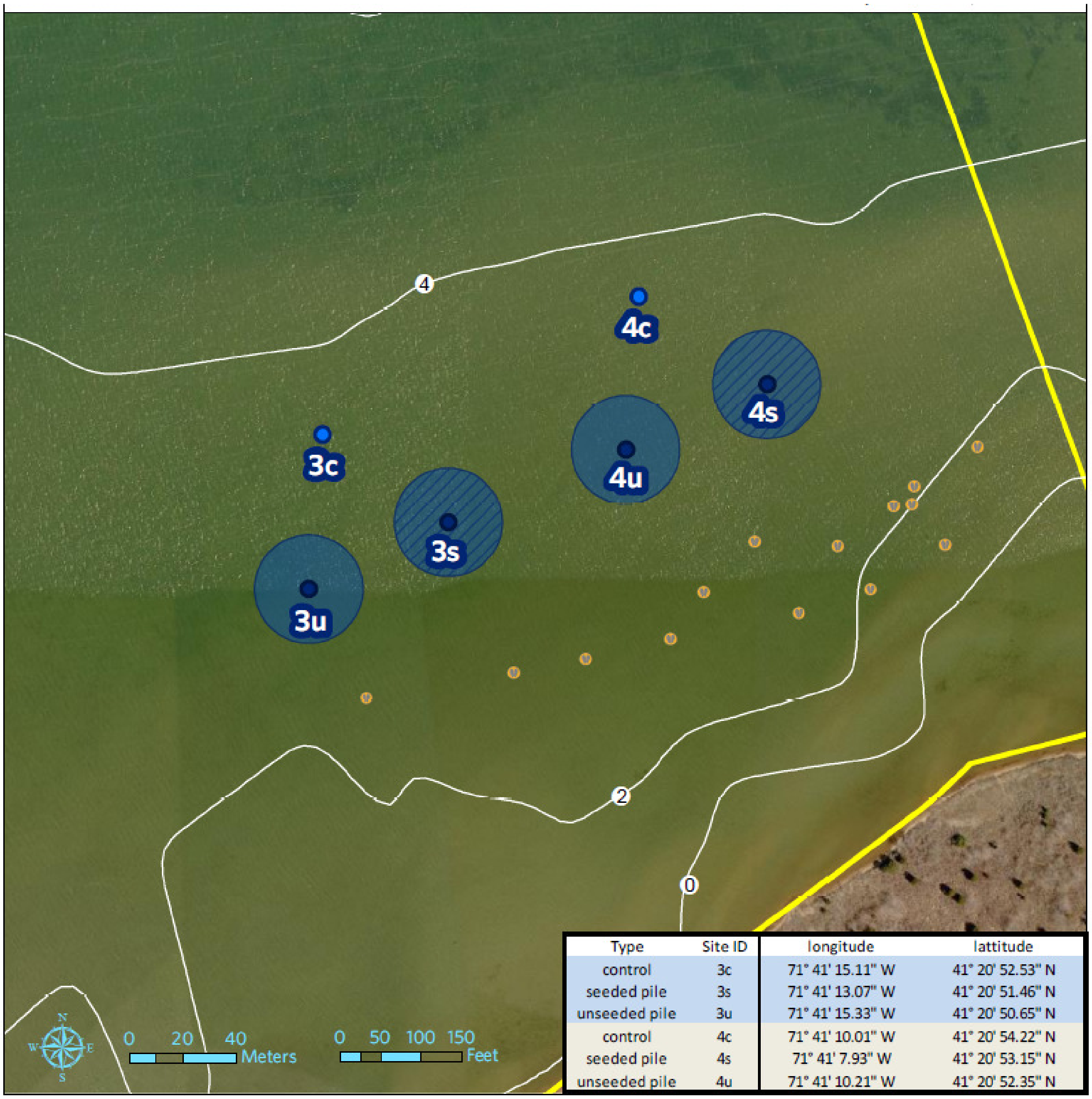


Figure 2. Project sites in the northern portion of the Shellfish Spawner Sanctuary, Ninigret Pond as depicted with yellow outline. Map produced by Kevin Ruddock.



Type	Site ID	longitude	lattitude
control	1c	71° 41' 27.87" W	41° 21' 22.27" N
seeded pile	1s	71° 41' 24.84" W	41° 21' 23.38" N
unseeded pile	1u	71° 41' 25.59" W	41° 21' 22.04" N
control	2c	71° 41' 21.05" W	41° 21' 27.93" N
seeded pile	2s	71° 41' 21.36" W	41° 21' 24.78" N
unseeded pile	2u	71° 41' 21.70" W	41° 21' 26.50" N

Figure 3. Project sites in the southern portion of the Shellfish Spawner Sanctuary of Ninigret Pond, as depicted by yellow outline. Points marked to the south of our reefs are existing EQIP sites. Map produced by Kevin Ruddock.



Type	Site ID	longitude	lattitude
control	3c	71° 41' 15.11" W	41° 20' 52.53" N
seeded pile	3s	71° 41' 13.07" W	41° 20' 51.46" N
unseeded pile	3u	71° 41' 15.33" W	41° 20' 50.65" N
control	4c	71° 41' 10.01" W	41° 20' 54.22" N
seeded pile	4s	71° 41' 7.93" W	41° 20' 53.15" N
unseeded pile	4u	71° 41' 10.21" W	41° 20' 52.35" N

Figure 4. Bar plot depicts mean +SE catch abundance by gillnet in the southern sites compared with northern sites in August.

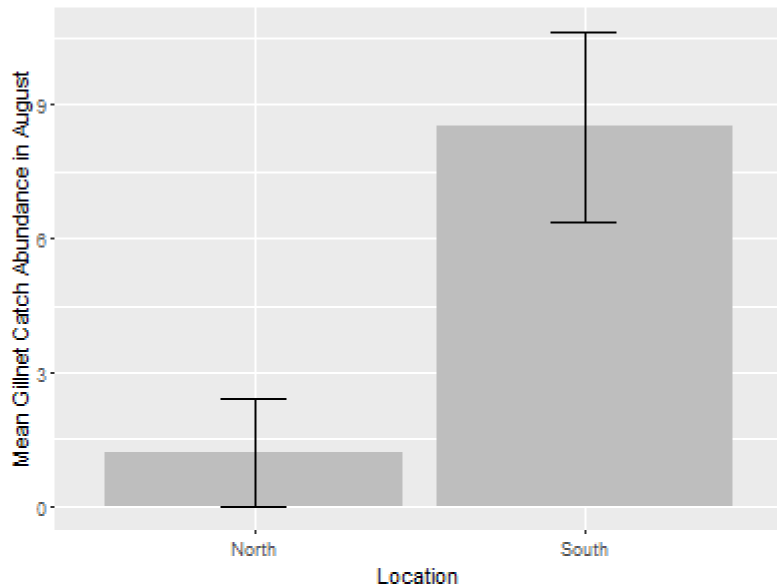


Figure 5. Bar plot depicts mean+SE of mean catch abundance by gillnet in the southern sites (3 & 4) in August and September.

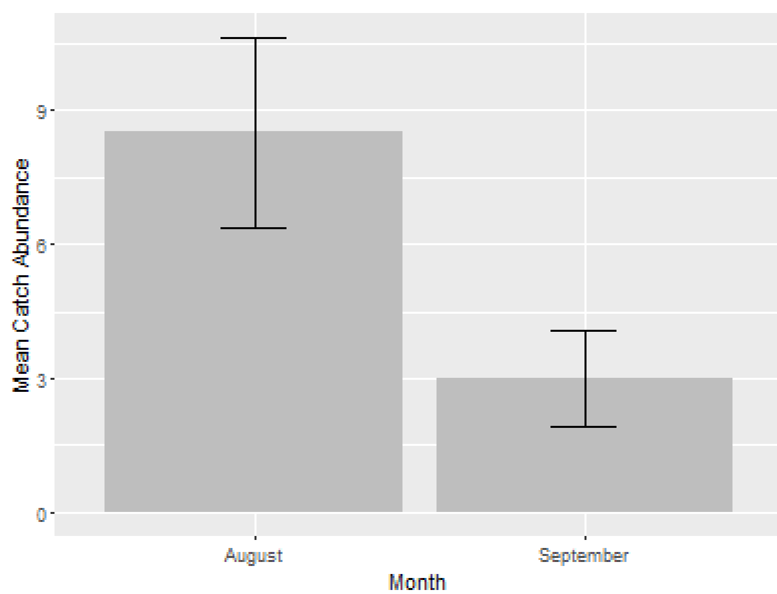


Figure 6. Bar plot shows the mean abundance+SE of Menhaden caught by gillnet per site and month. Gillnets were placed for northern sites (1 & 2) only in August.

Figure 7. Bar plot shows the abundance of Bluefish caught by gillnet per site and month. Bluefish were only observed in the Southern sites in August. Gillnets were placed in northern sites (1 & 2) only in August.

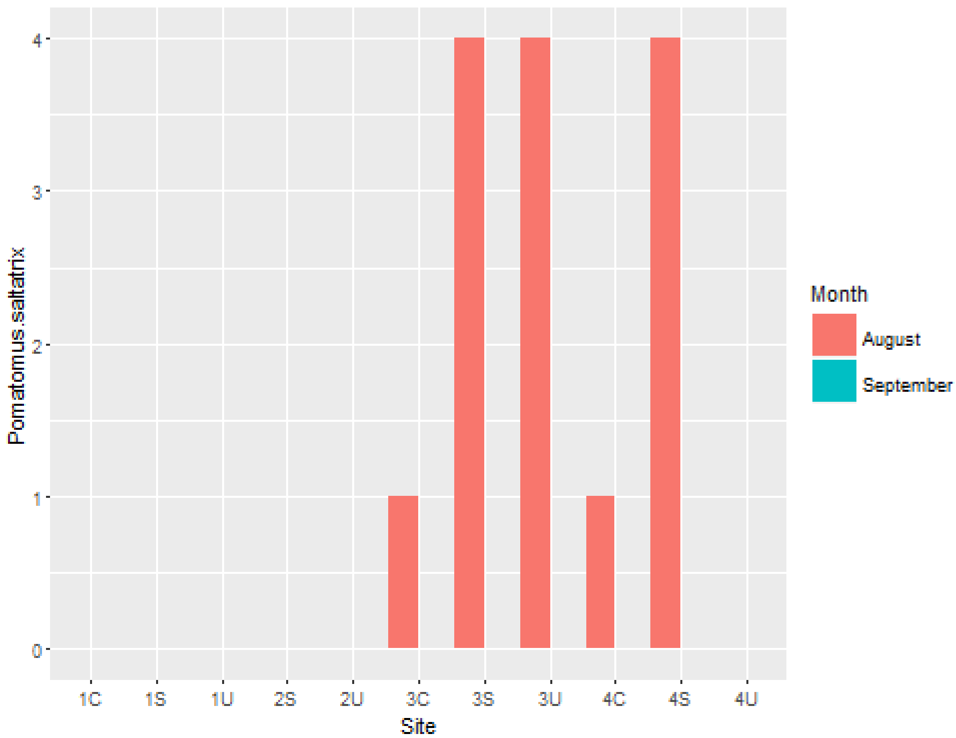


Figure 8. Mean abundance of finfish caught by minnow pots in June by site.

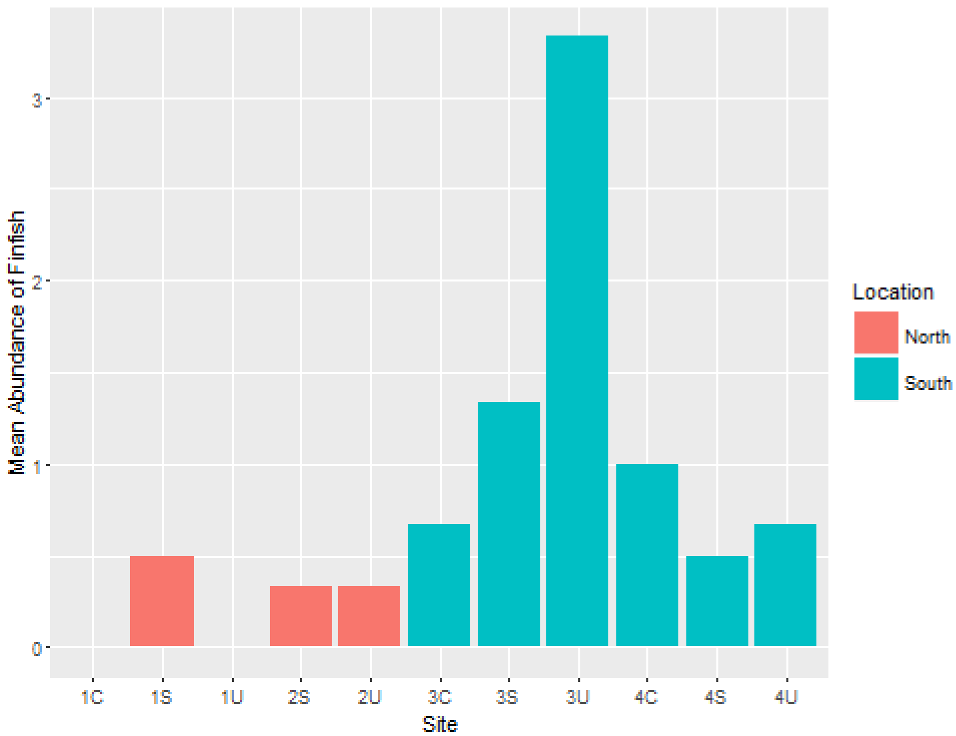


Figure 9. Mean abundance of finfish caught by minnow pots in June by site location.

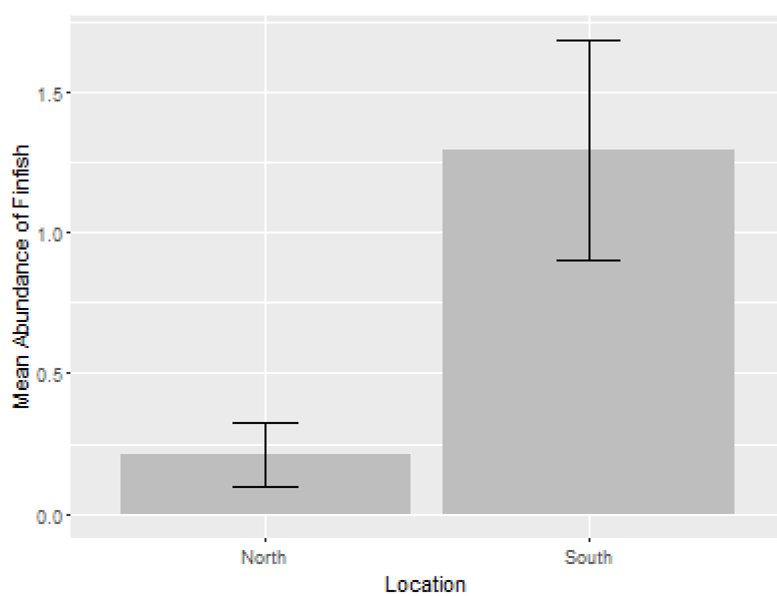


Figure 10. Photograph of TNC employees preparing minnow traps and eel pots for pre-construction monitoring of reefs in Ninigret Pond.

Figure 11. Photograph of staff staging and loading shell into totes then onto a barge for transport

Figure 12. Photograph of staff placing seed on shell onto reefs.

Figure 13. Photograph of seed on shell before it is placed into water.

Appendix I –

2015 Permit Application for *Investigating techniques to enhance degraded marine habitats to improve recreational fisheries*

PERMIT APPLICATION
REQUEST 2015

Proposed Work: Scientific research to assess if enhancing fish habitat by creating oyster reefs increases the growth and survival of fish populations

Water Body Name: Ninigret Pond

City/State/ Zip: Charlestown, Rhode Island 02813

Site Location: Research study plots will be located within the northern- and southern-halves of the RI DEM Shellfish Spawner Sanctuary within the Ninigret Pond Shellfish Management Area, Ninigret Pond, Charlestown, RI. The latitude and longitude of the center points of each study plot are presented in Table 1 and Figures 2 & 3.

Applicant(s):

Rhode Island Department of Environmental Management
Division of Fish and Wildlife, Marine Fisheries Section
Fort Wetherill Marine Laboratory, 3 Fort Wetherill Road
Jamestown, Rhode Island 02835

Primary Investigators: Jason McNamee (Chief of Marine Resource Management), & Eric Schneider (Principal Marine Fisheries Biologist)
Contact: Eric.Schneider@dem.ri.gov | Phone: 401-423-1933

RI Chapter of The Nature Conservancy (TNC) *
159 Waterman Street
Providence, RI 02906
Primary Investigators: Sara Coleman (Coastal Restoration Scientist) & Clair Matten (Science Technician)
*TNC is the co-applicant

Date Submitted: August 20, 2015

PERMIT APPLICATION
REQUEST 2015

Summary

The Rhode Island Department of Environmental Management (RI DEM) Division of Fish & Wildlife Marine Fisheries Section (RI DFW) in collaboration with The Nature Conservancy (TNC) is evaluating techniques to improve fisheries habitat in the coastal ponds along the south shore of RI. The scientific research outlined in this permit application is the pilot project of a multi-year collaborative research program to determine if the practice of establishing oyster reefs in shallow coastal waters can be used as a tool to improve populations of recreationally important sportfish. Previous work in the mid-Atlantic has shown these techniques to be successful, resulting in a significant increase in growth and survival of recreationally important species (e.g. Grabowski et al. 2005); however, these techniques have not yet been evaluated in a temperate region of the Atlantic.

Specific to this permit application is scientific research to determine if construction of oyster reefs (using oyster and surf clam shell) can be used to improve growth and survival (i.e. productivity) of early-life stages of recreationally important fishes such as black sea bass, tautog, scup, summer flounder, and winter flounder. The experimental design is discussed in the Approach section below. In general, we propose to create 4 study plots, a pair (Plots 1 & 2) in the northern-end (Figure 1, 2) and a pair (Plots 3 & 4) in the southern end of the RI DEM Shellfish Spawner Sanctuary in Ninigret Pond (Figure 1, 3). Within each study plot there will be 2 experimental reefs (1 seeded and 1 unseeded) and 1 control site (Figures 2 and 3). Each reef has a footprint of ~ 269 ft^2 and is comprised not more than 15 cubic yards (y^3) of steam-shucked surf clam and seasoned oyster shell (Table 1, Figure 4). The total oyster reef footprint will be ~2,152 ft^2 (0.05 acres) and consist of a volume of shell estimated at not more than 120 y^3. Oyster seed-on-shell will be placed on these reefs according to the experimental design (See Approach; Figure 4). Fish and habitat survey work will be conducted at these 8 experimental reef sites, as well as at 4 control sites prior to reef creation to determine the baseline conditions. These 12 sites will also be monitored for 3-years post reef creation to determine if the abundance, diversity, growth, and survival of fish at these reefs are different than at the control sites (i.e. does enhancing these sites by creating oyster reefs increase the productivity of recreationally important fish species) as well as the success of the oyster reef creation techniques.

We are requesting an Army Corps of Engineers (ACOE) Category II permit, RI DEM Water Quality Certification (WQC), and a Rhode Island Coastal Resource Management Council (CRMC) Letter of Authorization. We highlight that we are only returning shell to marine waters and seeding this shell with live oysters. We emphasize that this work is proposed within a duly promulgated RI DEM Shellfish Management Area (RI General Law § 20-3-4) and within a RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1) which is closed to shellfish harvest and will serve as a sanctuary for oyster propagation and growth; thereby protecting the oyster reefs and the fish habitat it provides.

We also emphasize that this research is conducted by a public entity and serves a compelling public purpose by providing benefits to public trust resources (e.g. the Ninigret Pond ecosystem and local fish stocks). Since this work consists of only returning substrate (shell) to waters of the state and placing oyster seed in areas that historically supported oysters or is currently sandy sediment with no complex structure and currently has low fish habitat value based on RI DFW finfish survey results, we expect the impacts will be beneficial, with no negative effects.

It is important to recognize that in addition to expertise provided by RI DFW and TNC, Dr. Jon Grabowski of Northeastern University is assisting with aspects including the experimental design monitoring design, and subsequent analyses of the data. We note that RI DFW and TNC have pooled their financial resources to help fund this work, with additional funding provided by a grant awarded to the RI DFW under the US FWS Sportfish Restoration Program.

Introduction

Alteration and loss of coastal habitats, such as saltmarshes, eelgrass, and oyster reefs, is believed to be one of the most important factors contributing to declines in populations of marine finfish (Deegan & Bucshbaum, 2005). For example, more than 70% of Rhode Island's recreationally and commercially important finfish spend part of their lives in coastal waters, usually when they are young (Meng & Powell, 1999). The shallow water, salt marshes, sea grasses, and oyster reefs provide excellent foraging and feeding areas as well as providing protection from larger, open-water predators. Juvenile finfish show a high degree of site fidelity, rarely moving far from shallow-water nursery habitats until either water cools in the late fall or resources are insufficient (Saucerman and Deegan, 1991). Habitats known to be important to early life stages of finfish include unvegetated soft sediments or tidal flats, submerged aquatic vegetation, and complex shellfish and oyster reefs (ASMFC 2007).

In Rhode Island, complex shellfish reefs formed by oysters (*Crassostrea virginica*) and ribbed mussels (*Geukensia demissa*) are found in intertidal and shallow subtidal waters of coastal lagoons and bays. Recent decades have witnessed declines in this habitat. For example, Beck *et al.* (2011) estimated that shellfish reefs are at less than 10% of their prior abundance and that ~85% of reefs have been lost globally. The decrease in oyster reef extent and condition has coincided with decreases in water quality and clarity, and loss of important nursery habitat for finfish and crustaceans (zu Ermgassen et al. 2013). Numerous studies have identified shellfish reefs as critical and essential fish habitat (EFH) for resident and transient finfish (Breitburg, 1999; Coen et al., 1999, ASMFC 2007). For example, Wells (1961) collected 303 different species of marine life that utilized oyster reef habitat. Reef-dwelling organisms are then consumed by transient finfish of recreational and commercial importance (Grabowski *et al.,* 2005; Grabowski and Peterson, 2007). Harding and Mann (2001) suggested that oyster reefs may provide a higher diversity and availability of food or a greater amount of higher quality food compared to other marine habitats. Grabowski et al. (2005) found that oyster reefs constructed in soft sediments increased the growth and survival of juveniles fishes such as the black sea bass *Centropristis striata*.

The growing recognition of the ecological and economic importance of complex benthic habitat has caused an increase in the efforts to construct oyster reefs (Coen and Luckenback, 2000; Brumbaugh et al., 2006). Although broadly accepted that habitat restoration and enhancement improves coastal ecosystems; it remains unclear if coastal habitat enhancement practices conducted here in RI would benefit the survival and growth of early life stages of finfish as in the mid-Atlantic.

Objectives

Specifically, the goal of the proposed research is to determine if oyster reef construction can be used to improve growth and survival (i.e., productivity) of early-life stages of recreationally important fishes such as black sea bass (*Centropristis striata*), tautog (Tautoga onitis), scup (*Stenotomus chrysops)*, summer flounder (*Paralichthys dentatus*), and winter flounder (*Pseudopleuronectes americanus*). We will obtain this goal by addressing the following objectives:

(1) Determine the appropriate location for reef establishment considering oyster suitability modeling, present habitat quality and value, and connectivity to adjacent fish habitat.

(2) Conduct pre-enhancement evaluation of the experimental sites and associated control sites to establish baselines

(3) Create and establish oyster reefs at the experimental sites, consistent with the experimental design; and

(4) Conduct post-enhancement evaluation of the experimental and control sites to determine if there are changes in fish productivity, such as changes in recruitment and survival of early life stages of recreationally important fish, and the effectiveness of the oyster reef construction techniques.

Approach

Experimental Design

Although this research will be expanded to other coastal ponds in future years, the 2015 research will occur within a duly promulgated Shellfish Management Area (RI General Law § 20-3-4) and within a RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret Pond (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1) which is closed to shellfish harvest and will serve as a sanctuary for oyster propagation and growth; thereby protecting the oyster reefs and the fish habitat it provides.. The experimental design for this research consists of 4 study plots, a pair (Plots 1 & 2) in the northern-end and a pair (Plots 3 & 4) in the southern end of the RI DEM Shellfish Spawner Sanctuary in Ninigret Pond (Figure 1). Within each study plot there will be 2 experimental reefs (1 seeded and 1 unseeded) and 1 control site that will remain untouched and with no shell or alterations (Figures 2 and 3). By having study plots in the same geographical areas we can ensure that these sites experience similar environmental conditions. In addition, by having plots in areas with different types of fish habitat (boulder vs. barren sand) we can investigate how adjacent habitat influence the fishery response. Leaving one plot unseeded allows us to evaluate if seeding is necessary to produce a fishery-related response.

Site Selection and Characteristics

The DFW and TNC completed a site suitability analysis using available geospatial and fisheries data, including TNC oyster restoration suitability modeling results, marine sediment data, fish habitat data and DFW seine survey data, combined with visual underwater inspections to determine potential suitable locations for establishing oyster reef habitat in Ninigret Pond. From the 16 *potential* experimental reef sites, we selected 8 experimental reef sites that minimize, and likely eliminate, impacts to other known uses occurring in these coastal ponds. For example, we eliminated potential sites that would be located along the central-portion of the western-boundary of the shellfish spawner sanctuary, which had habitat suitable for oyster restoration, but is also frequented by windsurfers.

These 8 experimental reef sites are grouped into 4 Study Plots. Study Plots 1and 2 (Figure 1, 2) are located in the northern-end of the Shellfish Spawner Sanctuary adjacent to a large boulder field and not in areas that are navigable or have moorings. This area has suitable habitat for oyster restoration and are uniquely located adjacent to habitat that could be high quality fish habitat. However, based on preliminary observations, this area appears to be underutilized by targeted fish species. The sediment at these sites consists of Napatree sand (i.e. loamy marine and estuarine deposits over till). Study Plots 3 and 4 (Figure 1, 3) are located in the southern-end of the Shellfish Spawner Sanctuary in the same general area as previous oyster reefs. This area is also not typically used for navigation. The bottom type consists of Nagunt sand (i.e. sandy marine and sandy estuarine deposits). Previous oyster monitoring show the adjacent oyster reefs are doing better than predicted based on suitability modeling. Given to the scientific value of having diverse locations and the apparent persistence of the EQIP reefs established in close proximity we believe conducting research at Study Plots 3 and 4 is appropriate and will provide valuable information to guide future management and enhancement work. In addition, these plots are in close proximity to a RI DEM Coastal Pond Juvenile Finfish Survey station. Results from long-term monitoring suggest that of the four stations sampled in Ninigret Pond, this area has the lowest abundance of the fish species targeted by this project (RI DFW unpublished data) and thus, there is potential to enhance the habitat and associated fish populations at this site.

Reef Construction

Shell used in this project will consist of disarticulated oyster and surf clam shell that has been seasoned for six months following Busheck et al. (2004) or steam-sucked and thus, possessing no viable biological material. Shell will be inspected by CRMC staff for residual tissue prior to use. Reef construction will occur as follows: Shell will be loaded into fish totes and transported by barge (16 x 16 ft^2 sectional) to each reef site. Shell will be deposited, by hand, along transects established by RI DFW and TNC. Each transect will mark the exact locations where shell will be deposited and the experimental reef will be created. Each reef will be round and have a footprint of ~ 269 ft^2 and comprised not more than 15 cubic yards (y^3) of steam-shucked surf clam and seasoned oyster shell (Table 1, Figure 4). The total oyster reef footprint of will be ~2,152 ft^2 (0.05 acres) and volume of shell estimated at not more than 120 y^3 (Table 1).

Research has shown that that reef height, or vertical relief from the bottom, significantly affects oyster larval survival and after one growing season, larval densities can be an order of a magnitude greater on high versus low vertical relief reefs (Brown, DS. 2013). At our experimental reef sites we aim to achieve sufficient relief to reduce impacts from predators and microalgae by deploying not more than 15 cubic yards of shell to create a round reef with an initial reef height of at least 18 inches and not more than 30 inches from the bottom. This "built" height accounts for future reef subsidence (up to 6" at some sites), general compression, and wave scour that will likely reduce the final reef height by as much as 6-12 inches. We note that the volume of shell at a given site will be a function of desired final reef height and water depth at the site. We anticipate the top of each reef will be at minimum 12 inches below the surface of the water and typically 12-30 inches below mean low water depending on the site and given tide. This is generally consistent with the amount of water over oyster reefs at restoration sites located in the southern-end of the Shellfish Spawner Sanctuary created by DEM-NRCS, reefs in Foster Cove created by DEM-NRCS and some reefs in Foster Cove and grassy point that were created by DEM-TNC.

Construction will occur during early to mid-October 2015. Live oyster seed-on-shell at a density of at least 1,000 oysters/m^2 will placed on reefs between mid-October and early November. Live oyster seed-on-shell will be contained in biodegradable mesh bags and placed on reefs as shown in Figure 4. These sites will be marked according to RI DFW and RI CRMC requirements.

Monitoring

Monitoring of fish habitat and assemblage will be conducted pre-reef construction at both experimental reef sites and adjacent control sites to establish baselines. Monitoring of fish habitat, fish assemblages, and oyster reefs will be conducted at both experimental reef sites and adjacent control sites (except controls will not have reefs, thus no reef monitoring) post-reef creation to determine if there are changes in fish productivity, such as changes in recruitment and survival of early life stages of recreationally important fish, and the effectiveness of the oyster reef construction techniques. This monitoring will conducted 3 times annually (May, July, and September) over 4 years (1-year pre- and 3-years post-reef creation) across sites. Pre-reef construction monitoring (i.e. baseline) began in 2015; post-construction monitoring will begin in 2016 and continue until at least 2018.

To assess fish assemblages we will use a combination of standard fisheries sampling techniques, including deploying minnow pots, modified eel pots, and gill nets at each study plot. Gillnets will be 10m long, consisting of two different mesh sizes. We will also evaluate the use of video sampling to target the resident fishes on the reefs. To determine the health of the oyster reefs and evaluate the success of reef creation techniques, each reef will be monitored using techniques consistent with those outlined in the "Essential Monitoring" requirements established by the Rhode Island Shellfish Technical Working Group and documented in the Monitoring Outline (pg 22) of the RI Oyster Restoration Minimum Monitoring Metric and Assessment Protocols (Griffin et al. 2012). We will assess whether recruitment monitoring using artificial spat collectors is needed based on other monitoring projects being conducted within the Shellfish Spawner Sanctuary.

It is important to recognize that in addition to expertise provided by RI DFW and TNC, Dr. Jon Grabowski of Northeastern University is assisting with aspects including the experimental design, monitoring design, and subsequent analyses of the data. We note that RI DFW and TNC have pooled their financial resources to help fund this work, with additional funding provided by a grant awarded to the RI DFW under the US FWS Sportfish Restoration Program.

Potential Impacts

We do not anticipate any negative impacts from the proposed restoration work. As part of the site selection process and baseline monitoring the 4 Study Plot locations were surveyed using underwater video, snorkel, and SCUBA to evaluate benthic habitat and eelgrass presence. Based on our findings, the proposed reef locations will not impact eelgrass or benthic habitat. In addition, there are no potential impacts to commercial or recreational shellfish fisheries given that that all sites are located in an area in which harvest of shellfish is prohibited (i.e. Shellfish Spawner Sanctuary). We note that any shellfish located within the reef footprint will be relocated prior to reef construction, thus there will be no impacts to current shellfish stocks located within the Shellfish Spawner Sanctuary. Furthermore, reef sites in the northern-half of the Shellfish Spawner Sanctuary are located adjacent to a large boulder field and not in areas that are navigable or used for navigation by local homeowners. Reef sites in the southern-half of the Shellfish Spawner Sanctuary are located in the same general area as previous oyster reefs and out of a typical navigation area.

We emphasize that this research is conducted by a public entity and serves a compelling public purpose by providing benefits to public trust resources (e.g. the Ninigret Pond ecosystem and local fish stocks). We also highlight that this work is proposed within a duly promulgated RI DEM Shellfish Management Area (RI General Law § 20-3-4) and RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1) which is closed to shellfish harvest and will serve as a sanctuary for oyster propagation and growth; thereby protecting the oyster reefs and the fish habitat it provides. Since this work consists of only returning substrate (shell) to waters of the state and placing oyster seed in areas that historically supported oysters or is currently sandy sediment with no complex structure and currently has low fish habitat value based on RI DFW finfish survey results, we expect the impacts will be beneficial, with no negative effects.

Potential Limitations on Success

Challenges to the establishment of these oyster reefs and the associated enhanced habitat they provide of recreationally important fish species include natural variation in oyster larval supply and recruitment success, predation, and physical disturbance, including sediment burial, wave impact, and scouring. Unlike most research and habitat enhancement projects, we have the ability to assess the success of these reefs and conduct maintenance seeding in future years if deemed necessary and appropriate.

REFERENCES

Atlantic States Marine Fisheries Commission (ASMFC). 2007. The Importance of Habitat Created by Molluscan Shellfish to Managed Species along the Atlantic Coast of the United States: Habitat Management Series #8. Atlantic States Marine Fisheries Commission, Washington, D.C.

Beck, MW., RD. Brumbaugh, L. Airoldi, A. Carranza, LD. Coen, C. Crawford, O. Defeo, G.Edgar, B. Hancock, M. Kay, H. Lenihan, M. Luckenbach, C. Toropova, G. Zhang and X. Guo. 2011. Oyster reefs at risk and recommendations for conservation, restoration, and management. BioScience 61(2): 107–116.

Breitburg DL. 1999. Are three-dimensional structure and healthy oyster populations the keys to an ecologically interesting and important fish community? In: Lucken-bach M, Mann R, Wesson J (eds) Oyster reef habitat restoration: a synopsis of approaches. Virginia Institute of Marine Science Press, Williamsburg, Virginia, p 239–250.

Brown, DS. 2013. Substrate enhancement – taking eastern oyster (Crassostrea virginica) restoration to the next scalable, low-cost, community-driven approach. National Oceanographic Atmospheric Administration Community Restoration Program. Award # NA10NMF4630081.

Brumbaugh RD, Beck MW, Coen LD, Craig L, and Hicks P. 2006. A practitioner's guide to the design and monitoring of shellfish restoration projects: an ecosystem services approach. The Nature Conservancy

Bushek, D., Richardson, D., Bobo, M. Y., & Coen, L. D. 2004. Quarantine of oyster shell cultch reduces the abundance of *Perkinsus marinus*. Journal of Shellfish Research *23*(2), 369-374.

Coen LD, Luckenbach MW, and Breitburg DL. 1999. The role of oyster reefs as essential fish habitat: A review of current knowledge and some new per- spectives. Pages 438–454 in Benaka LR, ed. Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society. Symposium no. 22.

Coen, LD and Luckenbach, MW. 2000. Developing success criteria and goals for evaluating oyster reef restoration: ecological function or resource exploitation? Ecol Eng 15:323–343.

Deegan, L.A., and Buchsbaum R. 2005. The effect of habitat loss and degradation on fisheries. *The Decline of Fisheries Resources in New England*, *67*.

Griffin, M., B DeAngelis, M. Chintala, B. Hancok, D. Leavitt, T. Scott, D. S. Brown, and R. Hudson. 2012. Rhode Island Oyster Restoration Minimum Monitoring Metrics and Assessment Protocols. Prepared for the Rhode Island Shellfish Technical Working Group. April 2012.

Grabowski, JH, Hughes AR, Kimbro DL, and Dolan MA. 2005. How habitat setting influences restored oyster reef communities. Ecology 86: 1926–1935.

Grabowski, JH, and CH Peterson. 2007. Restoring oyster reefs to recover ecosystem services. In: Cuddington K, Byers JE, Wilson WG, Hastings A (eds) Ecosystem engineers: concepts, theory and applications. Elsevier-Academic Press, Amsterdam, p 281–298.

Harding, JM & R Mann. 2001. Oyster reef habitat use by estuarine fishes: Optimal or essential fish habitat? Journal of Shellfish Research. 20(3): 951-959.

Meng, L., & Powell, J. C. 1999. Linking juvenile fish and their habitats: An example from Narragansett Bay, Rhode Island. *Estuaries*, *22*(4), 905-916.

Saucerman, S. E., & Deegan, L. A. 1991. Lateral and cross-channel movement of young-of-the-year winter flounder (Pseudopleuronectes americanus) in Waquoit Bay, Massachusetts. *Estuaries*, *14*(4), 440-446.

Wells, HW 1961. The Fauna of Oyster Beds, with Special Reference to the Salinity Factor. Ecological Monographs 31:239–266.

zu Ermgassen, P. S., Spalding, M. D., Grizzle, R. E., & Brumbaugh, R. D. 2013. Quantifying the loss of a marine ecosystem service: filtration by the eastern oyster in US estuaries. *Estuaries and Coasts*, *36*(1), 36-43.

Table 1. Summary of the footprint (ft ^{2}) and volume of shell (y^3) for each experimental reef and associated control sites. The associated areas/volumes represent the ideal experimental design and configuration; however, we recognize that these values could change if construction issues arise. All permitting agencies will be made aware of any substantial changes in construction/siting.

Study					area (ft^2)		
Plot	Site type	Site ID	Longitude	Latitude	of site	with shell	Shell (y^3)
1	control	1c	71° 41' 27.87" W	41° 21' 22.27" N	269	0	0
1	seeded reef	1s	71° 41' 24.84" W	41° 21' 23.38" N	269	269	15
1	unseeded reef	1u	71° 41' 25.59" W	41° 21' 22.04" N	269	269	15
2	control	2c	71° 41' 21.05" W	41° 21' 27.93" N	269	0	0
2	seeded reef	2s	71° 41' 21.36" W	41° 21' 24.78" N	269	269	15
2	unseeded reef	2u	71° 41' 21.70" W	41° 21' 26.50" N	269	269	15
3	control	3c	71° 41' 13.07" W	41° 20' 51.46" N	269	0	0
3	seeded reef	3s	71° 41' 15.11" W	41° 20' 52.53" N	269	269	15
3	unseeded reef	3u	71° 41' 15.33" W	41° 20' 50.65" N	269	269	15
4	control	4c	71° 41' 10.21" W	41° 20' 52.35" N	269	0	0
4	seeded reef	4s	71° 41' 10.01" W	41° 20' 54.22" N	269	269	15
4	unseeded reef	4u	71° 41' 7.93" W	41° 20' 53.15" N	269	269	15
				Totals	3228	2152	120

Figure 1. General locations of the 4 study plots within the RI DEM Shellfish Spawner Sanctuary in the western end of the RI DEM Ninigret Pond Shellfish Management Area in, Charlestown RI. Each study plot contains 2 experimental reef sites and 1 control site. A figure legend is located on the next page. In short displayed are: rocks and boulders located along the northern-shore (red pentagons); moorings (anchors); oyster reefs created by the NRCS EQIP program from 2008-2010 (tan circle containing an oyster), and the subaqueous soil type as identified and mapped by the Map Coast Project with comments from the TNC oyster suitably model output.

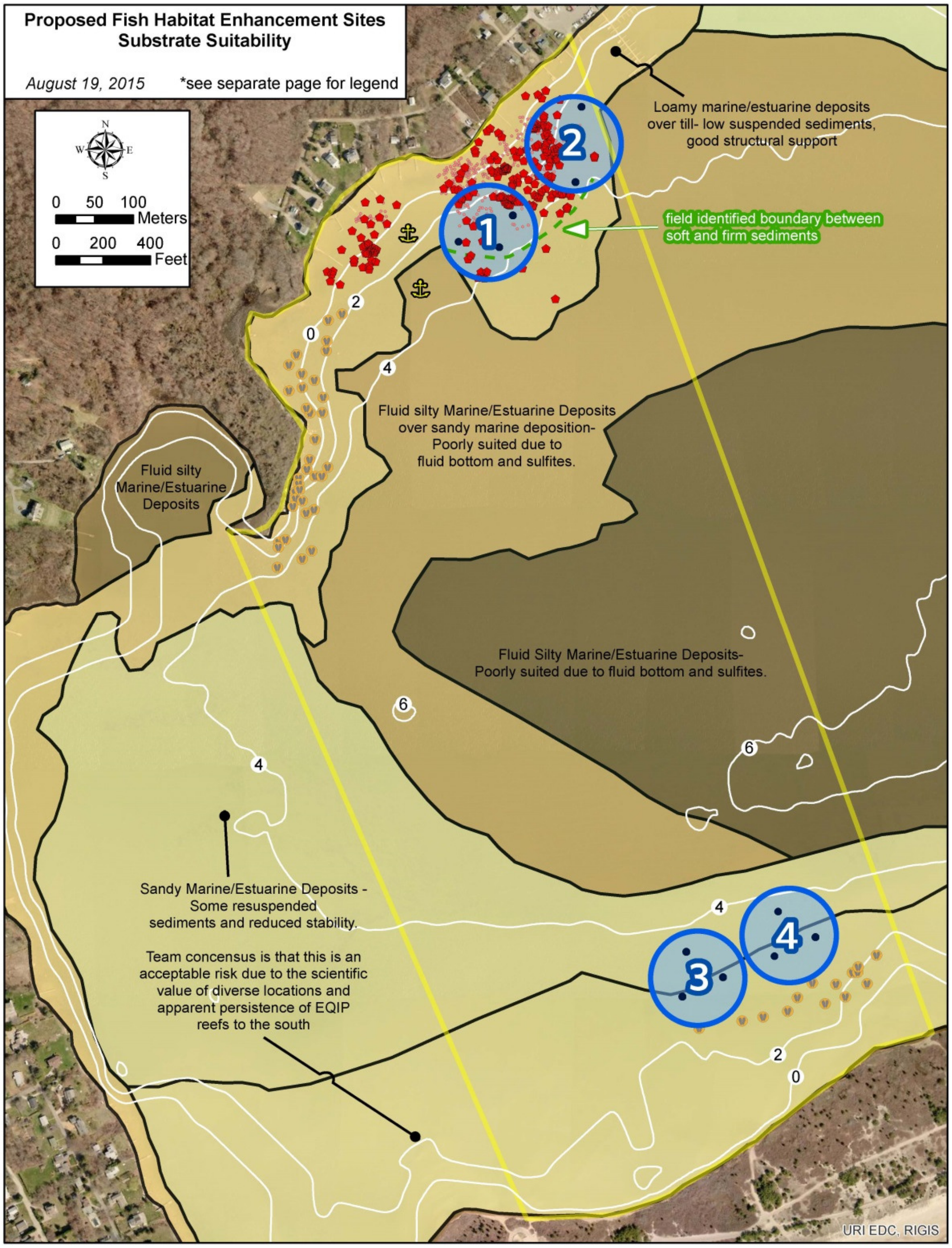


Figure 1. Continued …

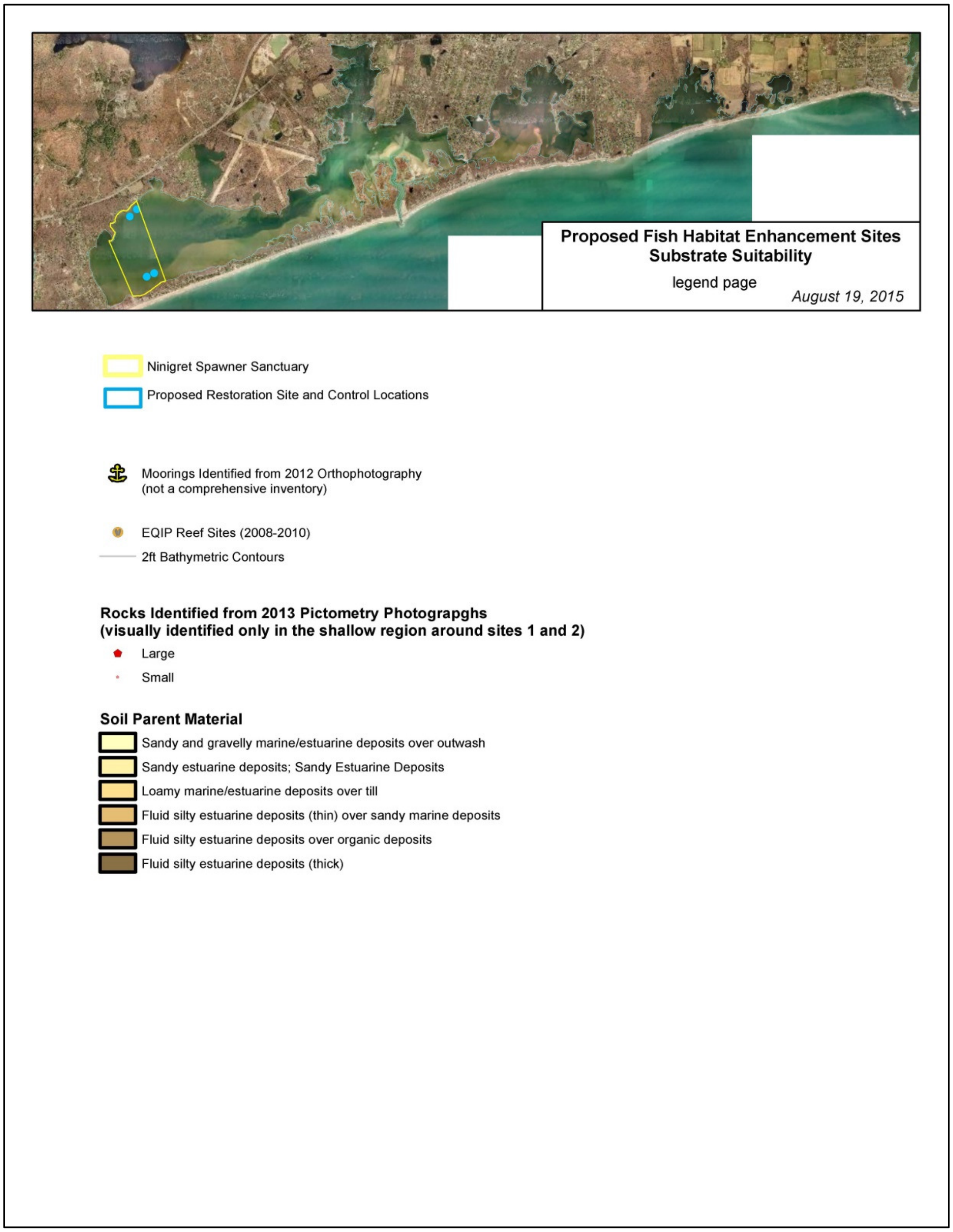
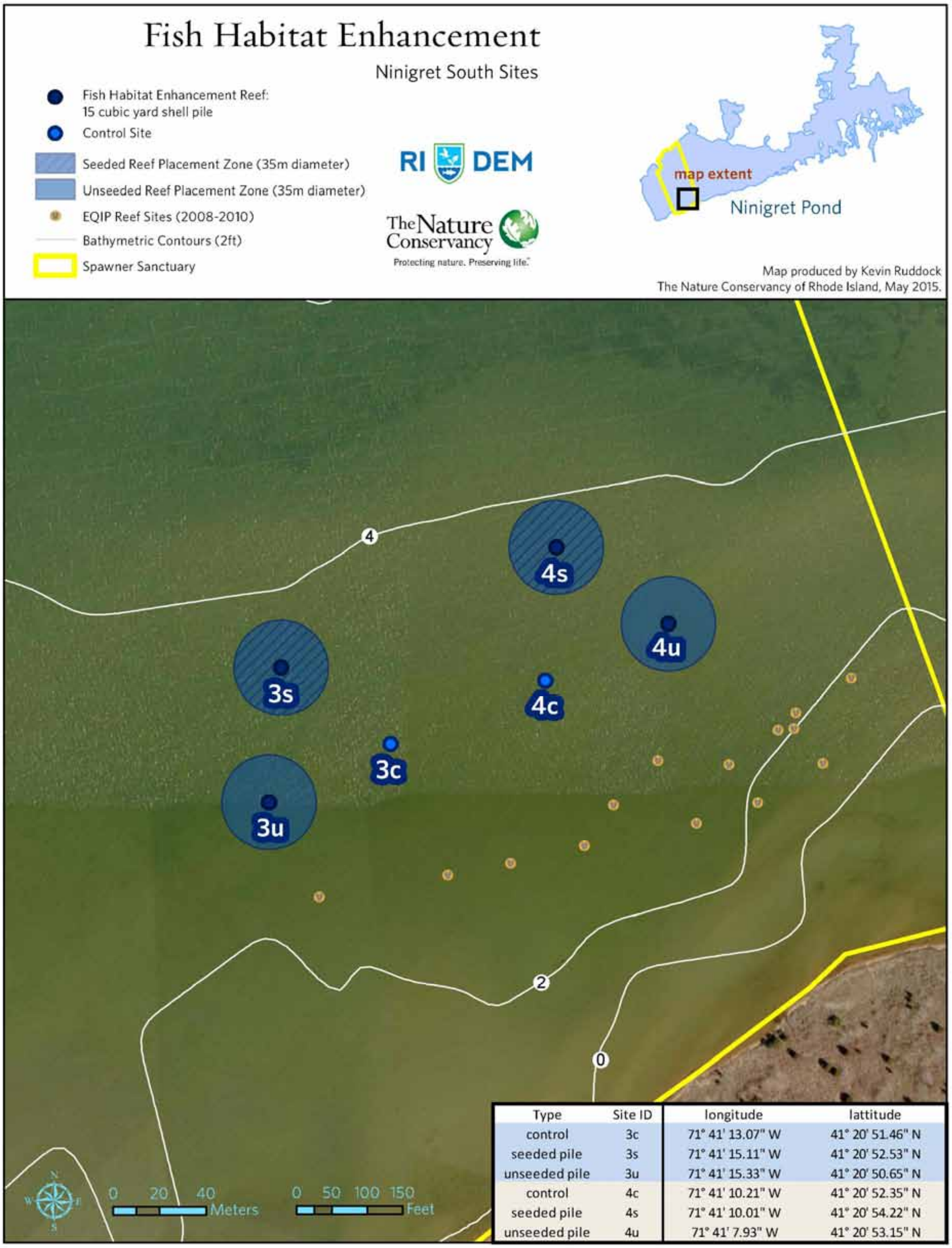


Figure 2. Proposed configuration for the 2 study plots and associated experimental reefs (4) and controls (2) in the northern-half of the RI DEM RI Shellfish Spawner Sanctuary located in Ninigret Pond, Charlestown RI**.**

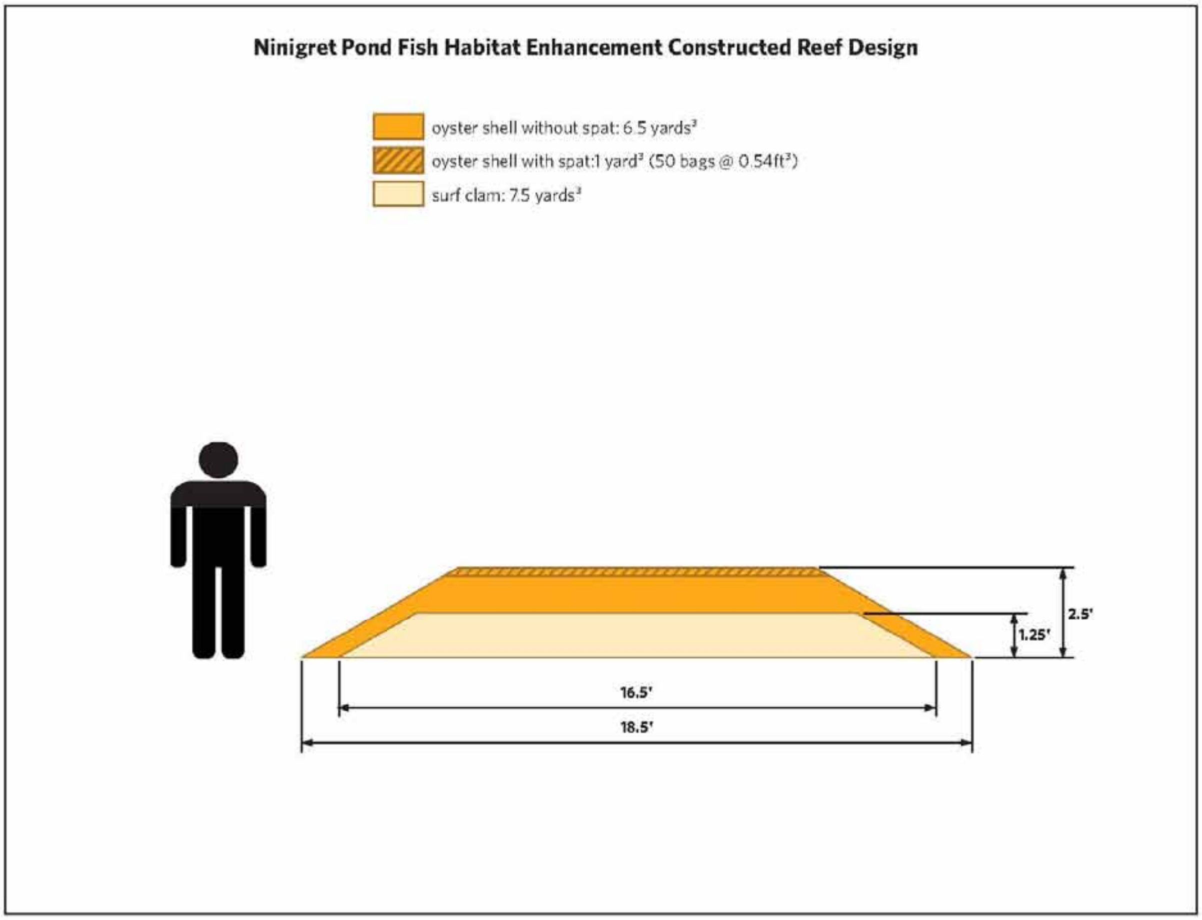
Type	Site ID	longitude	lattitude
control	1c	71° 41' 27.87" W	41° 21' 22.27" N
seeded pile	1s	71° 41' 24.84" W	41° 21' 23.38" N
unseeded pile	1u	71° 41' 25.59" W	41° 21' 22.04" N
control	2c	71° 41' 21.05" W	41° 21' 27.93" N
seeded pile	2s	71° 41' 21.36" W	41° 21' 24.78" N
unseeded pile	2u	71° 41' 21.70" W	41° 21' 26.50" N

Figure 3. Proposed configuration for the 2 study plots and associated experimental reefs (4) and controls (2) in the southern-half of the RI DEM RI Shellfish Spawner Sanctuary located in Ninigret Pond, Charlestown RI**.**



Type	Site ID	longitude	lattitude
control	3c	71° 41' 13.07" W	41° 20' 51.46" N
seeded pile	3s	71° 41' 15.11" W	41° 20' 52.53" N
unseeded pile	3u	71° 41' 15.33" W	41° 20' 50.65" N
control	4c	71° 41' 10.21" W	41° 20' 52.35" N
seeded pile	4s	71° 41' 10.01" W	41° 20' 54.22" N
unseeded pile	4u	71° 41' 7.93" W	41° 20' 53.15" N

Figure 4. Side profile of an experimental reef showing the maximum "built" height immediately following reef creation. We note that the volume of shell at a given site will be a function of desired final reef height and water depth at the site, as well as expected effects from reef subsidence. Each reef will be round extending 18.5 feet from the center, have a total footprint of ~ 269 ft^2, and comprised not more than 15 cubic yards (y^3) of steam-shucked surf clam and seasoned oyster shell. We anticipate the top of each reef will be typically 12-30 inches below mean low water depending on the site and given tide.



--- End of Permit Application Request ---

DEM

DIVISION OF FISH AND WILDLIFE
3 Fort Wetherill Road
Jamestown, RI 02835

TEL 401 423-1920
FAX 401 423-1925

To: Dave Beutel, CRMC Aquaculture Coordinator

From: Eric Schneider, Principal Biologist

Date: September 20, 2015

Subject: Section 300.1 Requirements: Fish Habitat Enhancement - RI DEM Div. Fish & Wildlife Marine Fisheries / TNC: *Scientific research to assess if enhancing fish habitat by creating oyster reefs increases the growth and survival of fish populations*

In accordance with Rhode Island Coastal Resources Management Program application requirements defined by Section 300.1 for a Category B Permit we are providing the following information. Please note that this information was also addressed in the permit narrative.

Please contact me at 401.423-1933 or via email at **Eric.Schneider@dem.ri.gov** if you have questions or need additional information.
Thank you.

In accordance with Rhode Island Coastal Resources Management Program application requirements defined by Section 300.1 for a Category B Permit we are providing the following information.

1. Demonstrate the need for the proposed activity or alteration:

- Alteration and loss of coastal habitats, such as saltmarshes, eelgrass, and oyster reefs, is believed to be one of the most important factors contributing to declines in populations of marine finfish (Deegan & Bucshbaum, 2005). For example, more than 70% of Rhode Island's recreationally and commercially important finfish spend part of their lives in coastal waters, usually when they are young (Meng & Powell, 1999). The shallow water, salt marshes, sea grasses, and oyster reefs provide excellent foraging and feeding areas as well as providing protection from larger, open-water predators. Juvenile finfish show a high degree of site fidelity, rarely moving far from shallow-water nursery habitats until either water cools in the late fall or resources are insufficient (Saucerman and Deegan, 1991). Habitats known to be important to early life stages of finfish include unvegetated soft sediments or tidal flats, submerged aquatic vegetation, and complex shellfish and oyster reefs (ASMFC 2007).

- In Rhode Island, complex shellfish reefs formed by oysters (*Crassostrea virginica*) and ribbed mussels (*Geukensia demissa*) are found in intertidal and shallow subtidal waters of coastal lagoons and bays. Recent decades have witnessed declines in this habitat. For example, Beck et al. (2011) estimated that shellfish reefs are at less than 10% of their prior abundance and that ~85% of reefs have been lost globally. The decrease in oyster reef extent and condition has coincided with decreases in water quality and clarity, and loss of important nursery habitat for finfish and crustaceans (zu Ermgassen et al. 2013).

- Numerous studies have identified shellfish reefs as critical and essential fish habitat (EFH) for resident and transient finfish (Breitburg, 1999; Coen et al., 1999, ASMFC 2007). For example, Wells (1961) collected 303 different species of marine life that utilized oyster reef habitat. Reef-dwelling organisms are then consumed by transient finfish of recreational and commercial importance (Grabowski et al., 2005; Grabowski and Peterson, 2007). Harding and Mann (2001) suggested that oyster reefs may provide a higher diversity and availability of food or a greater amount of higher quality food compared to other marine habitats. Grabowski et al. (2005) found that oyster reefs constructed in soft sediments increased the growth and survival of juveniles fishes such as the black sea bass (*Centropristis striata*).

- The growing recognition of the ecological and economic importance of complex benthic habitat has caused an increase in the efforts to construct oyster reefs (Coen and Luckenback, 2000; Brumbaugh et al., 2006). Although broadly accepted that habitat restoration and enhancement improves coastal ecosystems; it remains unclear if coastal habitat enhancement practices conducted here in RI would benefit the survival and growth of early life stages of finfish as in the mid-Atlantic.

- Therefore, the Rhode Island Department of Environmental Management (RI DEM) Division of Fish & Wildlife Marine Fisheries Section (RI DFW) in collaboration with The Nature

Conservancy (TNC) is evaluating techniques to improve fisheries habitat in the coastal ponds along the south shore of RI. The scientific research outlined in this permit application is the pilot project of a multi-year collaborative research program to determine if the practice of establishing oyster reefs in shallow coastal waters can be used as a tool to improve populations of recreationally important sportfish. Specific to this permit application is scientific research to determine if construction of oyster reefs (using oyster and surf clam shell) can be used to improve growth and survival (i.e. productivity) of early-life stages of recreationally important fishes such as black sea bass, tautog, scup, summer flounder, and winter flounder.

2. **Demonstrate that all applicable local zoning ordinances, building codes, flood hazard standards, and all safety codes, fire codes, and environmental requirements have or will be met; local approvals are required for activities as specifically prescribed for nontidal portions of a project in Sections 300.2, 300.3, 300.6, 300.8, 300.9, 300.11, 300.13, 300.15 and 300.17; for projects on state land, the state building official, for the purposes of this section, is the building official:**

- This is in-water work and all RI DEM and CRMC requirements were addressed in the application materials.

- We emphasize that this work is proposed within a duly promulgated RI DEM Shellfish Management Area (RI General Law § 20-3-4) and within a RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret Pond (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1) which is closed to shellfish harvest and will serve as a sanctuary for oyster propagation and growth; thereby protecting the oyster reefs and the habitat and ecosystem services they provide.

- We also emphasize that this research is conducted by a public entity and serves a compelling public purpose by providing benefits to public trust resources (e.g. the Ninigret Pond ecosystem and local fish stocks). Since this work consists of only returning substrate (shell) to waters of the state and placing oyster seed in areas that historically supported oysters or is currently sandy sediment with no complex structure and currently has low fish habitat value based on RI DFW finfish survey results, we expect the impacts will be beneficial, with no negative effects.

3. Describe the boundaries of the coastal waters and land area that are anticipated to be affected:

- This work is proposed in subtidal waters and will not result in any impacts along the shore and on land.

- This research will occur within a duly promulgated Shellfish Management Area (RI General Law § 20-3-4) and within a RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret Pond (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1) which is closed to shellfish harvest and will serve as a sanctuary for oyster propagation and growth; thereby protecting the oyster reefs and the fish habitat it provides. The experimental design for this research consists of 4 study plots, a pair (Plots 1 & 2) in the northern-end and a pair (Plots 3 & 4) in the southern end of the RI DEM Shellfish Spawner Sanctuary in Ninigret Pond (Figure 1). Within each study plot there will be 2 experimental reefs (1 seeded and 1 unseeded) and 1 control site that will remain untouched and with no shell or alterations (Figures 2 and 3). By having study plots in the same geographical areas we can ensure that these sites experience similar environmental conditions. In addition, by having plots in areas with different types of fish habitat (boulder vs. barren sand) we can investigate how adjacent habitat influence the fishery response. Leaving one plot unseeded allows us to evaluate if seeding is necessary to produce a fishery-related response.

- Summary of the footprint (ft^2) and volume of shell (y^3) for each experimental reef and associated control sites. The associated areas/volumes represent the ideal experimental design and configuration; however, we recognize that these values could change if construction issues arise. All permitting agencies will be made aware of any substantial changes in construction/siting.

Study					area (ft^2)		
Plot	Site type	Site ID	Longitude	Latitude	of site	with shell	Shell (y^3)
1	control	1c	71° 41' 27.87" W	41° 21' 22.27" N	269	0	0
1	seeded reef	1s	71° 41' 24.84" W	41° 21' 23.38" N	269	269	15
1	unseeded reef	1u	71° 41' 25.59" W	41° 21' 22.04" N	269	269	15
2	control	2c	71° 41' 21.05" W	41° 21' 27.93" N	269	0	0
2	seeded reef	2s	71° 41' 21.36" W	41° 21' 24.78" N	269	269	15
2	unseeded reef	2u	71° 41' 21.70" W	41° 21' 26.50" N	269	269	15
3	control	3c	71° 41' 13.07" W	41° 20' 51.46" N	269	0	0
3	seeded reef	3s	71° 41' 15.11" W	41° 20' 52.53" N	269	269	15
3	unseeded reef	3u	71° 41' 15.33" W	41° 20' 50.65" N	269	269	15
4	control	4c	71° 41' 10.21" W	41° 20' 52.35" N	269	0	0
4	seeded reef	4s	71° 41' 10.01" W	41° 20' 54.22" N	269	269	15
4	unseeded reef	4u	71° 41' 7.93" W	41° 20' 53.15" N	269	269	15
				Totals	3228	2152	120

4. Demonstrate that the alteration or activity will not result in significant impacts on erosion and/or deposition processes along the shore and in tidal waters:

- This work is proposed in subtidal waters and will not result in any impacts on erosion and/or deposition processes along the shore and in tidal waters.

5. Demonstrate that the alteration or activity will not result in significant impacts on the abundance and diversity of plant and animal life:

- We do not anticipate any negative impacts from the proposed restoration work. As part of the site selection process and baseline monitoring the 4 Study Plot locations were surveyed using underwater video, snorkel, and SCUBA to evaluate benthic habitat and eelgrass presence. Based on our findings, the proposed reef locations will not impact eelgrass or benthic habitat. In addition, there are no potential impacts to commercial or recreational shellfish fisheries given that that all sites are located in an area in which harvest of shellfish is prohibited (i.e. Shellfish Spawner Sanctuary). We note that any shellfish located within the reef footprint will be relocated prior to reef construction, thus there will be no impacts to current shellfish stocks located within the Shellfish Spawner Sanctuary.

- In addition, recall that the goal of the proposed research is to determine if oyster reef construction can be used to improve growth and survival (i.e., productivity) of early-life stages of recreationally important fishes such as black sea bass (*Centropristis striata*), tautog (Tautoga onitis), scup (*Stenotomus chrysops)*, summer flounder (*Paralichthys dentatus*), and winter flounder (*Pseudopleuronectes americanus*). Previous work in the mid-Atlantic has shown these techniques to be successful, resulting in a significant increase in growth and survival of recreationally important species (e.g. Grabowski et al. 2005).

- We also emphasize that this research is conducted by a public entity and serves a compelling public purpose by providing benefits to public trust resources (e.g. the Ninigret Pond ecosystem and local fish stocks). Since this work consists of only returning substrate (shell) to waters of the state and placing oyster seed in areas that historically supported oysters or are currently sandy sediment with no complex structure and currently have low fish habitat value based on RI DFW finfish survey results, we expect the impacts will be beneficial, with no negative effects.

6. Demonstrate that the alteration will not unreasonably interfere with, impair, or significantly impact existing public access to, or use of, tidal waters and/or the shore;

- We do not anticipate any negative impacts from the proposed restoration work and no interference or impacts to existing public access to or use of tidal waters or the shore. For example, there are no potential impacts to commercial or recreational shellfish fisheries given that that all sites are located in an area where harvest of shellfish is prohibited (i.e. Shellfish Spawner Sanctuary). We note that any shellfish located within the reef footprint will be relocated prior to reef construction, thus there will be no impacts to current shellfish stocks located within the Shellfish Spawner Sanctuary. We highlight that we are only returning shell to marine waters and seeding this shell with live oysters.

- We emphasize that this work is proposed within a duly promulgated RI DEM Shellfish Management Area (RI General Law § 20-3-4) and within a RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret Pond (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1) which is closed to shellfish harvest and will serve as a sanctuary for oyster propagation and growth; thereby protecting the oyster reefs and the habitat and ecosystem services they provide.

- We also emphasize that this research is conducted by a public entity and serves a compelling public purpose by providing benefits to public trust resources (e.g. the Ninigret Pond ecosystem and local fish stocks). Since this work consists of only returning substrate (shell) to waters of the state and placing oyster seed in areas that historically supported oysters or are currently sandy sediment with no complex structure and currently have low fish habitat value based on RI DFW finfish survey results, we expect the impacts will be beneficial, with no negative effects.

7. Demonstrate that the alteration will not result in significant impacts to water circulation, flushing, turbidity, and sedimentation;

- We highlight that we are only returning shell to marine waters and seeding this shell with live oysters. The proposed work is far below a theoretical threshold that would/could result in impacts to water circulation or flushing. Oyster reef creation does not cause turbidity or sedimentation. In fact, oysters only result in positive effects on water quality.

- For example, oysters and ecological community supported by oyster reefs "clean the water" by removing nitrogen, enhancing water clarity, and also provide excellent habitat for juvenile fish and crustaceans. We do not anticipate any negative impacts from the proposed restoration work.

8. Demonstrate that there will be no significant deterioration in the quality of the water in the immediate vicinity as defined by DEM;

- We are only returning shell to marine waters and seeding this shell with live oysters. Oysters and ecological community supported by oyster reefs "clean the water" by removing nitrogen, enhancing water clarity, and also provide excellent habitat for juvenile fish and crustaceans. We do not anticipate any negative impacts from the proposed restoration work. We do not anticipate any negative impacts from the proposed restoration work.

- We also emphasize that this research is conducted by a public entity and serves a compelling public purpose by providing benefits to public trust resources (e.g. the Ninigret Pond ecosystem and local fish stocks). Since this work consists of only returning substrate (shell) to waters of the state and placing oyster seed in areas that historically supported oysters or is currently sandy sediment with no complex structure and currently have low fish habitat value based on RI DFW finfish survey results, we expect the impacts will be beneficial, with no negative effects.

9. Demonstrate that the alteration or activity will not result in significant impacts to areas of historic and archaeological significance;

- We note that we are only returning shell to marine waters and seeding this shell with live oysters. There is no dredging or removal of marine sediments associated with this project.
- We emphasize that this research is proposed within a duly promulgated RI DEM Shellfish Management Area (RI General Law § 20-3-4) and within a RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret Pond (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1). No areas of historic or archaeological significance have been identified within this area during numerous previous public meetings and previous APA processes.

10. Demonstrate that the alteration or activity will not result in significant conflicts with water-dependent uses and activities such as recreational boating, fishing, swimming, navigation, and commerce:

- We emphasize that this research is proposed within a duly promulgated RI DEM Shellfish Management Area (RI General Law § 20-3-4) and within a RI DEM Shellfish Spawner Sanctuary in the western end of Ninigret Pond (RI DEM Marine Fisheries Regulations, Shellfish Section, 13.17.1).

- These 8 experimental reef sites are grouped into 4 Study Plots. Study Plots 1and 2 (Figure 1, 2 in application) are located in the northern-end of the Shellfish Spawner Sanctuary adjacent to a large boulder field and not in areas that are navigable or have moorings.

- Study Plots 3 and 4 (Figure 1, 3 in application) are located in the southern-end of the Shellfish Spawner Sanctuary in the same general area as previous oyster reefs (n=14 reefs). Based on observations by DFW, TNC, and EPA as well as general comments by colleagues familiar with the area - this area is also not typically used for navigation and is out of the area used by windsurfers. In addition we note these plots are in the CRMC Water Type Classification of "Conservation Areas" and out of the "Low Intensity Use" area. We also attempted to site these reefs in waters outside of the area mapped as "surfing" by the Shellfish Management Process and as far from the DEM public access while staying within the Shellfish Spawner Sanctuary and suitable habitat requirements. Again the proposed reefs are in close proximity to existing reefs and we believe do not represent a significant modification to uses occurring in the general area.

- For reference, the DFW and TNC completed a site suitability analysis using available geospatial and fisheries data, including TNC oyster restoration suitability modeling results, marine sediment data, fish habitat data and DFW seine survey data combined with visual underwater inspections to determine potential suitable locations for establishing oyster reef habitat in Ninigret Pond. From the 16 potential experimental reef sites, we selected 8 experimental reef sites that minimize, and likely eliminate, impacts to other known uses occurring in these coastal ponds. For example, we eliminated potential sites that would be located along the central-portion of the western-boundary of the shellfish spawner sanctuary, which had habitat suitable for oyster restoration but is also frequented by windsurfers.

11. Demonstrate that measures have been taken to minimize any adverse scenic impact (see Section 330).

- The proposed work will result in no adverse scenic impacts given that these reefs will not be exposed or visible above the surface of the water. More specifically, we anticipate the top of each reef will be at minimum 12 inches below the surface of the water and typically 18-30 inches below mean low water depending on the site and given tide. This approach is generally consistent with the amount of water over oyster reefs at restoration sites located in the southern-end of the Shellfish Spawner Sanctuary created by DEM-NRCS, reefs in Foster Cove created by DEM-NRCS and some reefs in Foster Cove and grassy point that were created by DEM-TNC.

REFERENCES

Atlantic States Marine Fisheries Commission (ASMFC). 2007. The Importance of Habitat Created by Molluscan Shellfish to Managed Species along the Atlantic Coast of the United States: Habitat Management Series #8. Atlantic States Marine Fisheries Commission, Washington, D.C.

Beck, MW., RD. Brumbaugh, L. Airoldi, A. Carranza, LD. Coen, C. Crawford, O. Defeo, G.Edgar, B. Hancock, M. Kay, H. Lenihan, M. Luckenbach, C. Toropova, G. Zhang and X. Guo. 2011. Oyster reefs at risk and recommendations for conservation, restoration, and management. BioScience 61(2): 107–116.

Breitburg DL. 1999. Are three-dimensional structure and healthy oyster populations the keys to an ecologically interesting and important fish community? In: Lucken-bach M, Mann R, Wesson J (eds) Oyster reef habitat restoration: a synopsis of approaches. Virginia Institute of Marine Science Press, Williamsburg, Virginia, p 239–250.

Brown, DS. 2013. Substrate enhancement – taking eastern oyster (Crassostrea virginica) restoration to the next scalable, low-cost, community-driven approach. National Oceanographic Atmospheric Administration Community Restoration Program. Award # NA10NMF4630081.

Brumbaugh RD, Beck MW, Coen LD, Craig L, and Hicks P. 2006. A practitioner's guide to the design and monitoring of shellfish restoration projects: an ecosystem services approach. The Nature Conservancy

Bushek, D., Richardson, D., Bobo, M. Y., & Coen, L. D. 2004. Quarantine of oyster shell cultch reduces the abundance of *Perkinsus marinus*. Journal of Shellfish Research *23*(2), 369-374.

Coen LD, Luckenbach MW, and Breitburg DL. 1999. The role of oyster reefs as essential fish habitat: A review of current knowledge and some new per- spectives. Pages 438–454 in Benaka LR, ed. Fish Habitat: Essential Fish Habitat and Rehabilitation. American Fisheries Society. Symposium no. 22.

Coen, LD and Luckenbach, MW. 2000. Developing success criteria and goals for evaluating oyster reef restoration: ecological function or resource exploitation? Ecol Eng 15:323–343.

Deegan, L.A., and Buchsbaum R. 2005. The effect of habitat loss and degradation on fisheries. *The Decline of Fisheries Resources in New England*, *67*.

Griffin, M., B DeAngelis, M. Chintala, B. Hancok, D. Leavitt, T. Scott, D. S. Brown, and R. Hudson. 2012. Rhode Island Oyster Restoration Minimum Monitoring Metrics and Assessment Protocols. Prepared for the Rhode Island Shellfish Technical Working Group. April 2012.

Grabowski, JH, Hughes AR, Kimbro DL, and Dolan MA. 2005. How habitat setting influences restored oyster reef communities. Ecology 86: 1926–1935.

Grabowski, JH, and CH Peterson. 2007. Restoring oyster reefs to recover ecosystem services. In: Cuddington K, Byers JE, Wilson WG, Hastings A (eds) Ecosystem engineers: concepts, theory and applications. Elsevier-Academic Press, Amsterdam, p 281–298.

Harding, JM & R Mann. 2001. Oyster reef habitat use by estuarine fishes: Optimal or essential fish habitat? Journal of Shellfish Research. 20(3): 951-959.

Meng, L., & Powell, J. C. 1999. Linking juvenile fish and their habitats: An example from Narragansett Bay, Rhode Island. *Estuaries*, *22*(4), 905-916.

Saucerman, S. E., & Deegan, L. A. 1991. Lateral and cross-channel movement of young-of-the-year winter flounder (Pseudopleuronectes americanus) in Waquoit Bay, Massachusetts. *Estuaries*, *14*(4), 440-446.

Wells, HW 1961. The Fauna of Oyster Beds, with Special Reference to the Salinity Factor. Ecological Monographs 31:239–266.

zu Ermgassen, P. S., Spalding, M. D., Grizzle, R. E., & Brumbaugh, R. D. 2013. Quantifying the loss of a marine ecosystem service: filtration by the eastern oyster in US estuaries. *Estuaries and Coasts*, *36*(1), 36-43.

Sportfish Assessment and Management in Rhode Island Waters

Mark Gibson
Jason McNamee
John Lake
Eric Schneider
Nicole Lengyel

R. I. Division of Fish & Wildlife
Marine Fisheries
Ft. Wetherill Marine Laboratory
3 Ft. Wetherill Road
Jamestown, Rhode Island 02835

STATE: Rhode Island

PROJECT NUMBER: F-61-R

SEGMENT NUMBER: 22

PROJECT TITLE: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

PERIOD COVERED: January 1, 2015 – December 31, 2015

JOB NUMBER 8 TITLE: Sportfish Assessment and Management in Rhode Island Waters
During this segment, several fish stock assessments were completed that included a lobster benchmark stock assessment, a menhaden benchmark stock assessment, a striped bass stock assessment update, a bluefish benchmark stock assessment, a scup benchmark stock assessment, a tautog benchmark assessment, a winter flounder operational assessment, and a summer flounder stock assessment update. In addition to completed stock assessments, there are several other stock assessments that have been initiated and are in progress including a black sea bass benchmark stock assessment, an Atlantic sturgeon benchmark assessment, and a weakfish benchmark stock assessment. RI also contributes local small scale stock assessments to help inform local management decisions, and these often rely on survey information that is derived from surveys funded by the sportfish restoration grant. Scientific advice to fisheries managers emerged from these assessments, particularly during the deliberations of the state's licensing provisions for 2015 as well as in the process for setting the recreational management plans for 2016. The project leaders participated at the Atlantic States Marine Fisheries Commission's meetings relative to the management of recreationally important coastal stocks. They also participated in the National Marine Fisheries Service (NMFS) stock assessment meetings for species under their jurisdiction. Other project staff participated at fish stock assessment trainings conducted through ASMFC and NOAA. The status of the most important recreationally caught species in Rhode Island were presented in the finfish sector management plan which was submitted for public review and input for establishing management strategies for 2016 (Finfish Sector Management Plan 2015, see: http://www.dem.ri.gov/pubs/regs/regs/fishwild/mpfinfsh.pdf). The following is a summary of the activities that took place in 2015.

1. SUMMER FLOUNDER
Beginning when the new statistical catch at age stock assessment (ASAP = age structured assessment program) was introduced and peer reviewed in 2008, an annual update has been performed for the coastwide stock for summer flounder. These updates are less time consuming than full benchmark assessments, but still require some work to be able to perform the update. In 2013, a full benchmark assessment was performed and was peer reviewed at the SAW57 meeting (http://www.nefsc.noaa.gov/saw/saw57/Agenda-SAWSARC57-Rev%207242013.pdf). This assessment passed peer review and was updated for management use in 2014 and 2015. The main tasks are to gather both catch and fishery independent information from the previous year, and stratify that information by age based on aging information from the NMFS trawl survey. RI contributes its Division of Fish and Wildlife trawl survey data (see job number 2 from this grant) to the assessment. Staff collects the information and age stratifies it for the assessment. Staff also participates in several meetings where the assessment information is released, and staff were active members of the

southern demersal working group that reviewed all of the update stock assessment information including data and research on summer flounder.

2. ATLANTIC MENHADEN

The ASMFC began a benchmark assessment in 2013 for the coastwide stock for Atlantic menhaden. The Atlantic menhaden stock is assessed with a statistical catch at age model called BAM (Beaufort Assessment Model). This is a full benchmark assessment, therefore is more time consuming than an update assessment, so while it was begun in 2013, it concluded in 2014. The main tasks were to gather both catch and fishery independent information from the previous year, and stratify that information by age based on aging information from the NMFS menhaden sampling program, which RI contributed locally caught samples to. RI contributes its Division of Fish and Wildlife seine survey data (see job number 4 from this grant) to the assessment, and the use of the RI trawl survey data (jobs 1 and 2 from this report) was a new addition to the assessment data elements for this benchmark assessment. Staff collects the information and processes it for the assessment. Staff also participates in meetings where the assessment information is reviewed and are active members of the stock assessment sub-committee. The benchmark assessment passed peer review in December of 2014 and is now being used for management changes to be developed during 2015.

3. BLUEFISH

Beginning when the new statistical catch at age stock assessment (ASAP = age structured assessment program) was introduced and peer reviewed in 2005, an annual update has been performed for the coastwide stock for bluefish. These updates are less time consuming than full benchmark assessments, but still require some work to be able to perform the update. The main tasks are to gather both catch and fishery independent information from the previous year, and stratify that information by age based on aging information from the bluefish aging program, which RI contributes to. Staff collects the aging structures and processes them for aging. Staff has also started to participate in the aging process (see job 9 from this report). Staff also participates in meetings where the assessment update information is released. A full benchmark was initiated in 2014 and concluded in 2015. RI contributed both the trawl survey and seine survey information for the benchmark assessment, and staff participated in the development of all of the assessment information for use in the benchmark assessment with our partners at the ASMFC and NMFS.

4. ATLANTIC STURGEON

The ASMFC began a benchmark assessment in 2013 for the various stocks for Atlantic sturgeon. The Atlantic sturgeon stock is difficult to assess due to a lack of data. This is a full benchmark assessment, therefore is very time consuming and given the multistock nature of sturgeon, this assessment will take time to complete. While it was begun in 2013, it will not conclude until 2016 or perhaps even later. The main tasks are to gather both catch and fishery independent information from previous years. Staff collects the information and processes it for the assessment. Staff also participates in meetings where the assessment information is reviewed and are active members of the stock assessment sub-committee.

5. STRIPED BASS

The ASMFC began a benchmark assessment in 2013 for the coastwide stock for striped bass. The Atlantic striped bass stock is assessed with a statistical catch at age model called SCAM (Statistical Catch-at-age Assessment Model), though different model configurations were tested for the benchmark. A full benchmark assessment was performed and was peer reviewed at the SAW57 meeting (http://www.nefsc.noaa.gov/saw/saw57/Agenda-SAWSARC57-Rev%207242013.pdf), along with summer flounder. This assessment passed peer review in 2013 and was used for fisheries management in 2014 and 2015 through update assessments. The main tasks are to gather both catch and fishery independent information from the previous year, and stratify that information by age based on aging information from various sources, which RI contributed locally caught samples to. RI attempted to contributes its Division of Fish and Wildlife seine survey data (see job number 4 from this grant) to the assessment, however this survey did not make it in to the accepted assessment. Staff collects the information and processes it for the assessment. Staff also participates in meetings where the assessment information is reviewed.

6. TAUTOG

The ASMFC began a benchmark assessment in 2013 for the tautog stock. The tautog stock had been assessed with a Virtual Population Analysis, but for the benchmark several other data rich and data poor models were tested. This was a full benchmark assessment, therefore is more time consuming than an update. In addition, the stock assessment has progressed from a coastwide assessment to a regional set of assessments. The main tasks are to gather both catch and fishery independent information from the previous year, and stratify that information by age based on aging information that is collected in each state, and which RI contributed locally caught samples to. RI contributes its Division of Fish and Wildlife seine survey data (see job number 4 from this grant), trawl survey data (see jobs 1 and 2 from this document), and hopes to contribute the new ventless pot survey info in the future to the assessment. Staff collects the information and processes it for the assessment. Staff also participates in several meetings where the assessment information is reviewed and are active members of the stock assessment sub-committee. RI is contributed a novel data poor modeling approach to the benchmark review, a Bayesian State Space Surplus Production model. The benchmark assessment passed peer review in 2014 and was accepted for management in 2015 (http://www.asmfc.org/uploads/file//55131e862015TautogAssessmentOverview_Feb2015.pdf), though the process for setting specifications has continued in to 2016.

7. LOBSTER

The ASMFC began a benchmark assessment in 2013 for the three American lobster stock units (gulf of Maine, Georges Bank, and Southern New England), which concluded in 2015. The American lobster stocks are assessed with a statistical catch at length model developed by researchers from the University of Maine. This is a full benchmark assessment, therefore is more time consuming than an update assessment, so while it was begun in 2013, it was reviewed in 2015, and will now be considered for management use. The separate stocks for Georges Bank and the Gulf of Maine were combined in to a single stock unit for the 2015 benchmark. The main tasks are to gather both catch and fishery independent information from the previous year, and stratify that information by length based on biosampling information from numerous sources, which RI contributed locally caught samples to. RI contributes its Division of Fish and Wildlife trawl survey data (see job numbers 1 and 2 this grant) and ventless trap survey information to the assessment. Staff collects the information and processes it for the assessment. Staff also participates in meetings where the assessment information is reviewed and are active members of the stock assessment sub-committee.

8. BLACK SEA BASS

Beginning when the new statistical catch at length stock assessment (SCALE = statistical catch at length) was introduced and peer reviewed in 2008, an annual update has been performed for the coastwide stock for black sea bass. These updates are less time consuming than full benchmark assessments, but still require some work to be able to perform the update. In 2012, a full benchmark assessment was performed and was peer reviewed which switched to a statistical catch at age modeling framework. This assessment did not pass peer review so has not been used for management. A new benchmark assessment was initiated in 2015 and will go to review in 2016. The main tasks are to gather both catch and fishery independent information and stratify that information by age based on aging information from the NMFS trawl survey. RI contributes its Division of Fish and Wildlife trawl survey data (see job number 2 from this grant) to the assessment. Staff collects the information and age stratifies it for the assessment. Staff also participates in meetings where the assessment information is released, and staff are active members of the southern demersal working group. In addition to our participation with our federal and state partners, RI staff will be developing an alternative catch at age model that incorporates spatial considerations in to the modeling framework. As an additional assessment task, RI staff developed a data poor model management strategy evaluation in 2015, which was used to set 2016 quota levels for black sea bass.

10. SCUP

Beginning when the new statistical catch at age stock assessment (ASAP = age structured assessment program) was introduced and peer reviewed in 2008, an annual update has been performed for the coastwide stock for scup. These updates are less time consuming than full benchmark assessments, but still require some work to be able to perform the update. In 2014, a full benchmark assessment was initiated for scup and passed review in 2015. The main tasks are to gather both catch and fishery independent information from the previous year, and stratify that information by age based on aging information from the NMFS trawl survey. RI contributes its Division of Fish and Wildlife trawl survey data (see job number 2 from this grant) to the assessment. Staff collects the information and age stratifies it for the assessment. Staff also participates in meetings where the assessment information is released, and staff were active members of the southern demersal working group that reviewed all of the benchmark stock assessment information including data and research on scup.

11. WINTER FLOUNDER

Beginning when the new statistical catch at age stock assessment (ASAP = age structured assessment program) was introduced and peer reviewed in 2010, an updates and operational assessments has been performed for the coastwide stock for winter flounder. These updates are less time consuming than full benchmark assessments, but still require some work to be able to perform the update. In 2011, a full benchmark assessment was performed and was peer reviewed at the SAW52 meeting (http://www.asmfc.org/uploads/file/56d762c711-004_2011WinterFlounderStockAssessment[1].pdf). This assessment passed peer review and was updated through an operational assessment for management use in 2015. The main tasks are to gather both catch and fishery independent information from the previous year, and stratify that information by age based on aging information from the NMFS trawl survey. RI contributes its Division of Fish and Wildlife trawl survey data (see job number 2 from this grant) as well as seine survey data (see job number 4 from this grant) to the assessment. Staff collects the information and age stratifies it for the assessment. Staff also participates in several meetings where the assessment information is released, and staff were active members of the southern demersal working group that reviewed all of the update stock assessment information including data and research on winter flounder.

12. 2016 SCHEDULE

As previously noted, several stock assessments were initiated in 2015, and are scheduled to conclude in 2016. A weakfish benchmark assessment is scheduled for 2016, a black sea bass benchmark assessment is scheduled for 2016, and a sturgeon benchmark assessment will continue in to 2016.

ASSESSMENT OF RECREATIONALLY IMPORTANT FINFISH STOCKS IN RHODE ISLAND WATERS

Age and Growth Study

Nicole Lengyel
Thomas Angell

R. I. Division of Fish & Wildlife
Marine Fisheries
Ft. Wetherill Marine Laboratory
3 Ft. Wetherill Road
Jamestown, Rhode Island 02835

March 2016

PERFORMANCE REPORT

STATE: Rhode Island **PROJECT NUMBER:** F-61-R

SEGMENT NUMBER: 22

PROJECT TITLE: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

PERIOD COVERED: January 1, 2015 – December 31, 2015

JOB NUMBER AND TITLE: 9, Age and Growth Study

JOB OBJECTIVE: To collect age, growth, and diet composition data on recreationally and ecologically important finfish in Narragansett Bay for management purposes. Data collected in this study will be used in state, regional and coast-wide fisheries management.

SUMMARY: Investigators collected lengths, weights, and age structures from target species of recreationally important finfish. The type of age structure collected and the number of samples collected varied by species. Investigators were able to achieve all sampling targets in 2015 with the exception of bluefish and tautog as a result of breakage of fragile bluefish otoliths and cancellation of tautog sampling trips due to adverse weather. Investigators continued to utilize recreational fishing groups in 2015, specifically, the Rhode Island Party and Charter Boat Association (RIPCBA), to obtain fish racks. The donation of fish racks decreases the amount of time that investigators need to be in the field collecting samples and allows more time for processing and ageing the collected structures. Work to age the primary ageing structures collected in 2015 is complete.

In addition to age and growth data collected in 2015, investigators continued the collection of stomach content, sex and maturity stage data from target species in 2015. This data was collected through collaboration with investigators on the RIDEM monthly and seasonal trawl survey (Jobs 1 and 2).

TARGET DATE: Ongoing

STATUS OF PROJECT: On schedule

SIGNIFICANT DEVIATIONS: No significant deviations occurred in 2015

RECOMMENDATIONS: Move into the next project segment and continue data collection in 2016.

REMARKS: None

INTRODUCTION

Age and growth information is essential in estimating the age-structure of a fish population. Understanding the age-structure of a population allows scientists to make informed management decisions regarding acceptable harvest levels for a species. In recent years, diet composition of finfish has become increasingly important in understanding the age and growth of a population. Diet composition of a species may help to inform managers on whether an observed change in a population may be due to prey availability. Understanding predator –prey dynamics can also allow managers to utilize a multi-species modeling approach by which they can better understand not only the population dynamics of one particular target species, but other choke or prey species that may be associated with the target species.

This study is aimed to characterize the age-structure and diet composition of stocks whose ranges extend into Narragansett Bay and will supplement data collected in the Northeast Fisheries Science Center (NEFSC) spring and fall surveys, which limit their sampling to the mouth of Narragansett Bay. Data collected in this study is already used in several stock assessments and we expect that number to increase each year as benchmark stock assessments are conducted. Additionally, this study satisfies the requirements of the Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plans (FMP's) for striped bass, tautog, bluefish, menhaden and weakfish which require the state of Rhode Island to collect a minimum number of age and growth samples annually for stock assessment purposes. This study has also been designed to use other jobs in this grant as a platform for obtaining biological samples.

Collection of stomach content, sex, and maturity stage data for the species listed above was initiated in 2014. This task also included collection of both scale and otolith samples for ageing, except for menhaden for which only scale samples were taken and weakfish and bluefish for which only otolith samples were taken.

METHODS, RESULTS & DISCUSSION

Seasonal port sampling of nine species of finfish considered to be extremely important to the recreational fishing community was conducted primarily from May through November of 2015. Data collected included lengths, weights and the appropriate age structure for the specific species (i.e. scale, otolith, or operculum). The number of samples and age structures collected varied depending on the species (Table 1). Investigators focused on obtaining samples from various locations throughout the state from various finfish dealers, recreational anglers, commercial floating fish trap companies, a commercial purse seine company, and Rhode Island Division of Fish and Wildlife (RIDFW) surveys (otter trawl and fish pot) (Table 2).

Diet composition data was collected for high priority species by excising fish stomachs from fish collected during the RIDFW seasonal and monthly bottom trawl surveys, RIDFW Fish Pot survey, or from fish racks and whole fish collected during port sampling. Additional data collected from these samples included length, weight (if whole fish available), sex, and maturity. Once stomachs were removed, they were analyzed in the laboratory by sorting and identifying prey to the lowest taxonomic level possible and recording the wet mass for each taxon. All collected data were entered and stored in a database.

Black sea bass

A total of 116 black sea bass age samples were collected from multiple sources including floating fish traps, hook and line, and RIDFW otter trawl and fish pot surveys in 2015. Currently the use of scales is an acceptable ageing technique for black sea bass; however some labs that have fishery independent surveys along the Atlantic coast use a combination of scales and otoliths. While scales are the primary age structure collected by project staff, when available, otoliths are collected as well. Black sea bass samples ranged in size from 10-19 inches (24-50 cm) total length and were 2-6 years old (Figure 1). Biological samples were dominated by 4 year old fish due to a strong 2011 year class. Stomach content and maturity stage data was collected from 38 black sea bass. Stomach contents included prey items from 8 taxonomic groups (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10 and demonstrates that black sea bass stomachs were dominated by bivalve molluscs and crustaceans.

Bluefish

The ASMFC requires that a minimum of 100 bluefish age samples be collected annually by the state of Rhode Island. Due to the assistance of the RIPCBA and RIDFW otter trawl survey, we successfully collected 96 bluefish age samples in 2015. Bluefish have very fragile otoliths, and due to breakage during otolith removal, we fell slightly short of our target of 100 structures. Bluefish samples ranged in fork length from 12-33 inches and 1-11 years old (Figure 2). Stomach content and maturity stage data was collected from 89 bluefish. Stomach contents included prey items from 4 taxonomic groups (Table 3). Figure 10 shows that of the bluefish stomachs examined, 62% of all stomach contents contained other finfish.

Menhaden

Atlantic menhaden age samples were collected in 2015 from floating fish trap and purse seine operations. Typically scale samples collected from menhaden are sent to the NMFS Southeast Fisheries Science Center (SEFSC) Beaufort Lab for ageing due to the degree of difficulty in ageing Atlantic menhaden. In 2014 however, the ASMFC conducted a hard parts exchange of menhaden scales and in early 2015 held an ageing workshop to train state and federal agencies on ageing menhaden. As a result, DFW staff aged all menhaden scales collected in 2015. A total of 110 menhaden samples were collected that ranged in fork length from 10.1-12.5 inches (26-32 cm) and age from 2-4 years old (Figure 3). The vast majority of fish sampled were 2 and 3 year olds with only 2 fish at 4 years old. Stomach content and maturity stage data was also collected from all 110 menhaden. Due to the fact that menhaden are filter feeders, all stomach contents encountered were liquefied, with prey item(s) unable to be identified and classified (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10.

Scup

Scup age samples were collected in 2015 from multiple sources including floating fish traps, hook and line, and RIDFW otter trawl and fish pot surveys. Investigators successfully collected scales from 143 scup ranging in fork length from 5.2-15.4 inches and age from 1-10 years old (Figure 4). Stomach content and maturity stage data was collected from 48 scup. Stomach contents included prey items from 6 taxonomic groups (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10 and shows that 62% of stomach contents were comprised of crustaceans, bivalve molluscs and polychaetes.

Striped Bass

A total of 388 striped bass scale samples were collected and aged in 2015. Each year investigators set a sampling target of 150 samples from floating fish traps and 150 samples from the general category fishery. Floating fish traps have a minimum size of 26” while the commercial general category fishery has a minimum size of 34”. Sampling from both of these operations allows us to sample a wider size range of striped bass. Additionally, 15 of the 388 striped bass age samples were collected from the RIDFW otter trawl survey. Striped bass sampled ranged from 18.5-49.2 inches fork length and 3-17 years old (Figure 5). Stomach content and maturity stage data was collected from 124 striped bass. Stomach contents included prey items from 6 taxonomic groups with 69% of stomach contents being other finfish (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10.

Summer Flounder

A total of 102 summer flounder scale samples were collected in 2015. The majority of these samples came from the floating fish trap fishery (n=73) and additional samples were collected by RIDFW staff (n=29) on board our RIDFW otter trawl survey (Jobs 1 and 2). Summer flounder samples collected varied in size from 10.3-22.4 inches (26-47 cm) total length and 1-6 years old (Figure 6). Stomach content and maturity stage data was collected from 29 summer flounder. Stomach contents included prey items from 4 taxonomic groups (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10 and shows that summer flounder stomachs were dominated by finfish and cephalopod molluscs.

Tautog

A total of 178 tautog operculum samples were collected in 2015 from the hook and line fishery and RIDFW fish pot survey. Several sampling trips planned for the fall of 2015 were cancelled due to inclement weather that prevented staff from reaching their target of 200 fish. Tautog samples ranged from 6.4-23.8 inches total length and 1-17 years old (Figure 7). Stomach content and maturity stage data was collected from 178 tautog. Stomach contents included prey items from 9 taxonomic groups (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10and shows that the tautog diet is primarily comprised of crustaceans.

Weakfish

The state of Rhode Island is required to collect three age structures per metric ton of weakfish landed commercially in the state by the ASMFC. In 2015, this would have resulted in a sampling target of 21 fish. In recent years weakfish have become scarce in RI which has resulted in extreme difficulty in obtaining samples. Investigators now purchase fish directly from seafood dealers at market value to ensure that they can obtain samples. A total of 33 weakfish otolith samples were collected in 2015. Weakfish sampled ranged from 10.7-28.1 inches total length and 1-5 years old (Figure 8). The majority of weakfish sampled were 1-3 years old with only one individual at 5 years old. Stomach content and maturity stage data was collected from 33 weakfish. Stomach contents included prey items from 3 taxonomic groups with finfish comprising 63% (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10.

Winter Flounder

A total of 13 winter flounder scale samples were collected in 2015. All of these samples were collected by RIDFW staff on board our RIDFW otter trawl survey (Jobs 1 and 2). Winter flounder samples collected varied in size from 10-15 inches total length and 2-4 years old (Figure 9). Stomach content and maturity stage data was collected from 13 winter flounder. Stomach contents included prey items from 6 taxonomic groups with polychaetes making up 53% of all stomach contents (Table 3). The proportional contribution of stomach contents encountered is shown in Figure 10.

SUMMARY

In 2015 investigators were able to collect the target sample numbers for black sea bass, menhaden, scup, striped bass, summer flounder, and weakfish; target sample numbers were not achieved for bluefish (96/100) and tautog (178/200). In the two cases where the sample target was not achieved, this was due to inclement weather, and breakage of fragile otoliths. In 2015, staff will continue reaching out to additional seafood dealers and the recreational community to ensure that the target number of samples is met for each species. Processing and ageing of all hard parts is complete for 2015. Staff participated in two ageing workshops in 2015, a menhaden ageing workshop and a joint workshop between the Gulf States Marine Fisheries Commission and ASMFC to draft a Gulf and Atlantic coasts ageing manual. Staff will continue to participate in ASMFC ageing workshops as they occur in 2016.

FIGURES

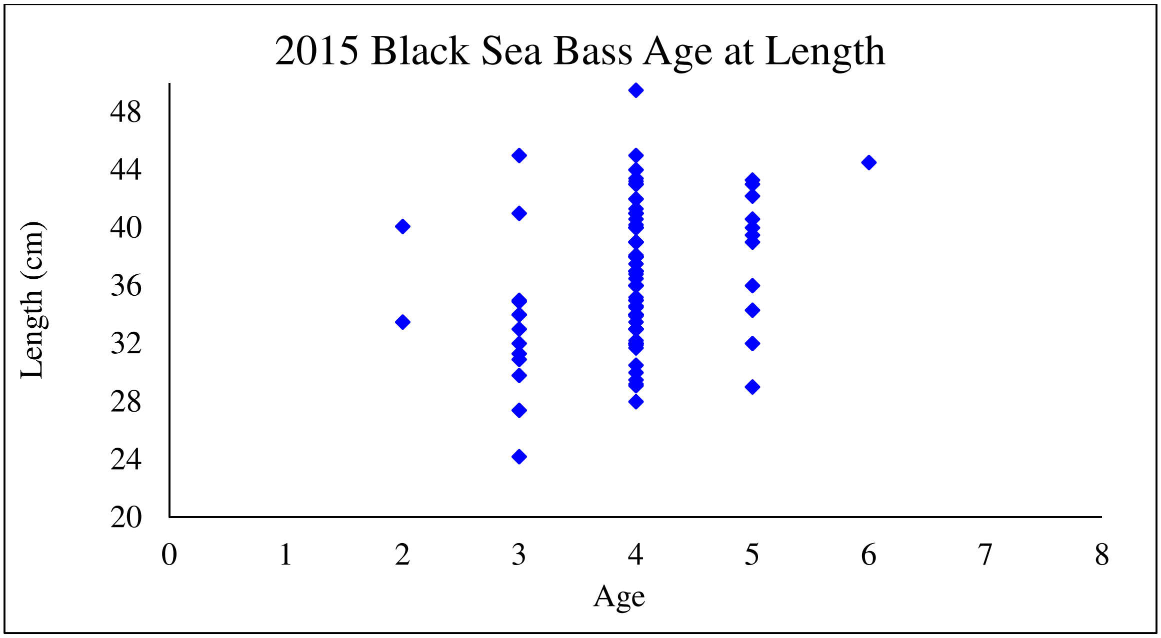


Figure 1. Black sea bass age at length.

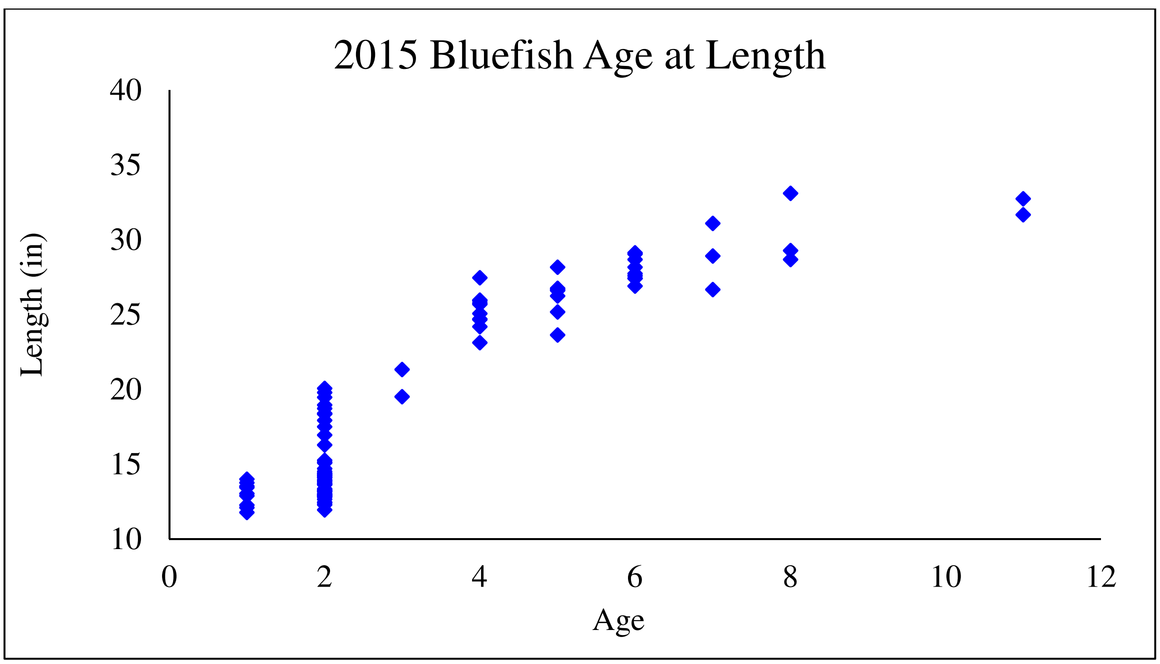


Figure 2. Bluefish age at length.

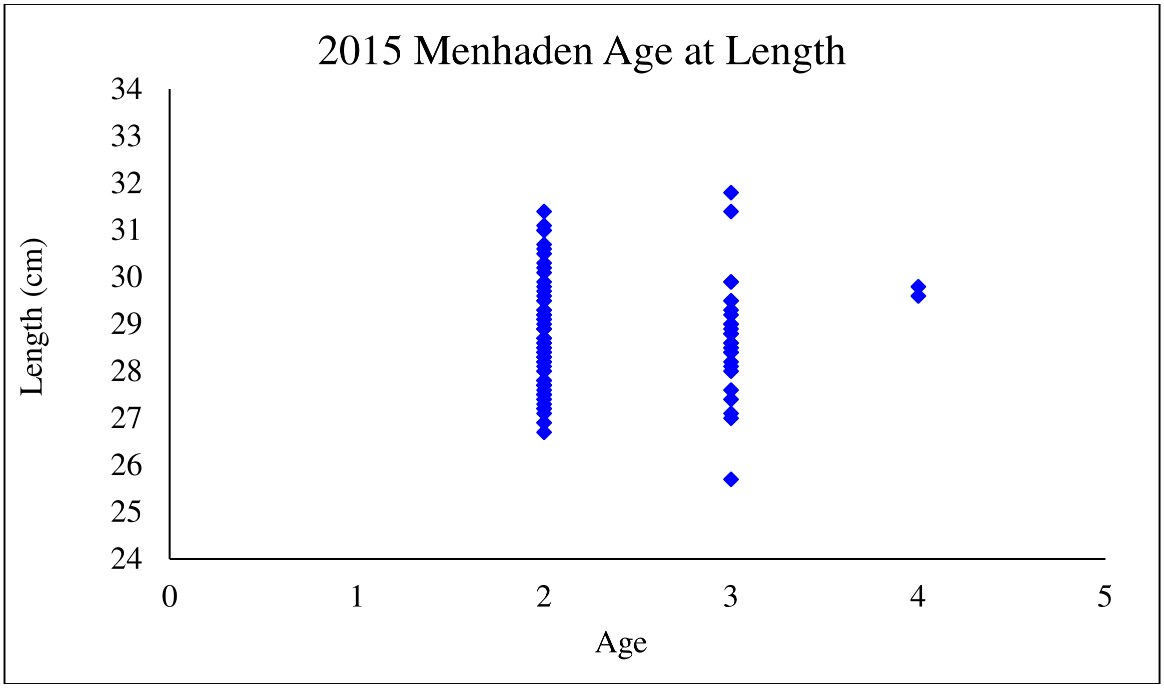


Figure 3. Menhaden age at length.

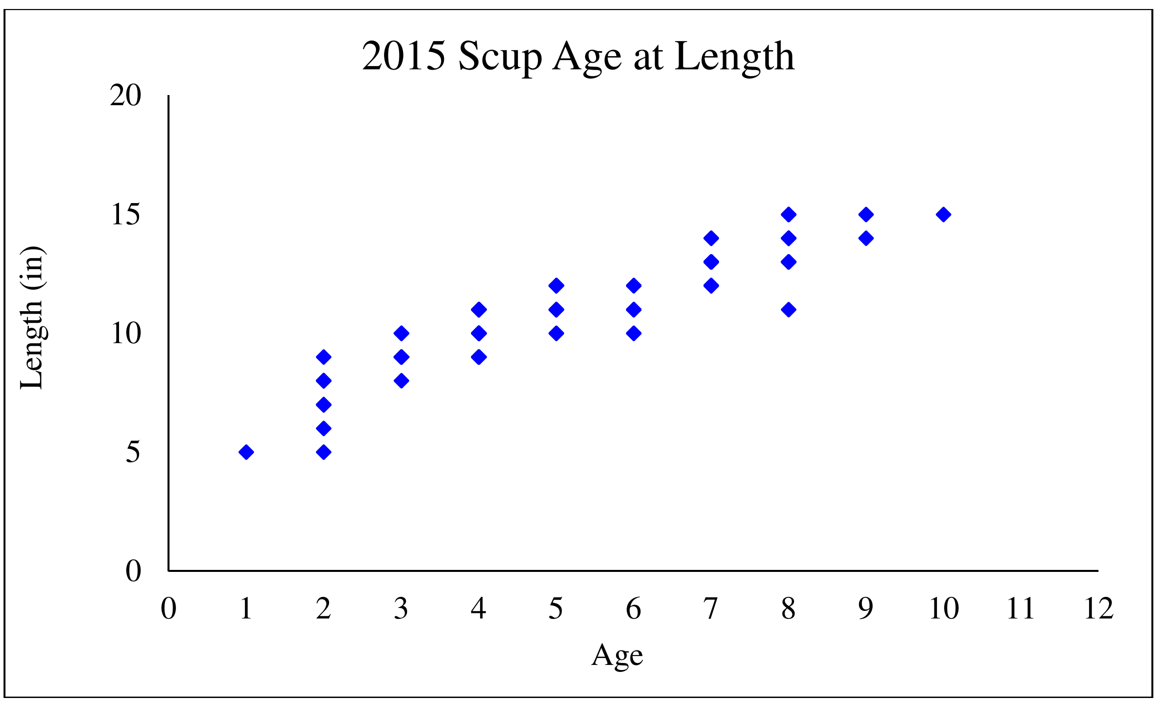


Figure 4. Scup age at length.

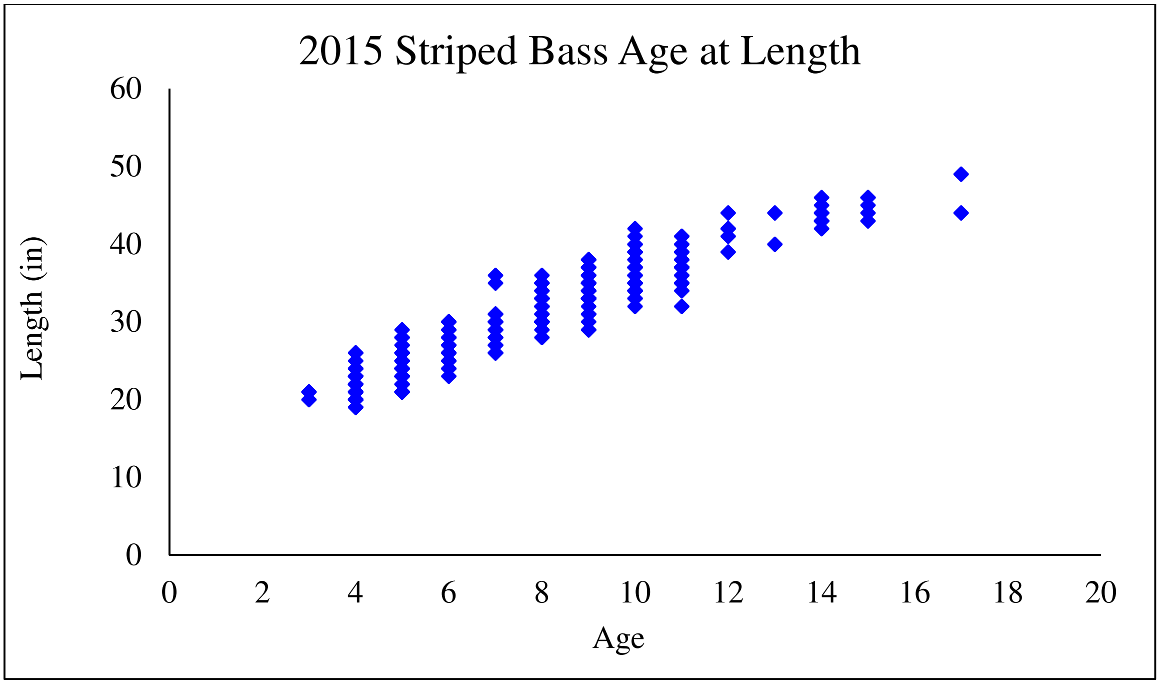


Figure 5. Striped bass age at length.

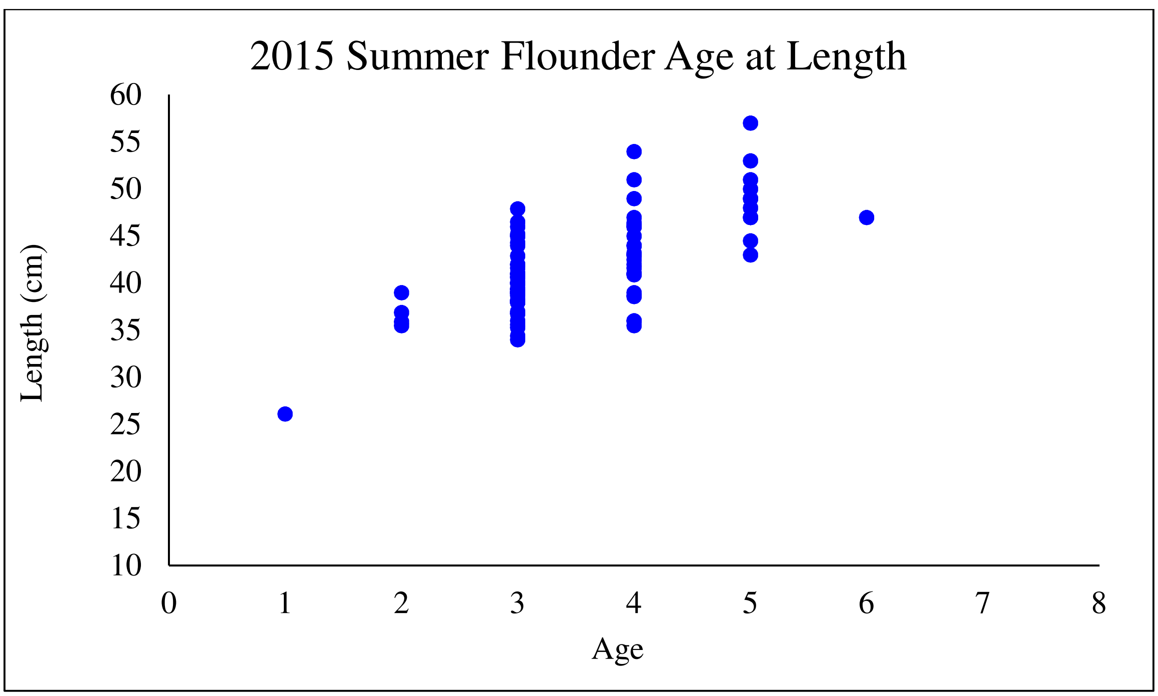


Figure 6. Summer flounder age at length.

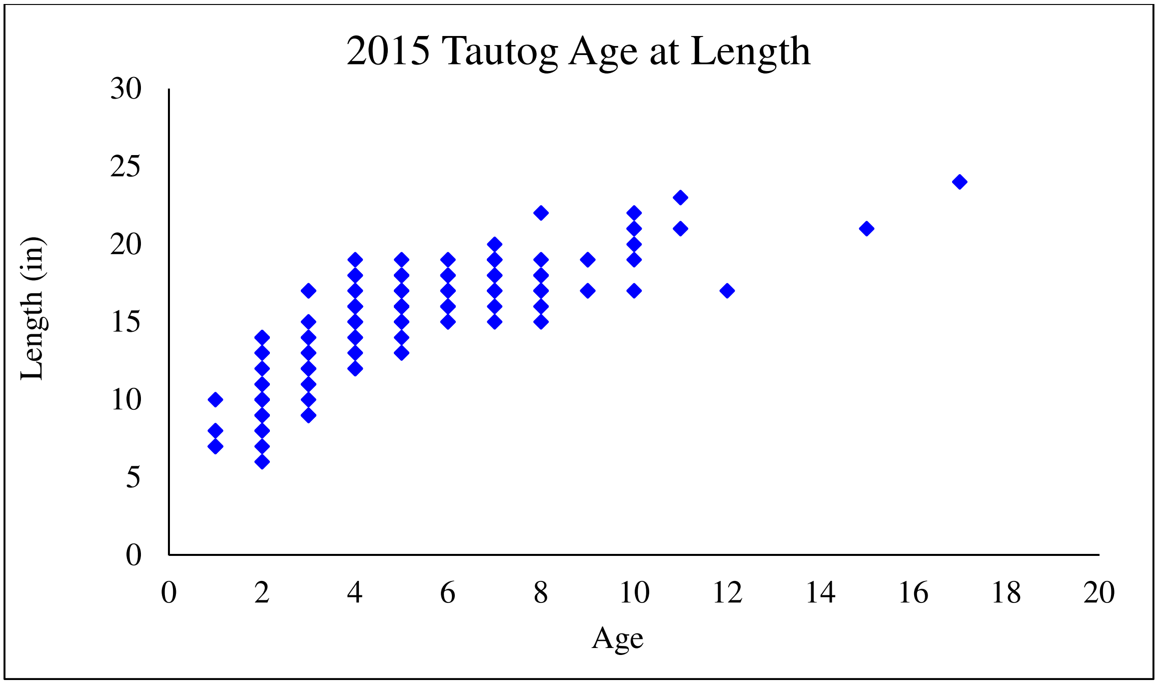


Figure 7. Tautog age at length.

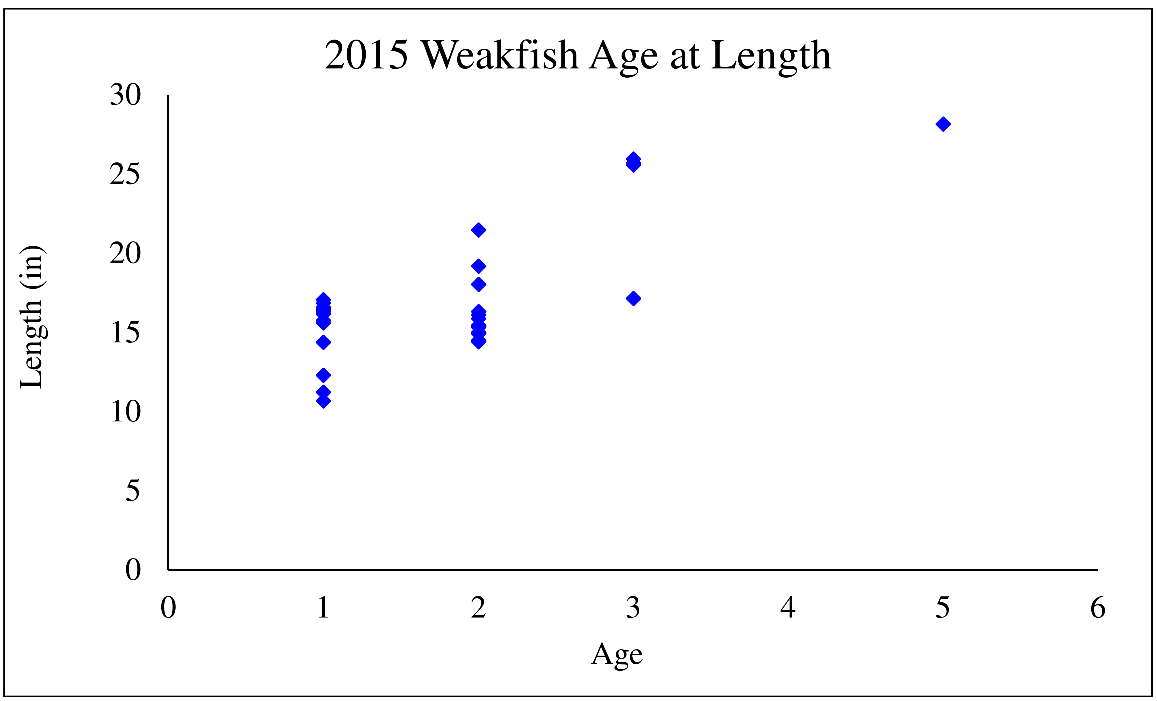


Figure 8. Weakfish age at length.

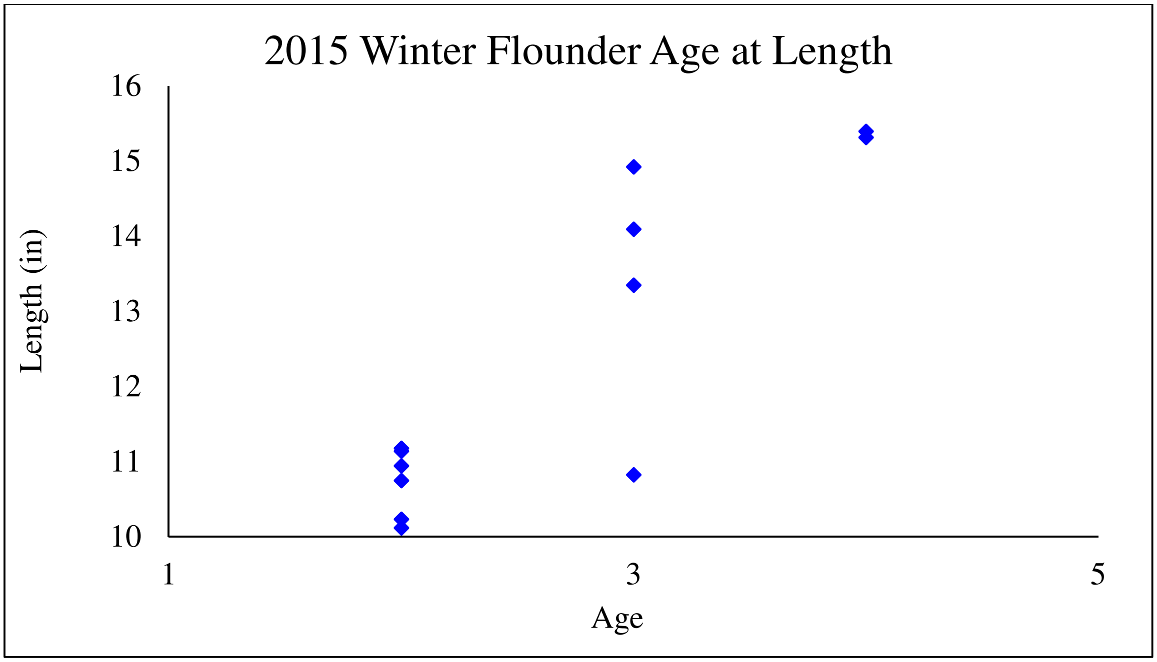


Figure 9. Winter flounder age at length.

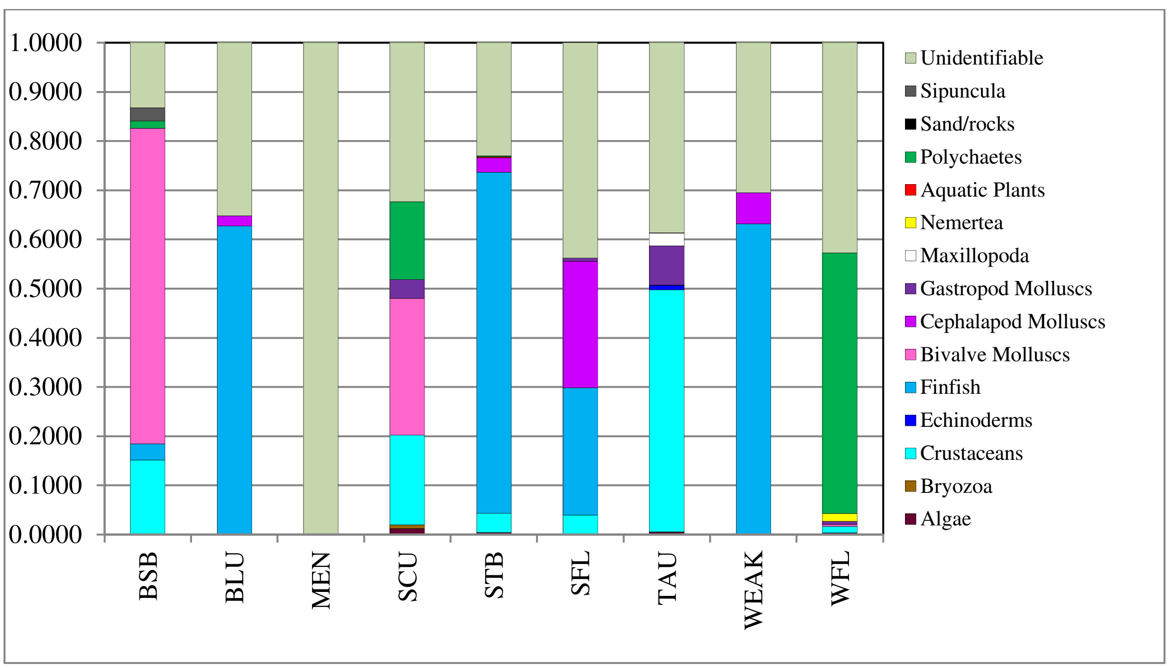


Figure 10. Proportional contribution of stomach content types by species.

TABLES

Table 1. Species, number of ageing structures, and number of fish sampled in 2014.

Common name	Ageing structure	Target number of ageing structures	Number of ageing structures collected
Black sea bass	Scale	100	116
Bluefish***	Otolith	100	96
Menhaden	Scale	100	110
Scup	Scale	100	143
Striped bass	Scale	150 fish/gear type**	388
Summer Flounder	Scale	100	102
Tautog***	Operculum/Otolith	200	178
Weakfish	Otolith	3 fish aged per metric ton landed*	33
Winter Flounder	Scale	NA	13

*Per ASMFC FMP requirements, 21 ages required for 2015
**Gear types include floating fish trap and general category
***Required by ASMFC

Table 2. Gear type sampled for each species collected in 2015 (FFT=Floating Fish trap).

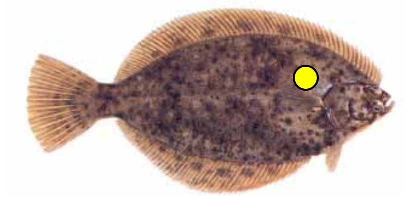
Common name	Gear Type
Black sea bass	FFT, Hook and Line, Fish Pot, Otter Trawl
Bluefish	Hook and Line, Otter Trawl
Menhaden	FFT, Purse Seine
Scup	FFT, Hook and Line, Fish Pot, Otter Trawl
Striped bass	FFT, Hook and Line, Otter Trawl
Summer Flounder	FFT, Hook and Line, Fish Pot, Otter Trawl
Tautog	Hook and Line, Fish Pot
Weakfish	Otter Trawl
Winter Flounder	Otter Trawl

Table 3. Summary of stomach content sampling by species.

SPECIES	# STOMACHS	# PREY TAXA
Black Sea Bass	38	8
Bluefish	89	4
Menhaden	110	0
Scup	48	6
Striped Bass	124	6
Summer Flounder	29	4
Tautog	178	9
Weakfish	33	3
Winter Flounder	13	6

Table 4. Proportional contribution of stomach content types by species (see Figure 10).

	BSB	BLU	MEN	SCU	STB	SFL	TAU	WEAK	WFL
Algae	0.0001	0.0001		0.0119	0.0042		0.0049		0.0035
Bryozoa				0.0079			0.0007		
Crustaceans	0.1514			0.1821	0.0388	0.0392	0.4924	0.0014	0.0130
Echinoderms							0.0086		
Finfish	0.0327	0.6271			0.6934	0.2589		0.6304	
Bivalve Molluscs	0.6413			0.2784			0.0010		0.0043
Cephalapod Molluscs		0.0208			0.0295	0.2572		0.0631	
Gastropod Molluscs	0.0003			0.0383		0.0068	0.0794		0.0061
Maxillopoda							0.0258		
Nemertea									0.0156
Aquatic Plants	0.0003	0.0002			0.0022				
Polychaetes	0.0148			0.1583	0.0015		0.0001		0.5303
Sand/rocks							0.0008		
Sipuncula	0.0269								
Unidentifiable	0.1322	0.3517	1.0000	0.3232	0.2304	0.4378	0.3863	0.3051	0.4273



Assessment of Recreationally Important Finfish Stocks in Rhode Island Coastal Waters

Winter Flounder Spawning Stock Biomass Survey in Pt. Judith Pond ,RI

Scott D. Olszewski
Scott.Olszewski@dem.ri.gov
John Lake
John.Lake@dem.ri.gov

Rhode Island Division Fish and Wildlife
Marine Fisheries
Jamestown, Rhode Island

Rhode Island Department of Environmental Management
Federal Aid in Sportfish Restoration
F-61-22

Performance Report March, 2016

State:	Rhode Island	Project Number: F-61-R-22

Project Title: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

Period Covered: January 1, 2005 - May 30, 2015

Job Number and Title: Job III - Spawning Stock Biomass (SSB) in Rhode Island Coastal Ponds.

Job Objective: To support a seasonal Young of the Year Winter flounder survey by providing data on the dynamics and abundance of the spawning population of winter flounder in Rhode Island coastal ponds.

Significant Deviations: None

Summary: In 1999 the Rhode Island Coastal Ponds Project was expanded to support an adult winter flounder monitoring and tagging project. This winter phase of the seasonal coastal pond juvenile flounder work was an opportunity to collect data on the adult spawning populations of winter flounder in the south shore coastal ponds. An experimental winter flounder tagging study and monitoring project could be conducted with little additional funding or manpower. A commercial fisherman who had historically fished for winter flounder in the coastal ponds agreed to assist the RI Marine Fisheries staff and get the survey off the ground.

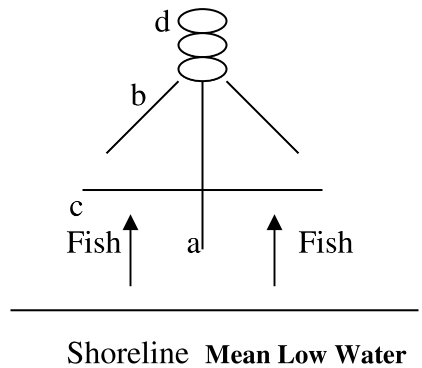
The research project runs from January - May annually. Fishing gear is deployed depending on ice cover in the ponds and the gear is generally hauled on three to seven night sets. There are a total of eight stations where data exists, all found in the Pt. Judith Pond system including Potters Pond. (NOAA Nautical Chart 13219) These two ponds use the same breach to connect to Block Island and Rhode Island Sounds.

Additional Research : In 2012 an additional coastal pond system was added to the survey. As adult winter flounder abundance in the Point Judith system declined to all-time lows, an adjacent pond, Charlestown Pond, also known as Ninigret Pond (NOAA Nautical Chart 13205) was surveyed during the same time period and continued during the 2014 sampling year. Rhode Island Coastal Trawl Survey data (Spring Survey) shows a sharp increase in relative abundance in the Block Island Sound area. This appears to be a similar trend in the Charlestown Pond system. If, through this continuation of the multiple sampling areas, Point Judith continues to experience low abundance and recruitment while other area surveys show a diverging trend then the assumption would be that the Point Judith system is having localized winter flounder depletion from sources other than fishing mortality. Commercial fishing activity in Block Island Sound is also returning valuable tag recapture information from the Charlestown Pond sampling, that which is now missing from the Point Judith Pond survey due to the inability to catch enough fish to tag. The Environmental Protection Agency partners in this project on Charlestown Pond and currently has collected data during three winter survey seasons. In the future this data set will be added to the current Adult Winter Flounder time series which was existed since 1999.

Methods and Materials:

Fyke Nets are a passive fixed fishing gear, attached perpendicular to the shoreline at mean low water. A vertical section of net wall or leader directs fish toward the body of the net where the catch is funneled through a series of parlors, eventually being retained in the terminal parlor. The wings of the net accomplish further direction of the catch.

Net dimensions:
a. Leader - 100'
b. Wings - 25'
c. Spreader Bar - 15'
d. Net parlors – 2.5’
Mesh size - 2.5" throughout



Station water profile:
Depth / turbidity - feet
Dissolved oxygen - mg/l
Salinity - ppt
Temperature - degree C

Fieldwork:

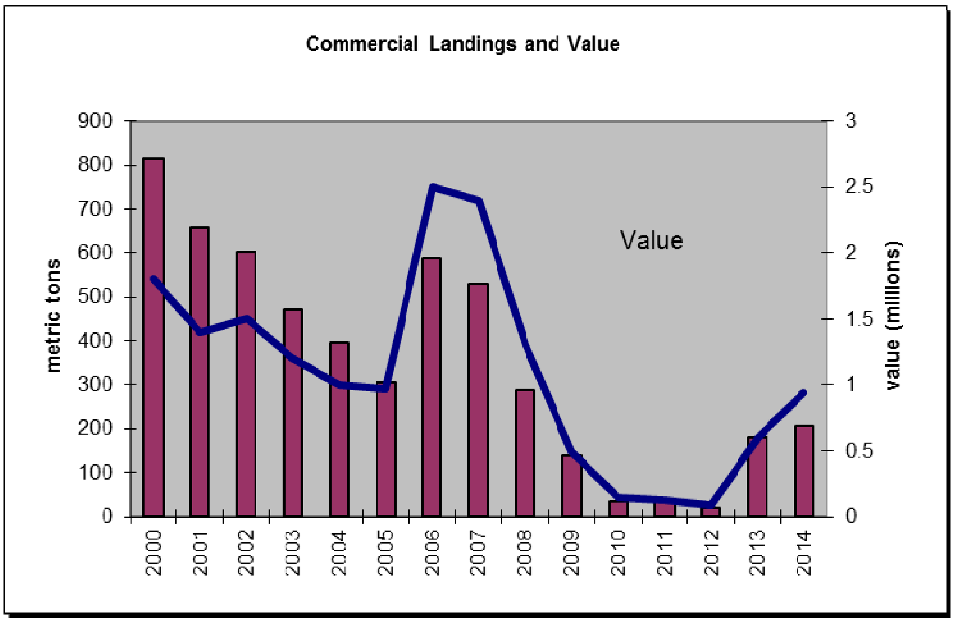
Three fyke nets were set at three fixed stations in Pt. Judith and Potter Ponds during January and April in 1999 - 2001 and two nets were set at four fixed stations from 2002 to present. The nets are fixed at mean low water and set perpendicular to the shoreline. Fyke nets are a passive fishing gear and allow the catch to be retained alive for a short period of time. Nets are tended from two to seven days depending on the size of the catch and weather conditions. Higher catches increase density inside the net and attract predators such as cormorants, seals and otters thus increasing survey-induced mortality.

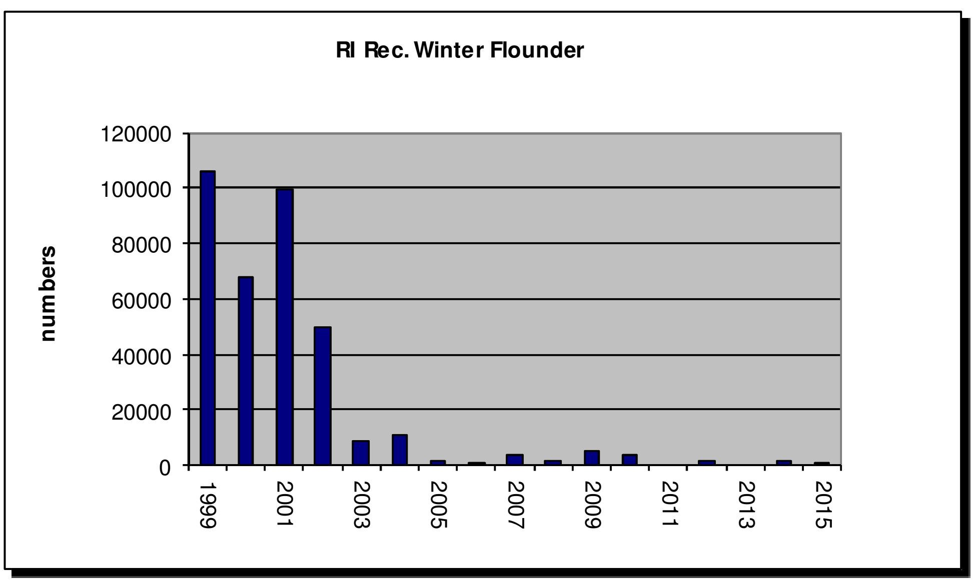
All fish captured are measured, sexed, enumerated and categorized to describe spawning stage. Spawning stage is defined as ripe (pre-spawn), ripe/running (active spawn), spent (post-spawn), resting (non-active spawn) and immature. These data illustrate how the spawning activity of flounder advances throughout the duration of the survey season. This is useful in determining the potential impacts of coastal zone activities such as harbor and breach way dredging and pier construction.

Fish of legal size, 30.48 cm or recruits to the fishery are tagged and released away from the capture area.

Fisheries:

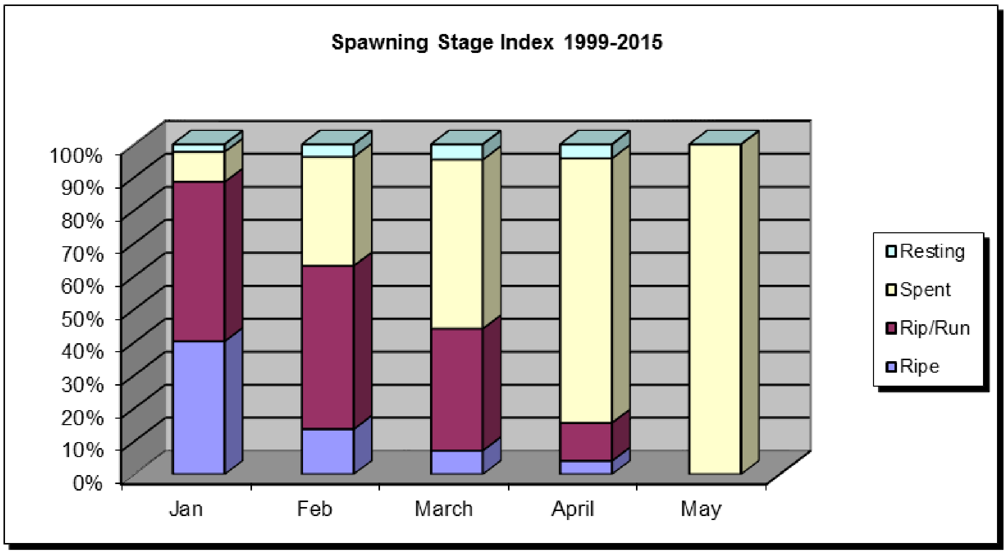
Winter Flounder (***Pseudopleuronectes americanus***) are both a commercially and recreationally important species to the State of Rhode Island. From 1999 - 2014 commercial landings of winter flounder in Rhode Island averaged over 300 metric tons and an average value of one million dollars annually. Recreational landings have declined rapidly throughout the period and remain low through 2015. (NMFS. 2014 Commercial landings query and MRFSS database)



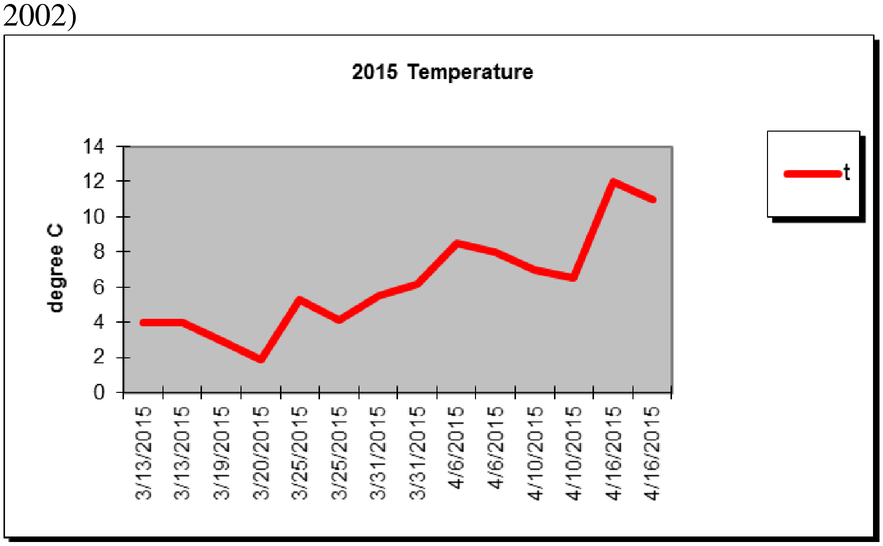


Spawning Behavior: Pt Judith / Potters Pond System

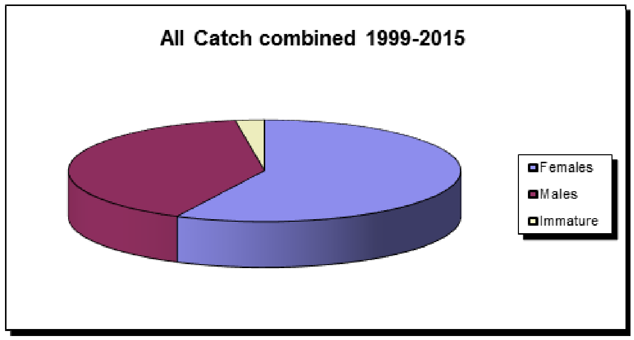
Winter Flounder enter the south shore coastal pond systems in Rhode Island to spawn in the early part of winter (November) and engage in spawning activity from January through May annually. Spawning and egg deposition takes place on sandy bottoms and algal accumulations. Winter Flounder eggs are non-buoyant and clump together on these substrates. Survey data indicate that peak-spawning activity takes place during the month of February, however this appears to vary annually in relation to average water temperatures.



Spawning occurs in inshore waters at close to seasonal minimal water temperatures of 0 - 1.7 degrees C and in estuarine salinities as low as 11.4 ppt. (Bigelow and Schroeder 2002)

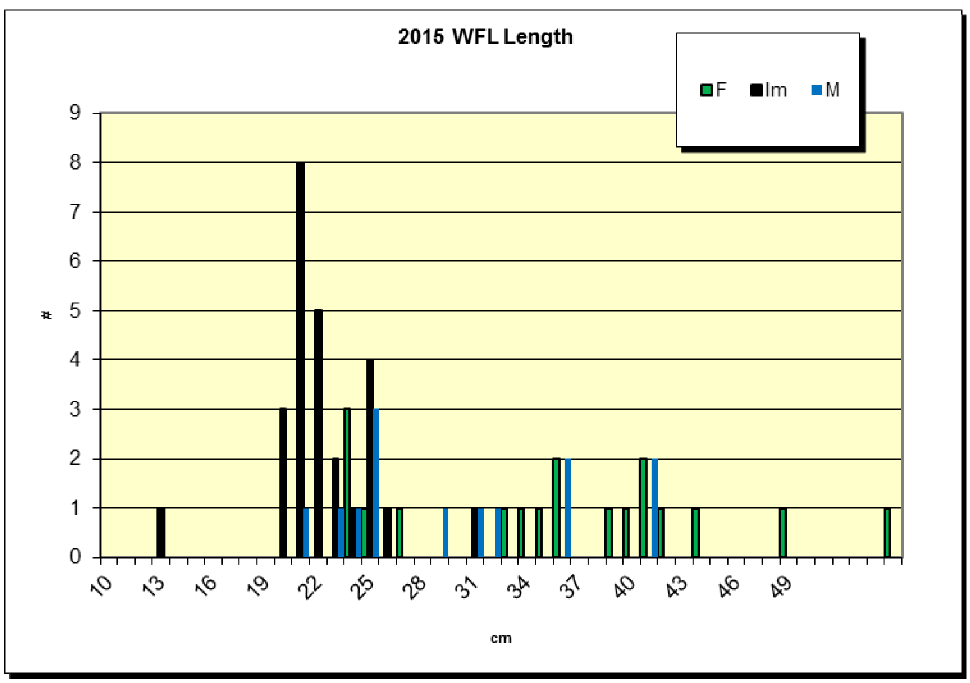


Sex ratios throughout the time series tend to favor females. Similar observations were made in Green Hill Pond, a neighboring coastal pond (Saila 1961), and in Narragansett Bay (Saila 1962).



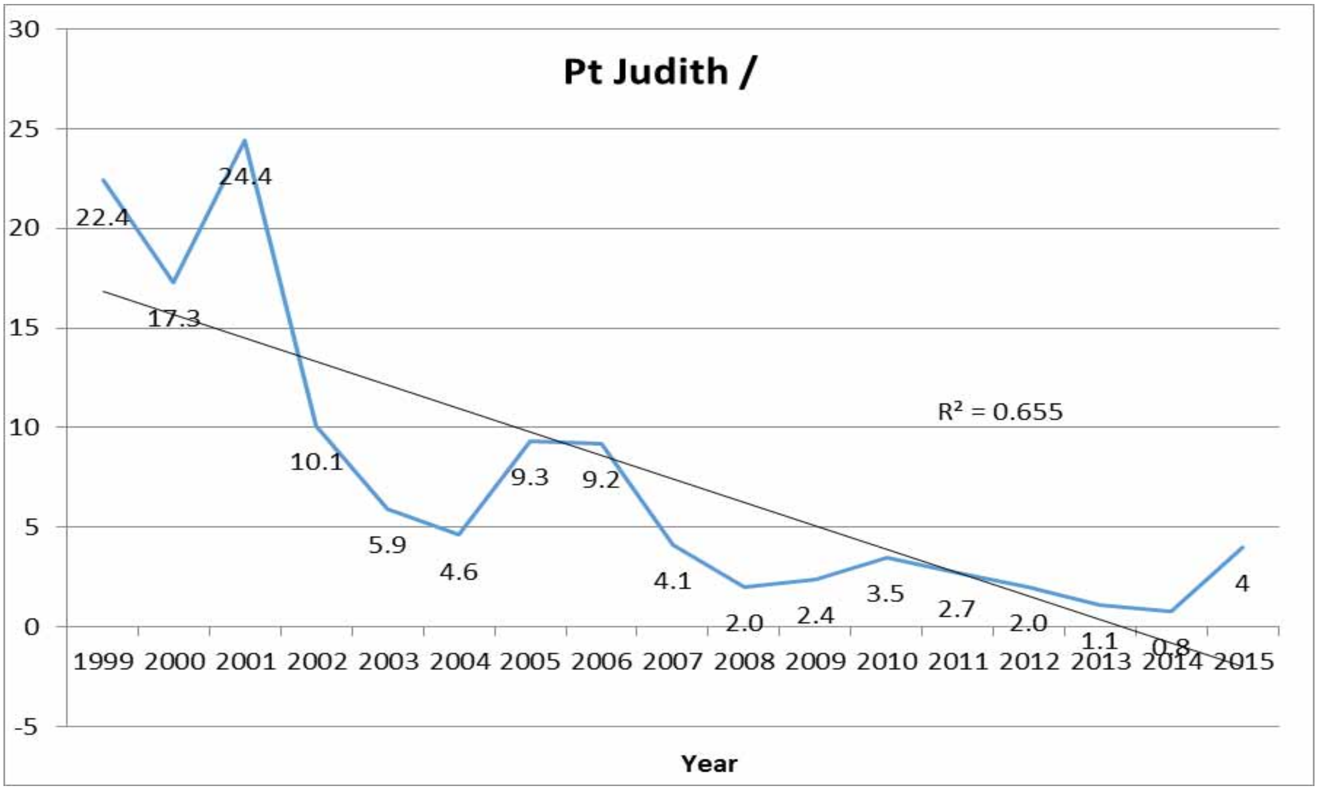
Size Distribution: Pt Judith / Potters Pond System

The total number of winter flounder sampled during the 2015 survey was 56. This was a 75% increase from the 2014 survey. Sizes ranged from 8cm to 50cm. The mean size sampled was 23.4cm.



Results:

2015 Adult winter flounder CPUE in Pt Judith Pond increased to 4.0 fish per net haul. A significant increase from the 2014 value of 0.4 fish per net haul. This value is well below the time series high of 24.4 in 2001. The catch rates have showed a downward trend throughout the time series with the 2014 CPUE being the lowest data point every recorded.



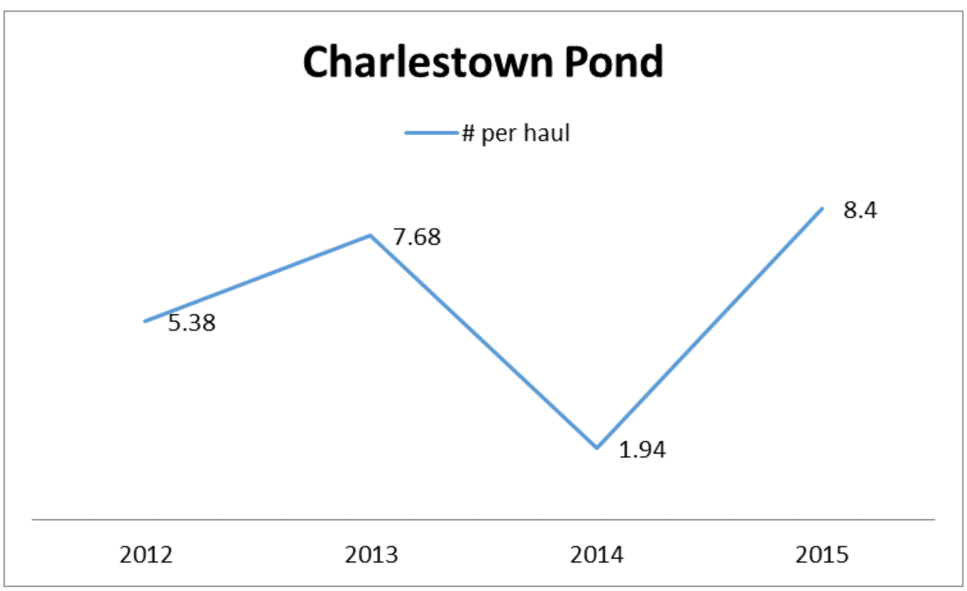


Table 1 Mark / recapture data 1999 - 2015 (Pt Judith / Potter Pond system)

Year	Number	Number	Number recaptured
1999	1301	332	31
2000	417	208	31
2001	538	358	70
2002	265	182	18
2003	160	87	6
2004	102	64	14
2005	252	115	7
2006	416	91	9
2007	120	35	6
2008	42	14	2
2009	63	0	0
2010	85	19	0
2011	68	11	0
2012	41	15	0
2013	22	5	0
2014	14	3	0
2015	56	14	0
Total	3962	1553	194

Table 2 Mark recapture in subsequent years (Survey and Fishing Recaptures) (Pt Judith system)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	% recap
1999	31	8	10	1	0	1	0	0	0	0	0	0	0	0	0	0	0	51	0.1536145
2000		23	17	5	1	0	0	0	0	0	0	0	0	0	0	0	0	46	0.2211538
2001			43	11	1	2	0	0	0	0	0	0	0	0	0	0	0	57	0.1592179
2002				1	3	1	0	0	0	0	0	0	0	0	0	0	0	5	0.0274725
2003					1	1	2	0	0	0	0	0	0	0	0	0	0	4	0.045977
2004						9	1	2	0	0	0	0	0	0	0	0	0	12	0.1875
2005							4	4	2	1	0	0	0	0	0	0	0	11	0.0956522
2006								3	2	0	0	0	0	0	0	0	0	5	0.0549451
2007									2	1	0	0	0	0	0	0	0	3	0.0857143
2008										0	0	0	0	0	0	0	0	0	0
2009											0	0	0	0	0	0	0	0	0
2010												0	0	0	0	0	0	0	0
2011													0	0	0	0	0	0	0
2012														0	0	0	0	0	0
2013															0	0	0	0	0
2014																0	0	0	0
2015																	0	0	0
Total	31	31	70	18	6	14	7	9	6	2	0	0	0	0	0	0	0	194	1.0312472

Table 3 Mark recapture in subsequent years (Fishing Recaptures Only) (Pt Judith system)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total	% recap
1999	26	6	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	39	0.1174699
2000		18	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	28	0.1346154
2001			39	2	1	2	0	0	0	0	0	0	0	0	0	0	0	44	0.122905
2002				1	3	1	0	0	0	0	0	0	0	0	0	0	0	5	0.0274725
2003					1	1	2	0	0	0	0	0	0	0	0	0	0	4	0.045977
2004						9	1	2	0	0	0	0	0	0	0	0	0	12	0.1875
2005							1	3	2	1	0	0	0	0	0	0	0	7	0.0608696
2006								1	1	0	0	0	0	0	0	0	0	2	0.021978
2007									2	1	0	0	0	0	0	0	0	3	0.0857143
2008										0	0	0	0	0	0	0	0	0	0
2009											0	0	0	0	0	0	0	0	0
2010												0	0	0	0	0	0	0	0
2011													0	0	0	0	0	0	0
2012														0	0	0	0	0	0
2013															0	0	0	0	0
2014															0	0	0	0	0
Total	26	24	54	3	6	14	4	6	5	2	0	0	0	0	0	0	0	144	0.8045017

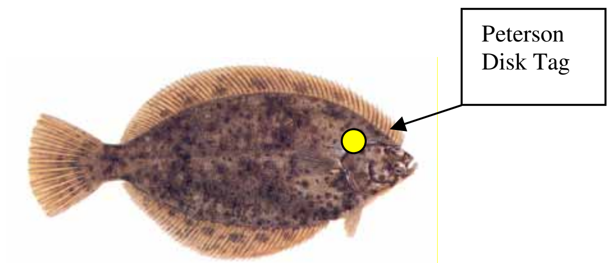
Charlestown Pond

Year	Number caug	Number tagg	Number recaptured
2012	113	98	11
2013	147	128	12
2014	33	33	2
2015	140	67	11

	2012	2013	2014	2015	Total	% recap
2012	10	0	1	0	11	0.0973451
2013		10	1	0	11	0.0748299
2014			1	1	2	0.0606061
2015				10	10	0.0714286

Discussion: Much lower catch rates are being observed in the later years of the adult coastal pond survey. For some time the data indicated that the problems found in nearby Narragansett Bay, were not as obvious in the south shore coastal ponds and that possibly, there were lower fishing mortality rates exhibited on the stocks that inhabit theses ponds and Block Island Sound.

Tag / Recapture data gives accurate estimations on population size and year class structure. These estimations depend on additional years and recapture data and therefore show the need for a more long-term approach to adult winter flounder assessments in Rhode Island south shore coastal ponds. Tag return rates for the survey time series are between 8 and 9 %. In past years almost the entire set of tag returns come from the recreational fishery which has now been closed since 2012. The offshore trawl fleet has been the source of tag returns in the recent years along with survey recaptures indicating the increased willingness of the offshore commercial trawler fleet to supply information on flounder movements and mortality rates.



<u>Recommendations:</u> Continuation of all adult winter flounder work statewide in order to make accurate connections between coastal pond, Narragansett Bay and Rhode Island/Block Island Sounds winter flounder stocks. Continuation of the Charlestown Pond System to track local adult winter flounder abundance and use the catch as a source of tag able animals to gain information on population size, mortality and year class structure. Stress the importance of returning tag data from commercial trawl fleet in Rhode Island Sound and Block Island Sound

Additional Species captured:

Winter Flounder ***Pseudopleuronectes americanus***
Summer Flounder ***Paralicthes detatus***
Striped Bass ***Morone saxatilis***
White Perch ***Morone americana***
Atlantic Tomcod ***Microgadus tomcod***
Tautog ***Tautoga onitis***
Alewife ***Alosa pseudoharengus***
Atlantic Menhaden ***Brevortia tyrannus***
American Eel ***Anguilla rostrata***
Horseshoe Crab ***Limulus polyphemus***
American Lobster ***Homarus americanis***
Green Crab ***Carcinus maenas***
Atlantic Rock Crab ***Cancer irroratus***
Blue Crab ***Callinectes sapidus***
Longnose Spider Crab ***Libinia dubia***
Portly Spider Crab ***Libinia emarginata***

References

Burnett M. 2005 Assessment of the Young of the Year Juveniles in Rhode Island Coastal Ponds.

Collette B. and Klein-MacPhee G. 2002 Bigelow and Schroeder's Fishes of the Gulf of Maine. 3rd edition

Powell C. J. 2006 Juvenile Finfish in Narragansett Bay Performance Report F-61-R-14

Saila, S. B. 1961. The contribution of estuaries to the offshore winter flounder fishery in Rhode Island. Proc. Gulf Carib. Fish. Inst.

Saila, S. B. 1962. Proposed hurricane barriers related to winter flounder movements in Narragansett Bay. Trans. American Fisheries Society

Prepared by:____________________ Approved by:___________________
Scott D. Olszewski — Jason McNamee
Marine Fisheries Biologist — Chief, Marine Resources

Narragansett Bay Atlantic Menhaden Monitoring Program

Jason McNamee
Nicole Lengyel

R. I. Division of Fish & Wildlife
Marine Fisheries
Ft. Wetherill Marine Laboratory
3 Ft. Wetherill Road
Jamestown, Rhode Island 02835

STATE: Rhode Island

PROJECT NUMBER: F-61-R

SEGMENT NUMBER: 22

PROJECT TITLE: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

PERIOD COVERED: January 1, 2015 – December 31, 2015

JOB NUMBER 11 TITLE: Narragansett Bay Atlantic Menhaden Monitoring Program

JOB OBJECTIVE: Continue administering an Atlantic menhaden monitoring program in Narragansett Bay that will use sentinel fishery observations (information of landings from floating fish traps), abundance information from spotter flights (both with a trained spotter and independent flights), removal information by tracking fishery landings, and a mathematical model (Depletion Model for Open Systems; see Gibson, 2007) to monitor the abundance of menhaden in Narragansett Bay in close to real-time and adjust access to the fishery as necessary through a dynamic regulatory framework.

SUMMARY: Atlantic menhaden (menhaden) undergo large coastwide migrations each year. After aggregating in the offshore waters of the Mid Atlantic region during the winter, menhaden migrate west and north stratifying by size and age the further north they migrate (Arenholz, 1991). Menhaden arrive in RI coastal waters beginning in the early spring, and in some years enter Narragansett Bay in large numbers, where they can reside for varying amounts of time until they begin their southward migration in the fall. During the period when they reside in Narragansett Bay, a number of user groups compete for the resource. Commercial bait companies begin to fish on the schools of menhaden and provide bait for both recreational fishing interests and for the lobster fishery. As well, recreational fishermen access the schools of menhaden directly and use the resource as bait for catching larger sport fish such as striped bass and bluefish. Large numbers of sport fishermen can be seen in their boats surrounding large schools of menhaden throughout the spring and summer using various methods to harvest them (snagging lures, cast nets, dip nets). The migration of menhaden to the north is also one factor which brings these larger sport fish to northern areas, as they are an important food resource for these species (Arenholz, 1991; ASMFC, 2010). During the period when the menhaden resource is within Narragansett Bay and multiple user groups are accessing it, user group conflicts are an inevitable outcome. These conflicts were further exacerbated in 2013 with the implementation of Technical Addendum I and Amendment 2 to the Interstate Fishery Management Plan for Atlantic menhaden. Amendment 2 established coast-wide state quotas for Atlantic menhaden while Technical Addendum I established an Episodic Event Set Aside program. Both of these new management measures have resulted in increased resource conflicts and make it important now more than ever for RI to accurately monitor the Atlantic menhaden resource in Narragansett Bay.

To help assuage some of these conflicts, to allow for an amount of the menhaden resource to remain unharvested by commercial interests for use by the recreational community, and to allow

a portion of the menhaden resource to remain in Narragansett Bay to provide ecological services, the RI Division of Fish and Wildlife (DFW) administered a menhaden monitoring program in Narragansett Bay. The program collectively uses sentinel fishery observations (floating fish trap data), spotter flight information both with a trained spotter pilot and from independent helicopter flights, fishery landings information, computer modeling, and biological sampling information to open, keep track of, and close the fisheries on menhaden as conditions dictate.

TARGET DATE: December 2015

SIGNIFICANT DEVIATIONS: No deviations occurred in 2015 compared to the previous year for this project.

RECOMMENDATIONS: Continue spotter flights and data collection to create the estimate of Narragansett Bay Atlantic menhaden biomass. Continue to analyze and provide data for use in the RI menhaden fishery management program. Continue development of the assessment model and continue to move from a Microsoft excel framework in to a more advanced statistical program such as ADMB.

REMARKS: Abundance estimates derived from the menhaden monitoring program have been used to open and close the Narragansett Bay menhaden fishery. The management is performed to accommodate the recreational sportfish fishery that depends on menhaden as a source of bait for striped bass, bluefish, and weakfish, popular sportfish species in Narragansett Bay. In addition, the maintenance of a standing stock of menhaden biomass in Narragansett Bay meets other ecological services that this species performs.

The structure of the management is to maintain a biomass threshold of 1.5 million pounds in the Bay, which provides forage for the predatory species of striped bass and bluefish. Prior to the commencement of commercial fishing, the biomass needs to reach 2 million pounds to provide a body of fish for the fishery to remove without dropping below the 1.5 million pound threshold. Once fishing is authorized, the commercial fishery is allowed to remove 50% of the biomass above the 1.5 million pound threshold, leaving the rest for ecological services and for use as bait by recreational fishermen. If the biomass estimates based on the spotter flights drop below the 1.5 million pound threshold, the fishery will close. In addition, if landings by the commercial fishery reach the 50% cap, the fishery closes.

METHODS, RESULTS & DISCUSSION: The program in 2015 consisted of three main elements: collection of fishery landing information through call in requirements, computer modeling work, and field work (spotter fights and biological sampling). DEM regulations require that purse seine vessels fishing for menhaden in Narragansett Bay report their catches to DFW staff. The commercial fishery interests also agree to carry a DFW observer on the fishing vessel upon request, or allow a port sample to occur while the catch is being offloaded. In 2015, port samples were undertaken where DFW observers sampled the catch and recorded the weight of catch offloaded. Catch sampling includes length frequencies, body weights, and collecting scales for age determination (see Age and Growth Study, Job 9). The DFW also contracted with a trained spotter pilot to make abundance estimates of menhaden in Narragansett Bay. When in the air, the pilot records counts of the number of menhaden schools observed, the estimated weight within the schools, and the location of the schools. An additional series of flights were taken in a state helicopter independent of the contracted spotter pilot. During these flights, DFW staff recorded the number and location of schools, allowing for independent verification of the spotter pilot estimates of school number. Other commercial harvesters such as floating fish trap operators were required to file logbook reports monthly with the DFW that detailed daily fishing activities. These fishers were also contacted for information and biological sampling during periods of increased menhaden activity on a more frequent basis. These fixed gear fisheries are useful as sentinels, documenting the arrival and movements of menhaden in state waters. Other information on menhaden abundance and movements were obtained from scientific staff on DFW research cruises and a network of fishers working in Narragansett Bay. Collectively, these sources of information were analyzed using the theory of depletion estimation as applied to open populations. All of the aforementioned information was centrally collected and used in a computer modeling approach that allows the DFW to monitor the abundance of menhaden in Narragansett Bay. The existing regulatory framework governing state waters allows the DFW to use the output from the mathematical modeling approach to set a number of fishing activity parameters including a static amount of fish that need to be present to allow commercial fishing to commence, thus protecting recreational and ecological interests if only a small population enters the Bay, allows for only half of the standing population present in Narragansett Bay above the initial threshold amount to be harvested, thus maintaining an amount of unharvested fish even when commercial fishing has commenced, and subsequently allows the DFW to close the fishery when the standing population of menhaden in Narragansett Bay drops back below the threshold level of fish, again maintaining a portion of the population for recreational fishermen and ecological services. This program also allows DFW to accurately track the newly implemented state quota and provides justification for Rhode Island to participate in the Episodic Event Set Aside Program as it has annually since 2013.

2015 Fishery Data

In 2015, two commercial menhaden fishing operations fulfilled requirements for fishing in Narragansett Bay. After biomass levels were estimated and confirmed, commercial fishing was allowed to commence in the Management Area on May 19, 2015. The commercial bait fishery landing in RI under the RI state quota was closed on May 28, 2015, as it was determined that the entire RI state quota had been harvested. During this closure a bycatch allowance of 6,000 pounds/vessel/day was permitted for cast netters and floating fish traps. Additionally, this closure only applied to vessels landing menhaden in RI, the Narragansett Bay Management Area remained open and therefore non-bycatch vessels were allowed to fish in the management area provided they were not landing their catch in RI.

As a result of exhausting our RI state quota but still having a large biomass of fish residing in state waters, RI applied for inclusion in the Atlantic menhaden episodic event set aside program administered by the ASMFC. On May 29, 2015, after being allowed access to the episodic event set aside program, the commercial bait fishery for vessels landing in RI was re-opened at a possession limit of 120,000 pounds/vessel/day. While RI state waters outside of the management area remained open through November 1, 2015, the management area experienced a number of closures and re-openings throughout the remainder of the year as a result of hitting biomass thresholds (Table 1). Between May and November under the episodic event set aside program, a total of five fishing operations, varying in size and gear type, had thirty-two landing events totaling 1,883,292 mlbs of menhaden.

Table 1. Summary of openings and closures for Atlantic menhaden fishery in 2015.

DATE	ACTION	REASON
May 19	Opened Bay	Threshold
May 28	Closed Outside Bay	Quota Reached
May 29	Opened Outside Bay	Opted in Episodic Event Set-Aside
June 28	Closed Bay	Threshold
July 27	Opened Bay	Threshold
August 9	Closed Bay	Threshold
September 15	Opened Bay	Threshold
November 1	Closed Outside Bay	Episodic Event Ended
November 9	Closed Bay	Threshold

In 2015 the landings cap was not exceeded and a total of 31 spotter flights were accomplished. The flights were spread throughout the season to make sure there were estimates that occurred before, during, and after the fishery occurred. This was done to achieve an accurate sense of the migratory patterns of this important species in to RI waters. Over time, these estimates could be used to improve the predictive power of the model. In addition to the professional spotter pilot estimates, five helicopter flights were also undertaken. The idea behind the helicopter flights is to add an additional independent observation in to the program. School counts are the metric used from the helicopter flights.

The model estimated a harvest cap of 3,460,000 pounds in 2015. This was driven by a couple of observations where 6-8 million pounds of menhaden was estimated to be in Narragansett Bay. This high level of biomass came in two distinct pulses, one in the spring and one in the fall, with each only remaining in the Bay for a period of less than two weeks. The second large pulse in biomass was followed by a significant drop in biomass which persisted for the rest of the season (Figure 1). In the future staff hopes that moving the model in to a different software package (ADMB) will help improve the model performance.

SUMMARY: The menhaden monitoring program in Narragansett Bay opened in May. There were several in season closures and subsequent re-openings throughout the year due to biomass thresholds and the episodic event set-aside program. Biomass estimates continued regularly throughout the season and ended in October. In total 31 spotter flights were taken and 5 helicopter flights were taken, giving ample data to use in the depletion model. Upon review, it was found that the harvest cap was not exceeded, therefore the program can be considered a success in 2015.

The RI State menhaden quota was exhausted, and thus the state waters fishery closed in May in 2015. Upon application to, and permission from the ASMFC to participate in the Atlantic menhaden episodic event set aside program, RI state waters re-opened to the landing of menhaden and remained open until November 1, 2015.

References

Arenholz, D.W. 1991. Population biology and life history of the North American menhadens, *Brevoortia spp*. Mar. Fish. Rev. 53: 3-19.

Atlantic States Marine Fisheries Commission (ASMFC). 2010. Atlantic Menhaden Stock Assessment and Review Panel Reports. Stock Assessment Report No. 10-02. Pp 326.

Gibson, M. 2007. Estimating Seasonal Menhaden Abundance in Narragansett Bay from Purse Seine Catches, Spotter Pilot Data, and Sentinel Fishery Observations. http://www.dem.ri.gov/programs/bnatres/fishwild/pdf/menabnnb.pdf

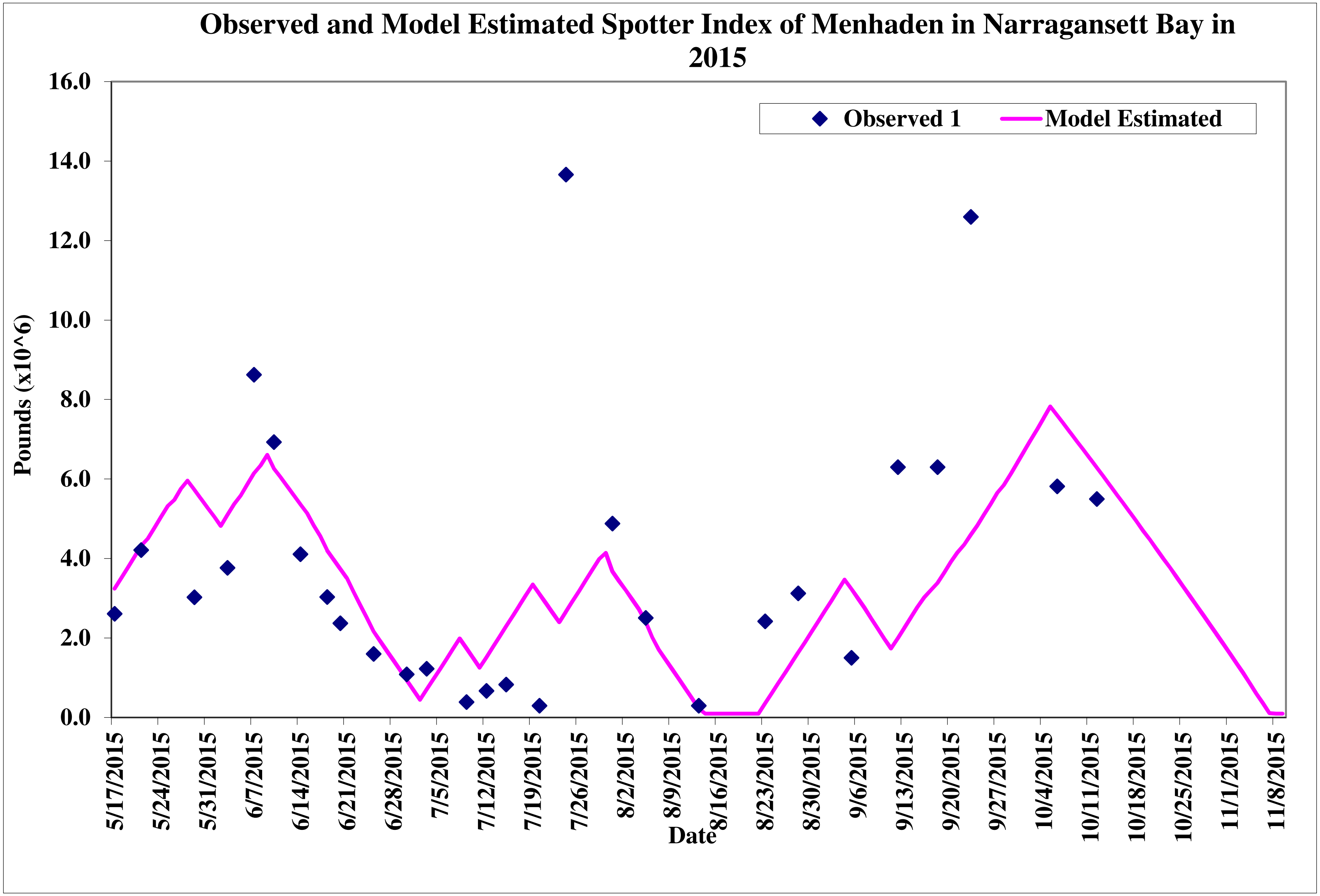


Figure 1. Predicted spotter pilot estimates and observed biomass in Narragansett Bay in 2015.

Narragansett Bay Ventless Pot, Multi-species Monitoring and Assessment Program

By
Richard J. Satchwill
Principal Marine Biologist
richard.satchwill@dem.ri.gov

Rhode Island Department of Environmental Management
Division of Fish and Wildlife

Performance Report - Job - 12 March 2016

PERFORMANCE REPORT

State: Rhode Island Project Number: F-61-R

Project Type: Resource Monitoring

Project Title: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

Period Covered: January 1, 2015 to December 31, 2015

Job Number & Title: 12- Narragansett Bay Ventless Pot, Multi-species Monitoring and Assessment Program

Job Objective: The goal of this project is to assess and standardize a time series of relative abundance for structure oriented finfish (scup, black sea bass, and tautog) in Narragansett Bay. Investigators will also collect age and weight at length information for these species, as well as collect data on other biological characteristics while they're in RI state waters. Abundance data will be integrated into both local and coastwide stock assessments for the target species.

Summary: Investigators didn't get the vessel assigned to the project back until June due to mechanical issues. Additionally, due to continuing vessel issues, we couldn't haul the required number of scup pots or sea bass trawls each month, Table 1. Despite our very limited sampling season, we added substantially to the established database for scup, black sea bass, and tautog. The majority of black sea bass, scup, and tautog caught were in excess of three or four years old, which is what this project was designed to do. Investigators are confident that this project is working properly as designed and getting the desired results. In 2015, we caught 2,474 Scup, 790 Black Sea Bass, 157 Tautog, as well as 12 other species of finfish and four species of shellfish (Table 2).

Target Date: 2017

Status of Project: On Schedule

Significant Deviations: Investigators were unable to complete sampling during the entire sampling season due to vessel problems.

Recommendations: To continue on into the next segment.

Remarks: For the third consecutive year, we were unable to begin sampling in April. In 2014, we had hauled the vessel at our selected repair vendor in the late fall. The vendor having the vessel over the winter was unable to accomplish the repairs and they were finished in the spring. Consequently, we were unable to get the vessel in the water until late May. In June, we set and hauled ten Black Sea Bass Trawls, two in each sampling area, and ten scup pots in each of the five sampling areas, see Figure 1. In July, Investigators again set and hauled ten Black Sea Bass Trawls, two in each sampling area, and were only able to set 10 scup pots in two areas, the West Passage and the Upper Bay. Subsequent to this, the alternator, serpentine belt and idler pulley failed and the vessel was towed to Jamestown. The vessel was repaired in house and paperwork for parts, etc. resulted in the vessel being laid up for the month of August. Sampling began again in September, at which time, we set and hauled ten Black Sea Bass Trawls, two in each sampling area, and 19 scup pots. Again a minor engine disruption emanating from the raw water pump caused us to terminate sampling early. In October, we set and hauled four Black Sea Bass Trawls, before the vessel had additional mechanical issues. At this time, Investigators had the boat hauled and transported to a Mercruiser Repair Facility. The vessel has been repaired and should be reliable for the 2016 season.

In spite of the vessel down time, the 2015 field season was fairly successful. Investigators captured and measured 3613 individual fish representing 15 species, Table 2, and 248 invertebrates representing 4 species, Table 2 a. Additionally, we harvested 5,655 Spider crabs, *Libinia spp*., 24 Green crabs, *Carcinus maenus*, 21 Rock crab, *Cancer irroratus*, 20 Hermit crabs, *Pagurus spp*., 6 Jonah crab, *Cancer borealis*, 7 mud crabs, *Dyspanppeus sayi*. These aforementioned species are of little or no commercial or recreational importance and were merely counted and not measured, with the exception of Jonah and rock crabs. In 2015, we caught and measured approximately 9.6% more finfish despite the abrivated season. In 2014, we caught and measured 3,295 finfish. It is suspected that the majority of these fish are Scup.

As an additional work element in 2015, a new chart was produced by researchers at the University of Rhode Island (Graduate School of Oceanography, Dr John King's lab) to better quantify areas with structure. The new maps were produced with side scan sonar technology. The Division received maps, PDF's and computer images of Narragansett Bay which showed structure in excess of two meters in diameter. Investigators have had the chart of the Bay with a superimposed grid system printed at DEM headquarters. We are in the process of numbering all sampling areas in order to look identical with the former sampling chart. Upon completion, this chart will be used to determine areas of structure or non structure for use and analysis during the survey in 2016. We will compare the old chart with the new chart at the end of the year to determine if there are any differences.

Personnel worked with staff from our age and growth project in order to obtain scales, otoliths, and weights from fishes. Additionally, black sea bass samples were brought back to the lab for stomach analysis. Tautog, between 17 and 38 cm, were also brought back to the lab for later operculum removal, weighting, etc.

Introduction: Working groups such as the Northeast Data Poor Stocks Working Group (2008), have reported that size classes of many species may be under represented in their assessments, particularly scup, black sea bass, and tautog. All three of these species tend to associate with bottom structure for a major portion of the year and as a result are believed to be unavailable to traditional trawl surveys.

This survey is an attempt to employ an alternative survey gear type for these species, e.g. fish traps, as recommended by Shepherd (2008) and Terceiro (2008) in order to attempt to index the abundance of older scup (ages 3 and older).

Methods: Narragansett Bay was divided into five sampling areas, The Providence/lower Seekonk River including portions of the Upper Bay/Greenwich Bay, West Passage, East Passage, Mount Hope Bay including portions of the Upper Bay, and the Sakonnet River including the area from Land's End to Sakonnet Point (Figure 1). Each area was subdivided into 0.5 deg. of latitude and longitude squares and numbered. These numbered boxes were referred to as stations. Investigators then located areas of hard bottom, shipwreck, major bridge abutments, or pilings, etc., in each station. The areas of structure were noted in the stations containing structural elements and the goal for each month was to randomly sample half of the replicates in areas of known structure and half in areas without known structure.

All sampling stations were selected randomly. In order to maintain a consistent methodology with the URI/Sea Grant projects, investigators adopted the following sampling schedule which they anticipate will take approximately two to three weeks.

A monthly survey was conducted in the Narragansett Bay from June, July, September, and part of October. The unvented scup pots (2'x2'x2') are constructed of 1.5" x 1.5" coated wire mesh. The unvented Black Sea Bass Pots (43.5" L, 23" W, and 16" H) are also constructed of 1.5" x 1.5" coated wire mesh, single mesh entry head, and single mesh inverted parlor nozzle.

> Beginning on Friday or Monday, investigators set black sea bass pots in five (5) pot trawls at two (2) randomly selected stations in two separate sampling areas. One trawl will be set on structured bottom and one on bottom without structure. These traps will be unbaited and allowed to fish for 96+/- 1 hr. After the four days, the traps will be hauled, the catch processed and the trawls held for 24 hours then moved to a new areas and allowed reset. This will be repeated until there are ten set in total for Narragansett Bay.
>
> In the intervening time, Investigators set scup pots at ten (10) randomly selected stations, five on structured bottom and five on bottom without structure, in one of the five sampling areas and left to soak for **24+/- 1 hr**. All pots were baited with sea clams. After 24 hrs. the pots set were hauled, the catch processed and gear either reset or removed from the water so investigators could tend trawls. This continues until 50 sets have been made throughout Narragansett Bay.

Upon hauling all gear types, the catch was sorted by species. Finfish were measured to the nearest centimeter, fork length (FL) or total length (TL). Invertebrates were measured using a species specific appropriate metric or counted. Personnel from the age and growth project have accompanied us in order to obtain scale samples and fish specimens from which to obtain stomach samples, otoliths and/or opercula. Going forward, it appears that this could become a normal part of this project. Project personnel collected data on water temperatures, salinities, dissolved oxygen, air temperature at each sampling station using a Eureka Systems Manta 2 Multiprobe.

Results/Discussion:

Due to intermittent vessel problems, we were unable to set all of our pots as scheduled. We set the black sea bass trawls 10 times, Table 1, or twice per area in June July, and September, and only 4 times in October. In October, Investigators were only able to set the West Passage and Mt Hope Bay. The scup pots were set 50 times in June, 20 times in July, 19 times in September, and not at all in October, Table 1. Table 2 enumerates the finfish species caught and the percentage of total catch, while Table 2 a, enumerates the shellfish caught. From this table, it is obvious that these gear types are very efficient at catching the target species. This table shows that scup dominated the catch with 2,475 individuals which comprised 64.02% of the total catch. However, only 790 black sea bass were caught which equaled 20.43%. In 2015, 157 Tautog were caught which equaled 4.06% of the total catch. Of the remaining species, butterfish and oyster toad fish were the only other species caught in any numbers, 135 and 25 animals respectively.

Despite our very limited sampling season, we approached our goals for the third year of the project. We added to the established database for scup, black sea bass and tautog with substantial numbers. Again, Investigators noted that according to the length at age graphs for these species, the majority of black sea bass caught ranged in age from three years to in excess of sixteen years old, which is a major goal of the survey. Additionally in 2015, we wrapped the black sea bass traps with 1” vexar in order to capture yoy black sea bass. This was successful for yoy, where we captured 194 in September. In 2016, these traps will be used in August and September. Additionally, we intend to set traps without vexar nearby to determine whether the vexar hinders the adults from entering the traps.

The scup caught ranged in age from approximately zero or yoy to as old as 13, however, the majority of the fish caught were in the two to six year old range. In 2015, we caught 157 Tautog throughout the season almost entirely in the black sea bass trawls. Again utilizing the length at age graph, these fish ranged in age from approximately 2 years of age to approximately 28 or 29 years of age. Again there was a small group of yoy, 5 fish in total. Investigators are confident that this project is working properly as designed and getting the desired results.

Length frequency histograms for black sea bass, scup, and tautog along with length at age graphs for each species are presented in figures 2 a, 2 b, 4 a, 4 b, and 5 a, 5 b respectively.

Figure 2 a depicts the frequency of black sea bass captured in 2015, where they ranged from 4 cm to 50 cm. Although we only fished for 14 weeks, we managed to capture and measure 790 black sea bass as opposed to 1,022 in 2014. Apart from the appearance of the yoy component of the population, it is obvious from the histogram that the mean has shifted upwards. Figure 3 compares the length frequencies of the RI Trawl Survey and the Ventless Survey. In this case, the ventless pot survey begins catching the animals at a smaller size (18 cm). However, the trawl survey tends to capture slightly larger fish, up to 55 cm, this may be due to selectivity of the traps.

Figures 4 a, represents the length frequencies of the scup captured and processed in 2015. This represents an increase of 490 fish over 2014. Some of this increase can be attributed to yoy scup, however, there was an increase in numbers in all size classes.

Figure 5 a, shows the various size classes of tautog that were caught in 2015. We caught 157 tautog, 82 fish less than in 2014. The two graphs are very similar ranging from 17 cm to 54 cm or 55 cm, however, in 2015 we caught 5 yoy tautog, Figure 5 b, compares the length frequencies of the RI Trawl Survey and the Ventless Survey. The ventless survey caught more tautog than the trawl survey, which isn't surprising because of where the gear is set. The trawl survey again caught larger fish up to 61 cm. As with the large black sea bass, this may be a function of the larger fish not being able to gain entry into the traps, or they may be more sensitive to crowding within the trap than smaller fish.

Temperature, Salinity, and Dissolved Oxygen:

Surface water temperatures varied only slightly from station to station but rose constantly and ranged from a low of 17.02 °C on June 2 to a high of 29.58 °C on July 22. This constant rise was probably attributable to the air temperatures which were variable throughout the survey and ranged from 12 °C to 27.9 °C. Bottom temperatures ranged from 13.29 °C on June 5 to a high of 23.55 °C on July 17. Surface salinities ranged from 21.03‰ to 32.21‰ and surface dissolved oxygen ranged from 6.23 mg/L to 10.04 mg/L. Bottom salinities ranged from 27.34‰ to 32.25‰ and dissolved oxygen ranged from 4.63 mg/L to 10.32 mg/L.

References:

Shepherd, G. 2008. Black Sea Bass. Northeast Data Poor Stocks Working Group Meeting. Dec 8-12. National Marine Fisheries Service. Northeast Fisheries Science Center. 166 Water St., Woods Hole, MA 02543

Terceiro, M. 2008. Scup: Stock Assessment and Biological Reference Points for 2008. Northeast Data Poor Stocks Working Group Meeting. Dec. 8-12. Northeast Fisheries Science Center, 166 Water St. Woods Hole, MA 02543.

Working Group Report. 2008. The Northeast Data Poor Stocks. Dec 8-12. Northeast Fisheries Science Center Reference Document 09-02A & B. Northeast Fisheries Science Center. 166 Water St., Woods Hole, MA 02543

Table 1
Number and Type of Traps set Each Month during 2014

Trap Type	Apr	May	Jun	Jul	Aug	Sept	Oct
BSB Trawls	0	0	10	10	0	10	4
Scup Pots	0	0	50	20	0	19	0
Total	0	0	60	30	0	29	4

TABLE 2

Ranking by Abundance of all Finfish Species
Collected in Fish Traps in Narragansett Bay, R. I.
(June 2015 - October 2015)

Scientific Name	Common Name	Number	% Catch
Stenotomus chrysops	Scup	2,475	64.02
Centropristis striata	Sea Bass Black	790	20.43
Tautoga onitis	Tautog	157	4.06
Opsanus tau	Toadfish Oyster	25	0.65
Paralichthys dentatus	Flounder Summer	10	0.26
Prionotus evolans	Searobin Striped	8	0.21
Sphoeroides maculates	Puffer Northern	1	0.03
Balistes capriscus	Triggerfish Gray	3	0.08
Peprilus triacanthus	Butterfish	135	3.49
Prionotus carolinus	Searobin Northern	2	0.05
Raja rinacea	Little Skate	1	0.03
Anguilla rostrate	American Eel	2	0.05
Gobiosoma bosc	Naked Goby	2	0.05
Trachurus lathami	Rough Scad	1	0.03
Pristigenys alta	Short Bigeye	1	0.03

TABLE 2a

Ranking by Abundance of all Shellfish Species
Collected in Fish Traps in Narragansett Bay, R. I.
(May 2014 - September 2014)

Scientific Name	Common Name	Number	% Catch
Busycotypus canaliculatus	Channeled Whelk	117	3.03
Busycon carica	Knobbed Whelk	76	1.97
Homarus americanus	American Lobster	38	0.98
Callinectes sapidus	Blue Crab	17	0.44

Figure 1. – Chart of Narragansett Bay with Colregs line of demarcation and Location of Five Sampling Areas.

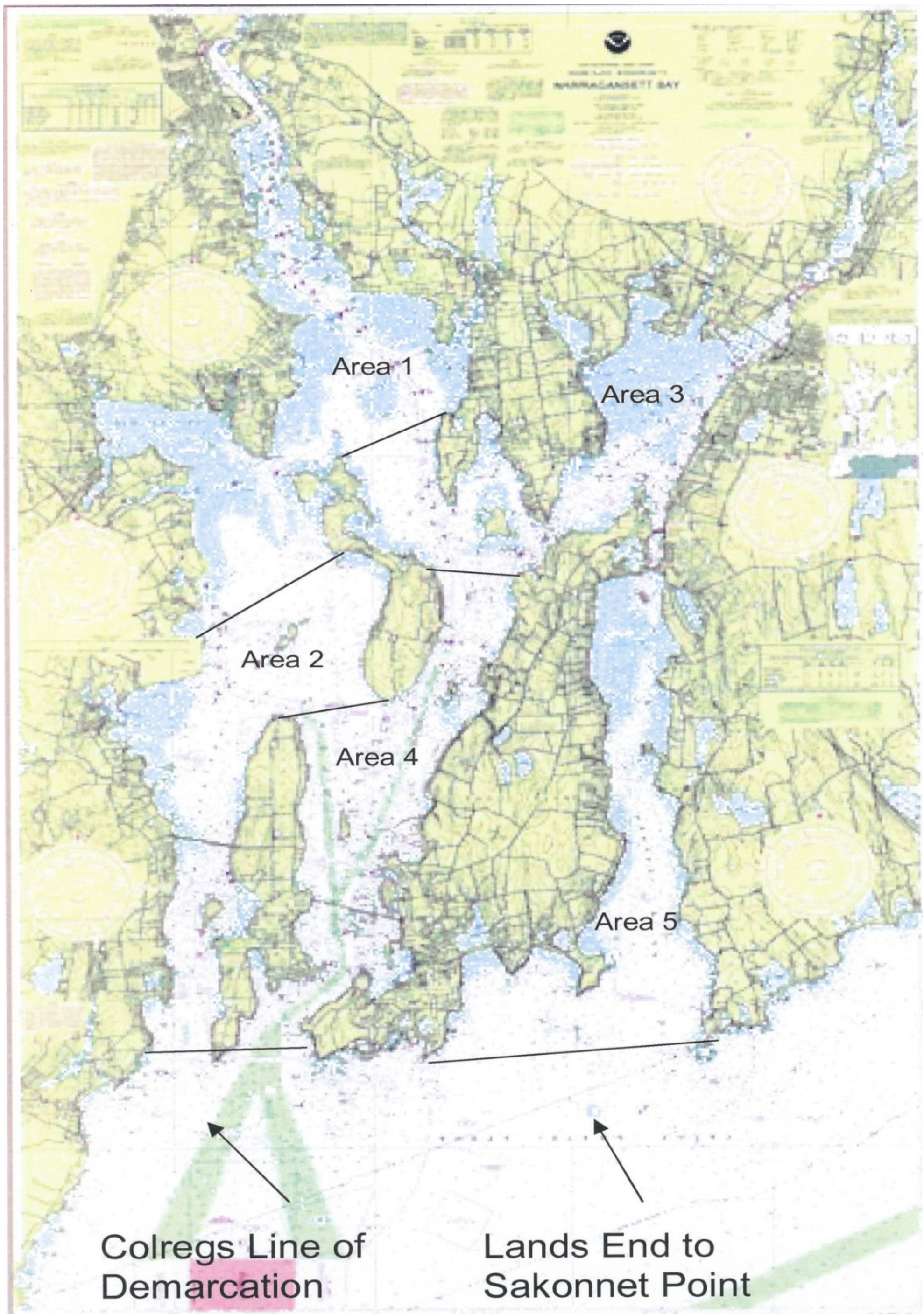


Figure 2a... Length Frequency Histogram for Black Sea Bass.

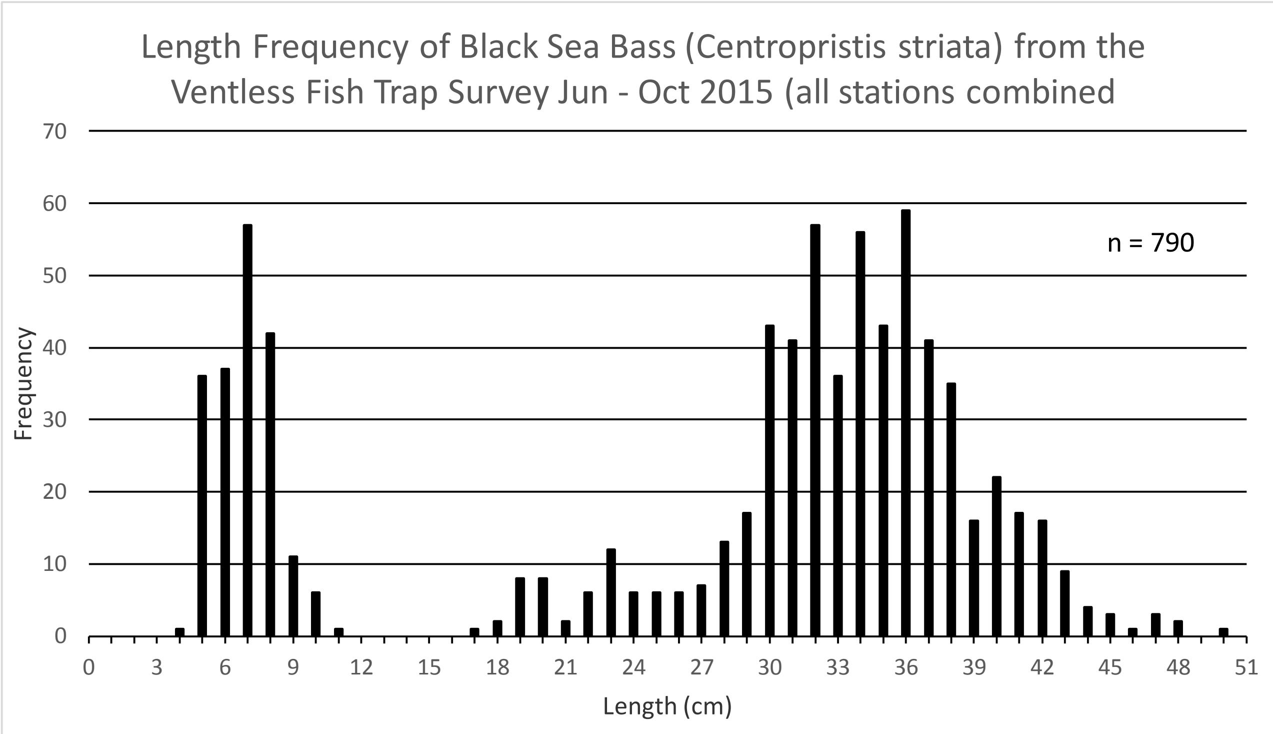


Figure 2b. Length at Age graph for Black Sea Bass

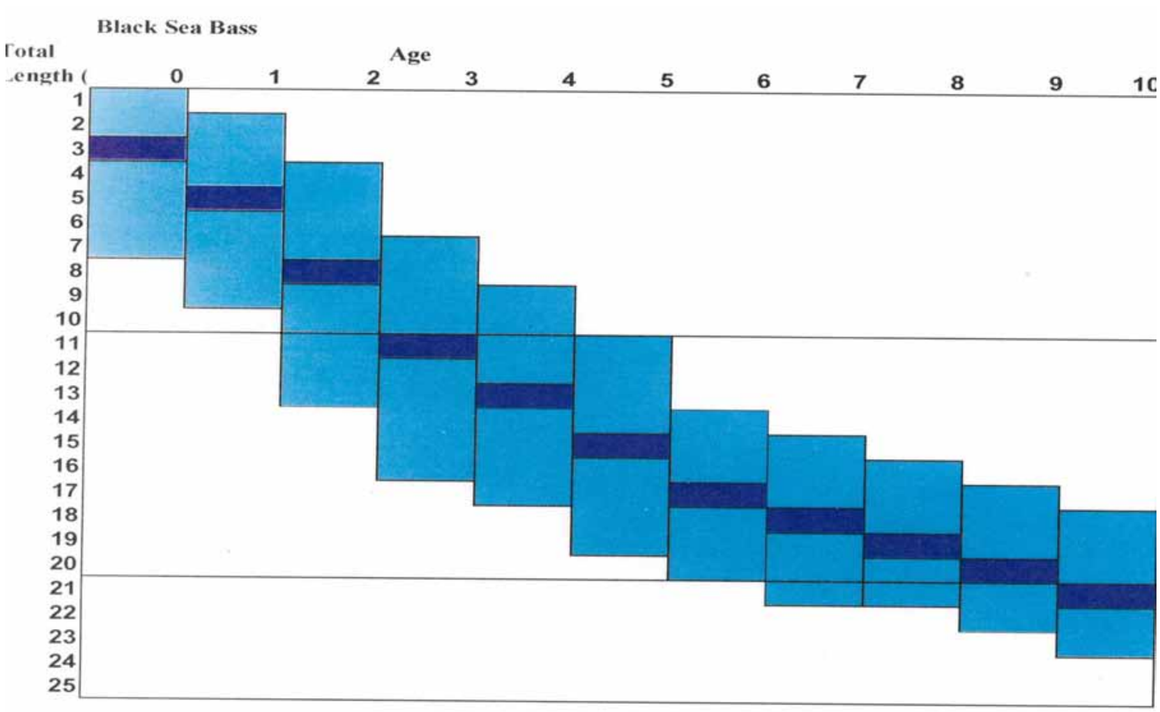


Figure 3. Comparison of Trawl Survey vs Ventless Trap Survey

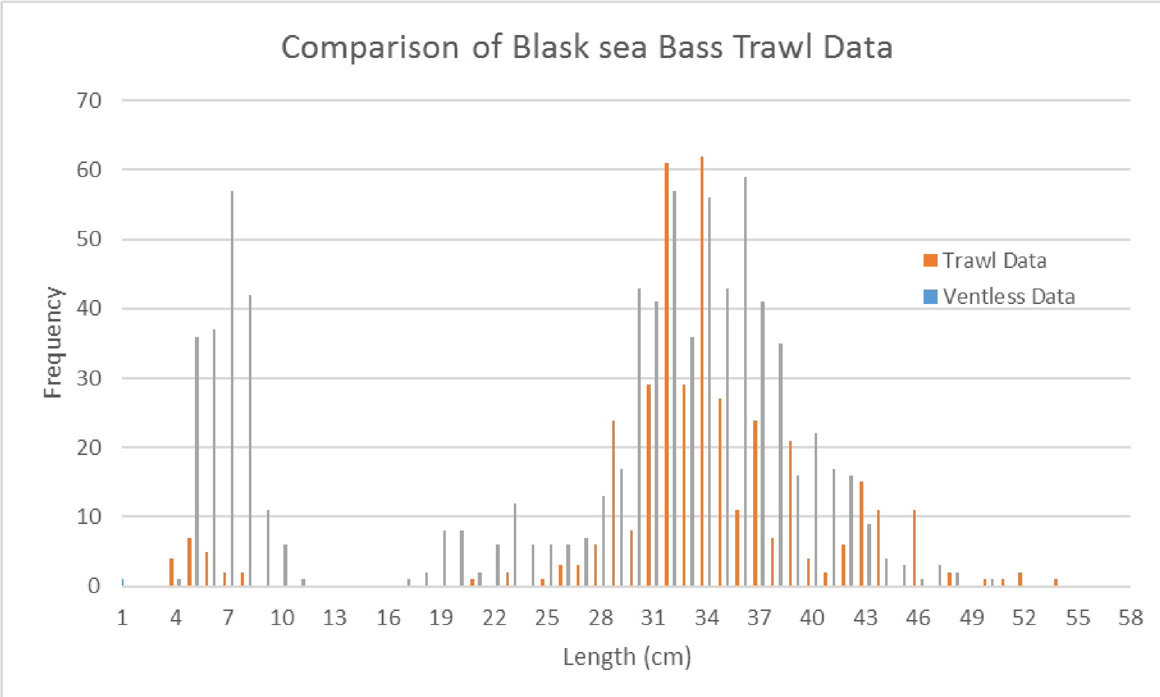


Figure 4 a. Length Frequency Histogram for Scup.

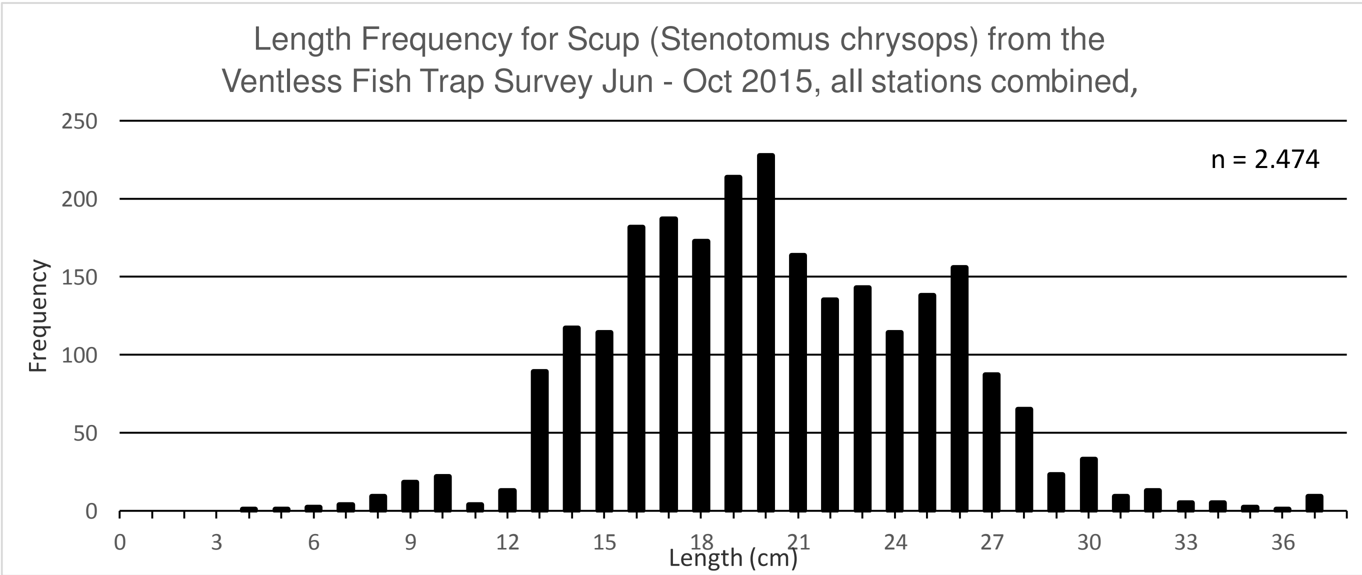


Figure 4b. Length at age graph for scup

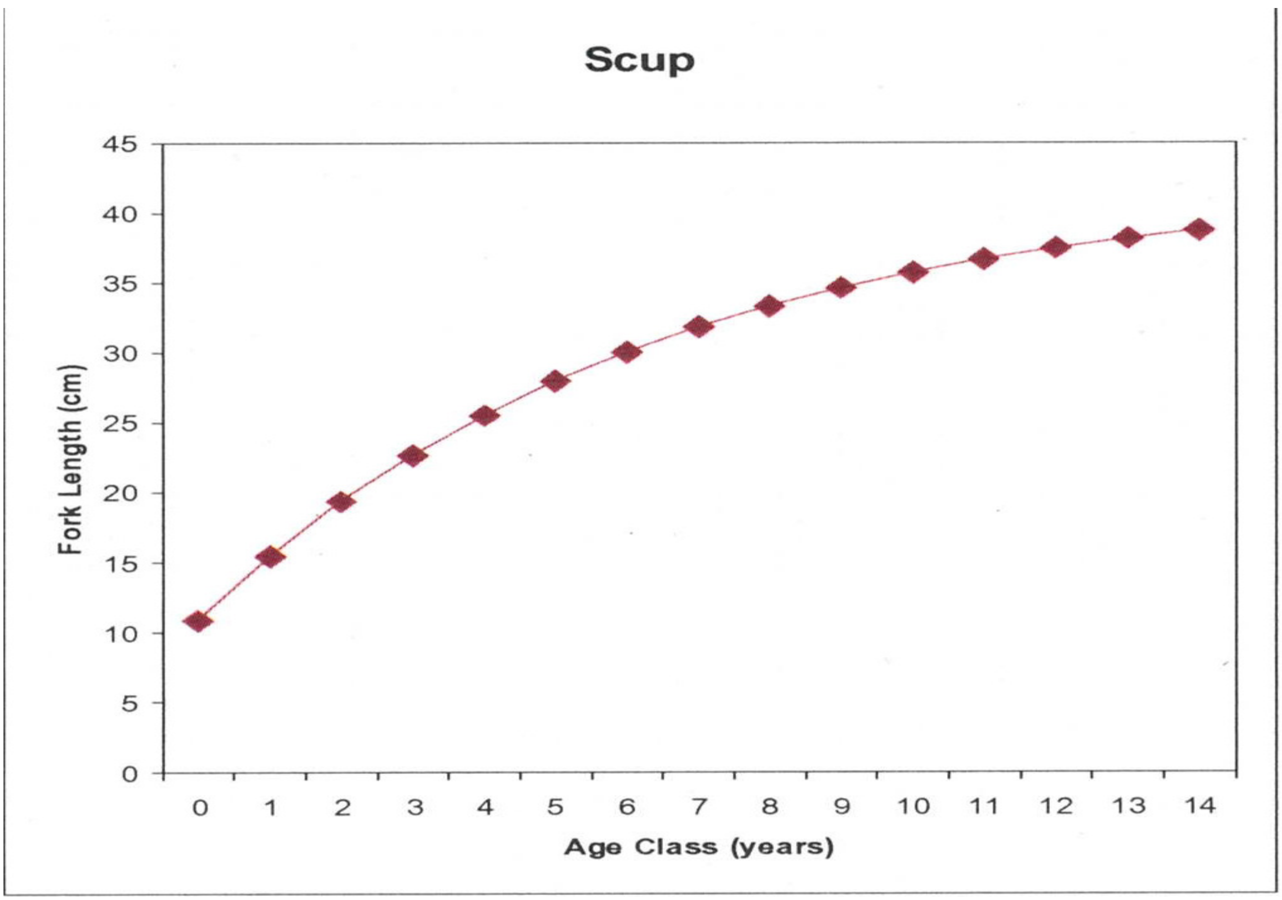


Figure 5 a. Length Frequency Histogram for Tautog.

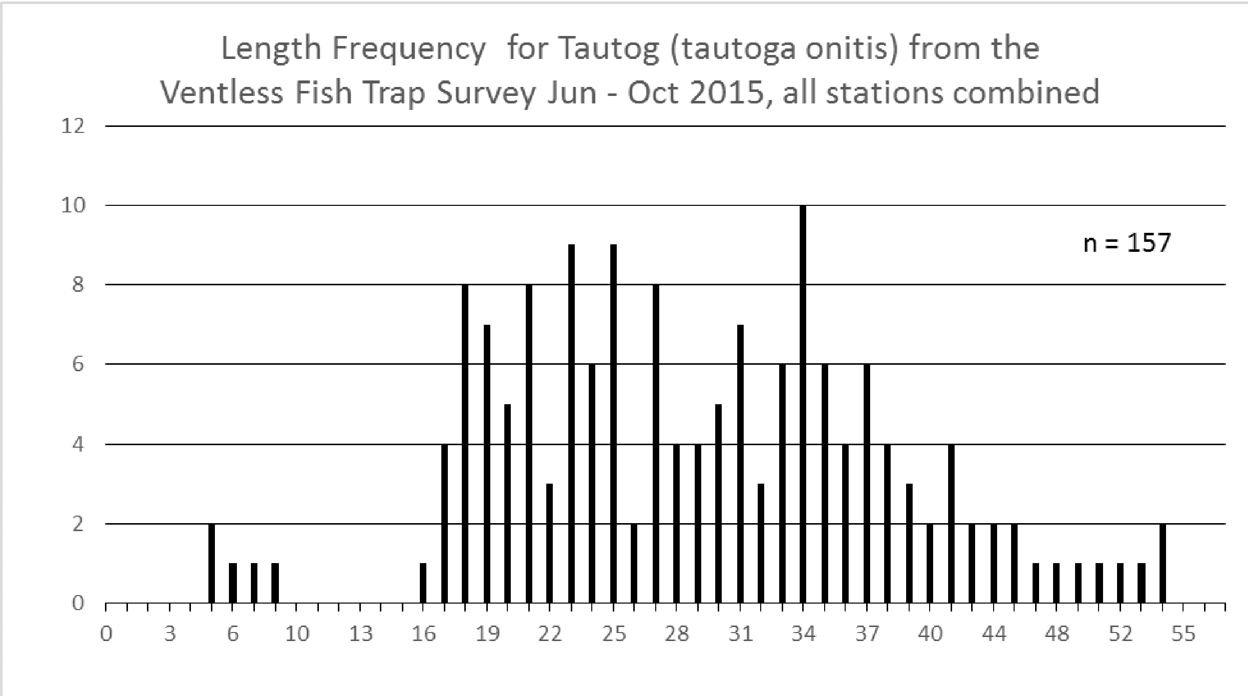


Figure 5 b. Length at age graph for Tautog

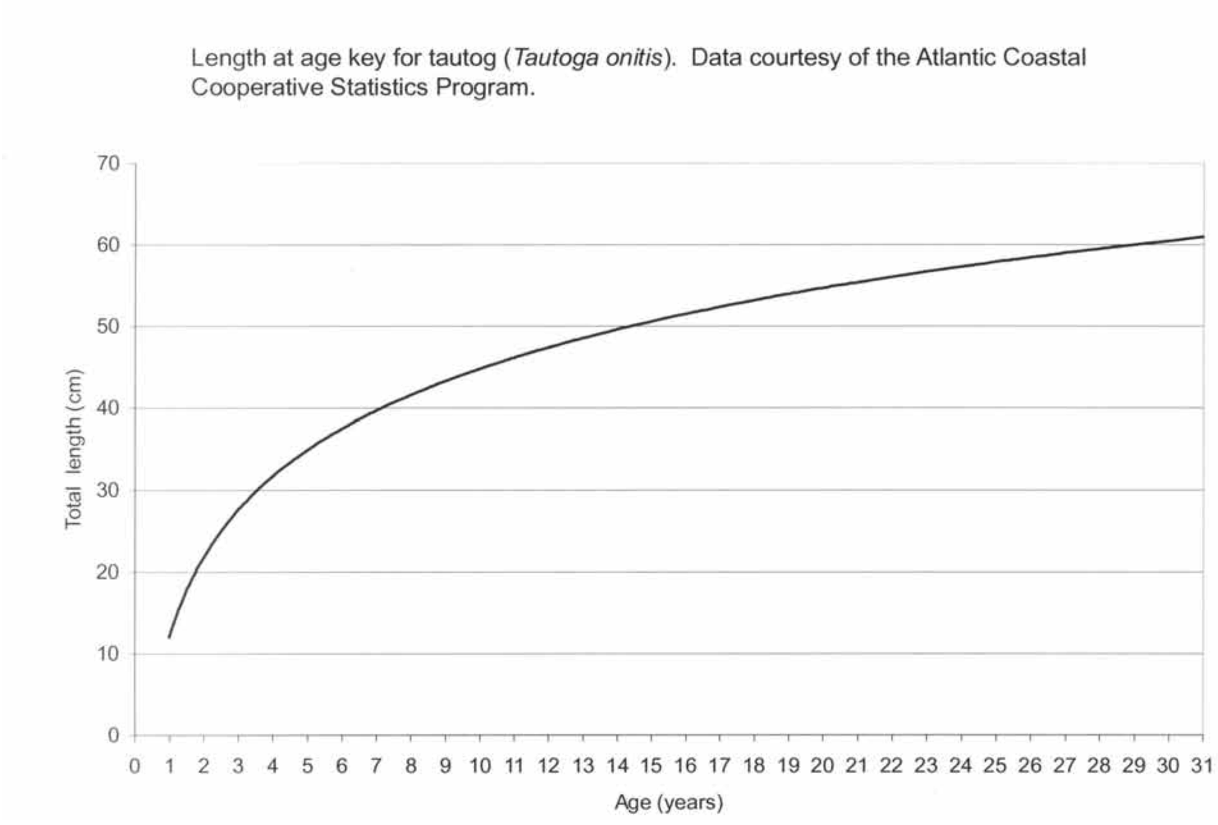
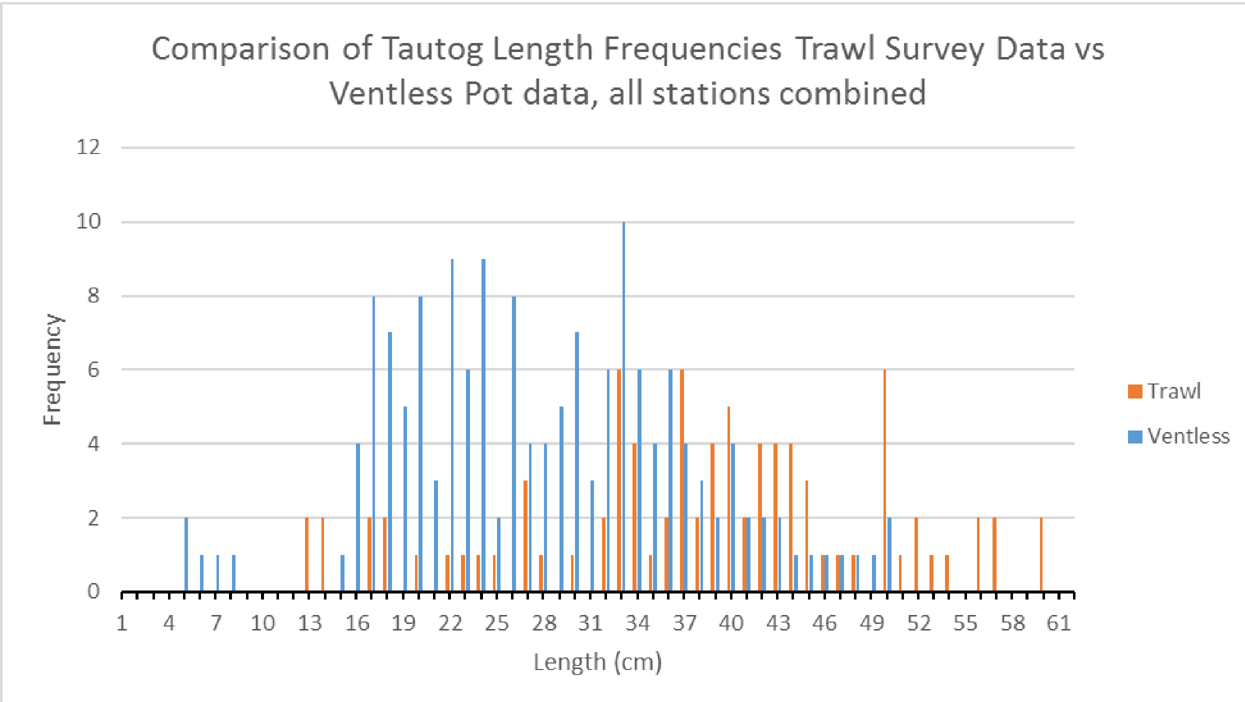


Figure 6 Comparison of Trawl Survey vs Ventless Trap Survey



Marine Fishes of Rhode Island

By
Richard J. Satchwill
Principal Marine Biologist
richard.satchwill@dem.ri.gov

Rhode Island Department of Environmental Management
Division of Fish and Wildlife

Performance Report - Job - 13 March 2016

PERFORMANCE REPORT

State: Rhode Island Project Number: F-61-R

Project Type: Resource Monitoring

Project Title: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

Period Covered: January 1, 2015 to December 31, 2015

Job Number & Title: 13- Marine Fishes of Rhode Island

Job Objective: The goal of this project is to produce a manuscript which will act as a reference text for recreational fishermen, fisheries scientists, and commercial fishermen alike. The finished product will summarize existing knowledge on the appearance, distribution, and life history information where such information exists, including growth, reproduction, food habits, and longevity of fishes caught within the marine waters of Rhode Island. The results will be listed systematically and the manuscript will include scientific illustrations and photographs of fish and distribution maps delineating range of fishes within the state. This volume will be designed to be a stand alone manuscript but also to be compatible with and be a companion volume to the "Fresh Water Fishes of Rhode Island".

Summary: We met with the artist and after discussions concerning species assignments and work efficiency changed the species assignment from our poster to a taxonomic approach. The sharks and rays were assigned first and where possible samples from our various field projects would be photographed and frozen for further study. We again spent considerable time on the internet gathering life history and management information for approximately 94 species in 45 families. We have begun to write species accounts for groups assigned to the artist beginning with the Sea Lamprey.

.

Target Date: 2017

Status of Project: Behind Schedule

Significant Deviations: Personnel were unable to complete significant amounts of work on this project. They were engaged in "Narragansett Bay Ventless Pot, Multi-species Monitoring and Assessment Program" sampling and vessel repair.

Recommendations: To continue on into the next segment.

Remarks: Personnel met with Robert Golder, the artist, concerning the assignment of species to be drawn. Specifically, he was concerned with the order of the species. He explained that when he had worked on "The Fresh Water Fishes of Rhode Island", scheduling for illustrations of fishes worked best when divided into taxonomic groups. He further went on to describe how he would visit the Great Swamp facility to study and make reference photos of preserved specimens. He also intimated that he accompanied the principal investigator on field trips, specifically to a herring run, where live specimens were collected, measured, studied, and photographed. He went on to say that painting all species in a taxonomic group at once was efficient for him because he used similar pigments for the species and could mix similar paints. Additionally, he mentioned that it was also more efficient for the principal investigator because he could compare taxonomic features within the group, and be assured that diagnostic features shown in the illustrations properly distinguished between them, e.g. Alewife from a Blueback Herring, or a Hickory Shad from an American Shad. In consideration of this information, we informed Mr. Golder that he should begin working on the Sharks and Rays, beginning with the Order LAMNIFORMES and the family RHINCODONTIDAE, species Ginglymostoma cirratum – Nurse Shark. We started there simply because the Sea lamprey was drawn for the fresh water book as an adult fish and needn't be redrawn. Mr. Golder indicated that he could begin investigating the sharks at the Woods Hole facility.

In changing Mr. Golder's work plan, we also changed the order in which we gathered information. We spent considerable time on the internet gathering life history information, management information and other pertinent information for 94 species which span 45 families, 20 orders, and 3 classes, ending with the family FUNDULIDAE. In addition to species profiles for Black Sea Bass and Scup, we have begun to write species accounts for species assigned to the artist beginning with the Sea Lamprey. We will seek additional grant monies, e.g. State Wildlife Grant funds, for the non-federal aid species which will be included in the manuscript as we get closer to working on those particular species. It is our intent to work on these species accounts that have been researched as time allows between field work on the ventless trap project.

Investigators spent the majority of the year, March through November, working on the Narragansett Bay Ventless Pot project, either completing field work, entering data, or working to restore our vessel to working order to resume sampling. When the ventless pot project ended in October, it was because of vessel issues which had to be resolved ASAP and which hopefully have been resolved for the 2016 season.

.

Prepared by:_________________
Richard J. Satchwill
Principal Biologist,
Marine Fisheries

Approved by:____________________
Jason McNamee
Chief of Marine Resources
Marine Fisheries

ASSESSMENT OF RECREATIONALLY IMPORTANT FINFISH STOCKS IN RHODE ISLAND WATERS

University of Rhode Island Graduate School of Oceanography Weekly Fish Trawl
2015

PERFORMANCE REPORT
F-61-R SEGMENT 21
JOB 14

Jeremy Collie, PhD
Professor of Oceanography
March 2016

Annual Performance Report

STATE: Rhode Island

PROJECT NUMBER: F-61-R
SEGMENT NUMBER: 22

PROJECT TITLE: Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

JOB NUMBER: 14

TITLE: University of Rhode Island Graduate School of Oceanography Weekly Fish Trawl

JOB OBJECTIVE: To collect, summarize and analyze bottom trawl data for biological and fisheries management purposes.

PERIOD COVERED: January 1, 2015 – December 31, 2015.

TARGET DATE: December 2015

SCHEDULE OF PROGRESS: On schedule.

SIGNIFICANT DEVIATIONS: None

RECOMMENDATIONS: Continuation of the weekly trawl survey into 2016, data provided by the survey are used extensively in the Atlantic States Marine Fisheries Commission and NOAA Fisheries fishery management process and fishery management plans. Work elements for 2016 will include the development of a shared database between URI and RIDEM.

Introduction:

The University of Rhode Island, Graduate School of Oceanography, began monitoring finfish populations in Narragansett Bay in 1959, continuing through 2015. These data provided weekly identification of finfish and crustacean assemblages. Since the inception of the weekly fish trawl, survey tows have been conducted within Rhode Island territorial waters at two stations, one representing habitat of Narragansett Bay and one representing more open-water type habitats, characteristic of Rhode Island Sound. The weekly time step of this survey and its long duration are two unique characteristics of this survey. The short duration time step (weekly) has enough definition to capture migration periods and patterns of important finfish species and the length of the time series allows for the characterization of these patterns back into periods of time that may represent different productivity or climate regimes for many of these species. This performance report reflects the efforts of the 2015 survey year as it relates to the past 56 years.

Methods:

A weekly trawl survey is conducted on the URI research vessel Cap'n Bert. Two stations are sampled each week: one off Wickford represents conditions in mid Narragansett Bay (Fox Island) and one at the mouth of Narragansett Bay represents conditions in Rhode Island Sound (Whale Rock). A hydrographic profile at each station measures temperature, salinity and dissolved oxygen. The same otter trawl net design has been used for the past 56 years. A half-hour tow is made at each station at a speed of 2 knots. All species are counted and weighed with an electronic balance. Winter flounder are routinely measured and the sex ratio determined. When present on board, an undergraduate intern measures all other species with an electronic measuring board.

The gear dimensions of the net are as follows:

Net type	2-seam with bag
Length of headrope	39 feet (11.9 meters)
Otter boards	steel, 24 inches tall, 48 inches long (61 centimeters by 1.24 meters)
Distance from otter boards to net	60 feet (18.3 meters)
Mesh size: net	3 inches (7.6 centimeters)
Mesh size: codend	2 inches (5.1 centimeters)
Distance between otter boards while fishing	52 feet (15.8 meters) at Fox Island 64.5 feet (19.7 meters) at Whale Rock

The following are the station locations for the survey:

Site	Location	Coordinates	Depth Range at Low Tide (North to South Along Tow Line)	Bottom Substrate
Fox Island	Adjacent to Quonset Point and Wickford	41°34.5' N, 71°24.3' W	20 feet (6.1 meters) to 26 feet (7.9 meters)	Soft mud and shell debris
Whale Rock	Mouth of West Passage	41°26.3' N, 71°25.4' W	65 feet (19.8 meters) to 85 feet (25.9 meters)	Coarse mud/fine sand

(For more information about the GSO fish trawl go to www.gso.uri.edu/fishtrawl)

Results:

Fifty-one weekly tows were made at the bay (Fox Island) and sound (Whale Rock) stations. No exceptions or problems were encountered.

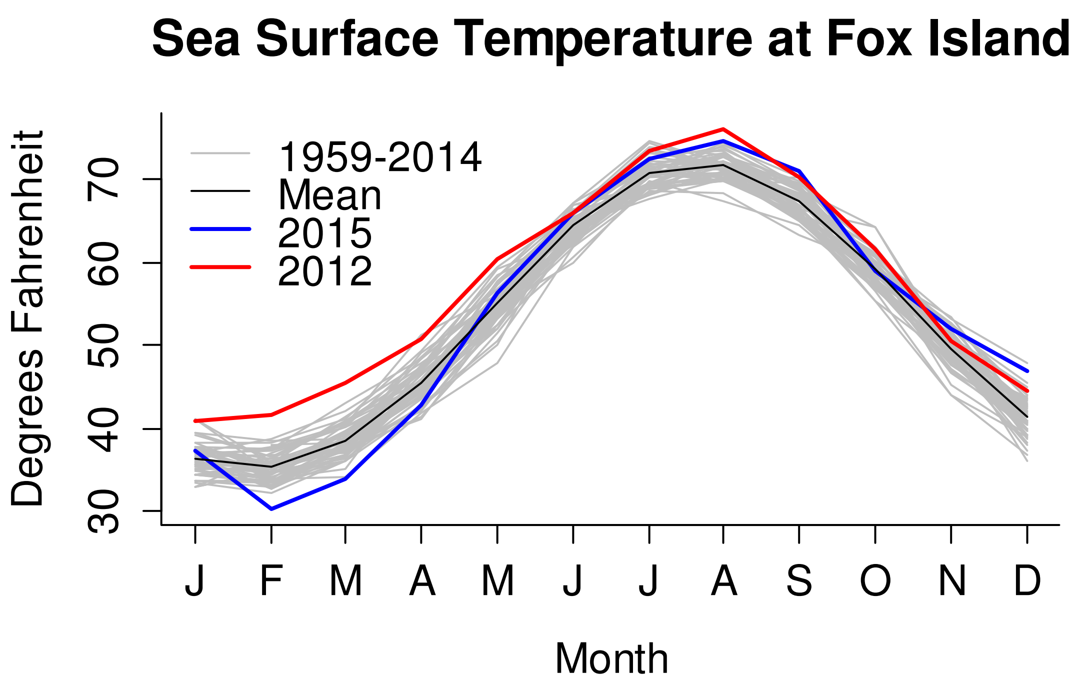


Figure 1. Monthly average sea surface temperature of Narragansett Bay near Wickford. The gray lines represent the seasonal temperature cycle for each year. The black line is the average temperature over all years. The most recent year, 2015, is labeled blue while 2012, the warmest year on record, is labeled red.

Environmental conditions

Hitting record lows and highs, the 2015 seasonal cycle of temperature in Narragansett Bay was one of the most extreme in the 56-year history of the Graduate School of Oceanography (GSO) fish trawl survey. Following a warm January, the sea surface temperature plummeted to 30 °F and parts of Narragansett Bay froze over. Record cold temperatures were observed in February and March. Cold temperatures persisted until late April when the bay warmed rapidly, crossing the seasonal average. The very cold winter likely benefited cold-water species such as lobster and winter flounder, which spawn in winter to avoid predation on their larvae. The GSO fish trawl caught 57 lobsters in just one tow in the lower bay—the last time over 50 lobsters were caught in one tow was in the summer of 2009. The cold winter was followed by a hot summer, surpassed only by the "ocean heat wave" of 2012. These warm temperatures are associated with the influx of warm-water species including scup, butterfish, and squid. In October, temperatures cooled toward the long-term average, but remained well above average during the final two months of the year, with some of the highest temperatures on record for November and December. This fall heat was associated with the strong El Niño developing in the eastern Pacific Ocean. These temperature extremes are consistent with climate predictions of more extreme weather events, and are superimposed on the general warming trend.

Summary catch statistics

Table 1. Total catch by species at Fox Island (FI) and Whale Rock (WR) for the top 25 species.

Species	**FI**	**WR**	**Total**
SCUP (*Stenotomus chrysops*)	19793	4828	24621
BUTTERFISH (*Peprilus triancanthus*)	1364	6194	7558
SQUID (*Loligo peali*)	1707	2204	3911
SPIDER CRAB (*Libinia emarginata*)	1131	664	1795
CANCER CRABS (*Cancer irroratus* & *Cancer borealis*)	42	1338	1380
LITTLE SKATE (*Raja erinacea*)	62	782	844
MENHADEN (*Brevootia tyrannus*)	489	2	491
SUMMER FLOUNDER (*Paralichthys dentatus*)	217	249	466
ALEWIFE (*Alosa pseudoharengus*)	239	18	257
MOONFISH (*Vomer setapinnis*)	221	11	232
STRIPED SEAROBIN (*Prionotus evolans*)	55	167	222
LOBSTER (*Homarus americanus*)	1	200	201
NORTHERN SEAROBIN (*Prionotus carolinus*)	36	157	193
HERMIT CRABS (*Pagurus pollicaris*)	183	5	188
WINTER FLOUNDER (*Pseudopleuronectes americanus*)	99	63	162
CONCH (*Busycon canaliculatum* & *Busycon carica*)	144	8	152

SAND FLOUNDER (*Scophthalmus aquosus*)	8	139	147
WEAKFISH (*Cynoscion regalis*)	37	90	127
TAUTOG (*Tautoga onitis*)	95	6	101
SILVER HAKE (*Merluccius bilinearis*)	1	83	84
FOURSPOT FLOUNDER (*Paralichthys oblongus*)	1	80	81
GULF STREAM FLOUNDER (*Citharichthys arctifrons*)	3	75	78
ATLANTIC (SEA) HERRING (*Clupea harengus*)	27	19	46
MANTIS SHRIMP (*Squilla empusa*)	42	4	46
SQUIRREL (RED) HAKE (*Urophycis chuss*)	1	44	45

The top 10 species caught in 2015 (and the station where they were most numerous) were: Scup (FI), Butterfish (WR), Squid (WR), Spider crabs (FI), Cancer crabs (WR), Little skate (WR), Menhaden (FI), Summer flounder (WR), Alewife (FI), and Moonfish (FI).

A number of species of recreational importance were collected during 2015 by the URI Fish trawl survey. Represented below are a number of important species and their abundance trends throughout the time series of this survey. On each graph, the species abundance at the two stations is represented separately for each station.

Winter flounder

Winter flounder are one of the target species for the survey. The population of winter flounder has declined dramatically during the time period of the survey with 2015 being one of the lowest estimates on record for both stations (Figure 2). The survey information is used during the stock assessment process for winter flounder.

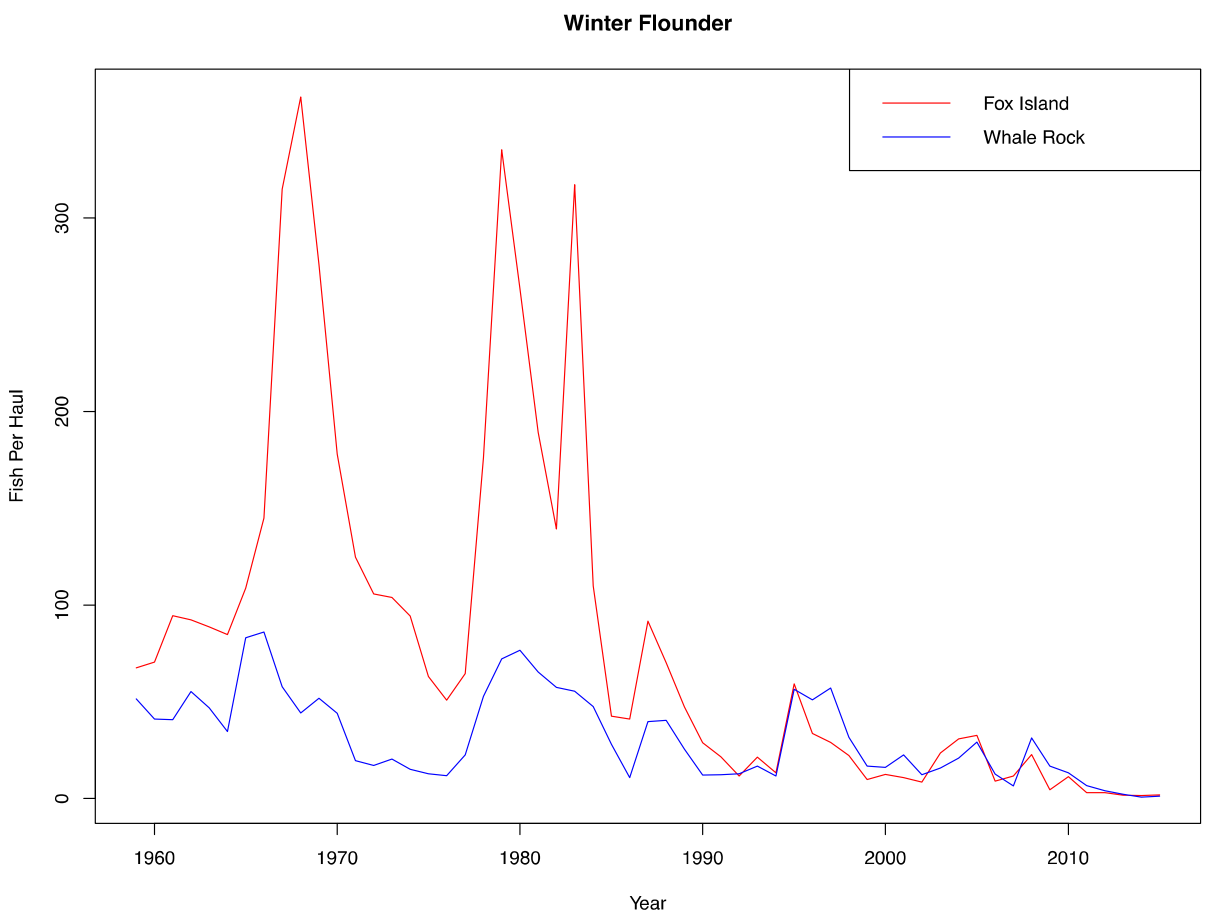


Figure 2 – Survey data for entire time series for winter flounder at both sampling stations (Fox Island and Whale Rock).

Tautog

Tautog are another important recreational species caught by the survey. The population of tautog has declined dramatically during the time period of the survey, but does show some small improvement in the most recent period of time (Figure 3). Despite the improvement, the population according to the survey has not rebounded to former levels. Tautog are mainly caught at the Fox Island station, with only random and infrequent catches occurring at Whale Rock. The survey information was reviewed during the stock assessment process for tautog.

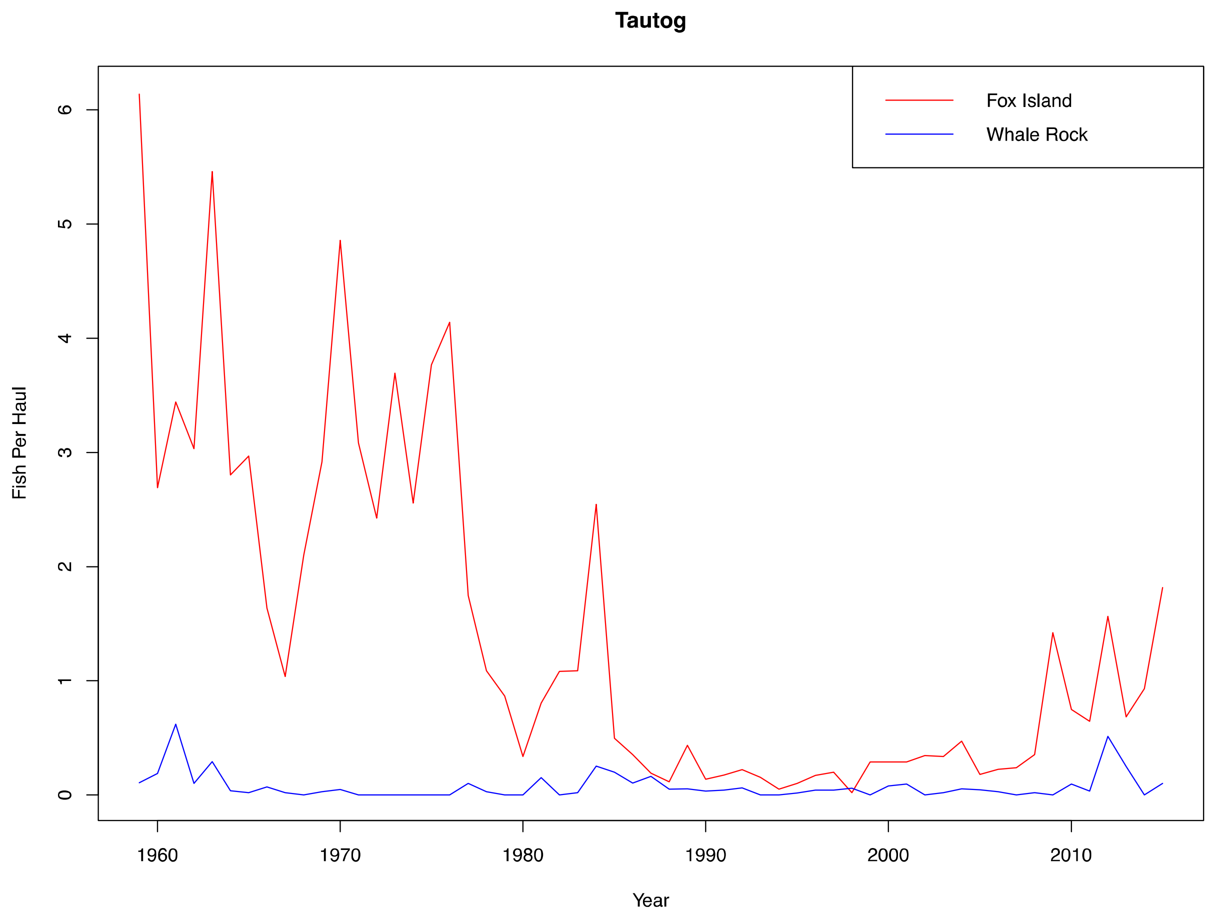


Figure 3 – Survey data for entire time series for tautog at both sampling stations (Fox Island and Whale Rock).

Summer Flounder

Summer flounder are another important recreational species caught by the survey. The population of summer flounder has increased dramatically during the time period of the survey, but does showing a fair amount of variability in the most recent time period (Figure 4). Summer flounder are caught at both sampling stations pretty consistently, though abundance has increased at Whale Rock relative to Fox Island. The survey information was reviewed during the stock assessment process for summer flounder, and the trends indicated by the survey are similar to those indicated by the overall population trends.

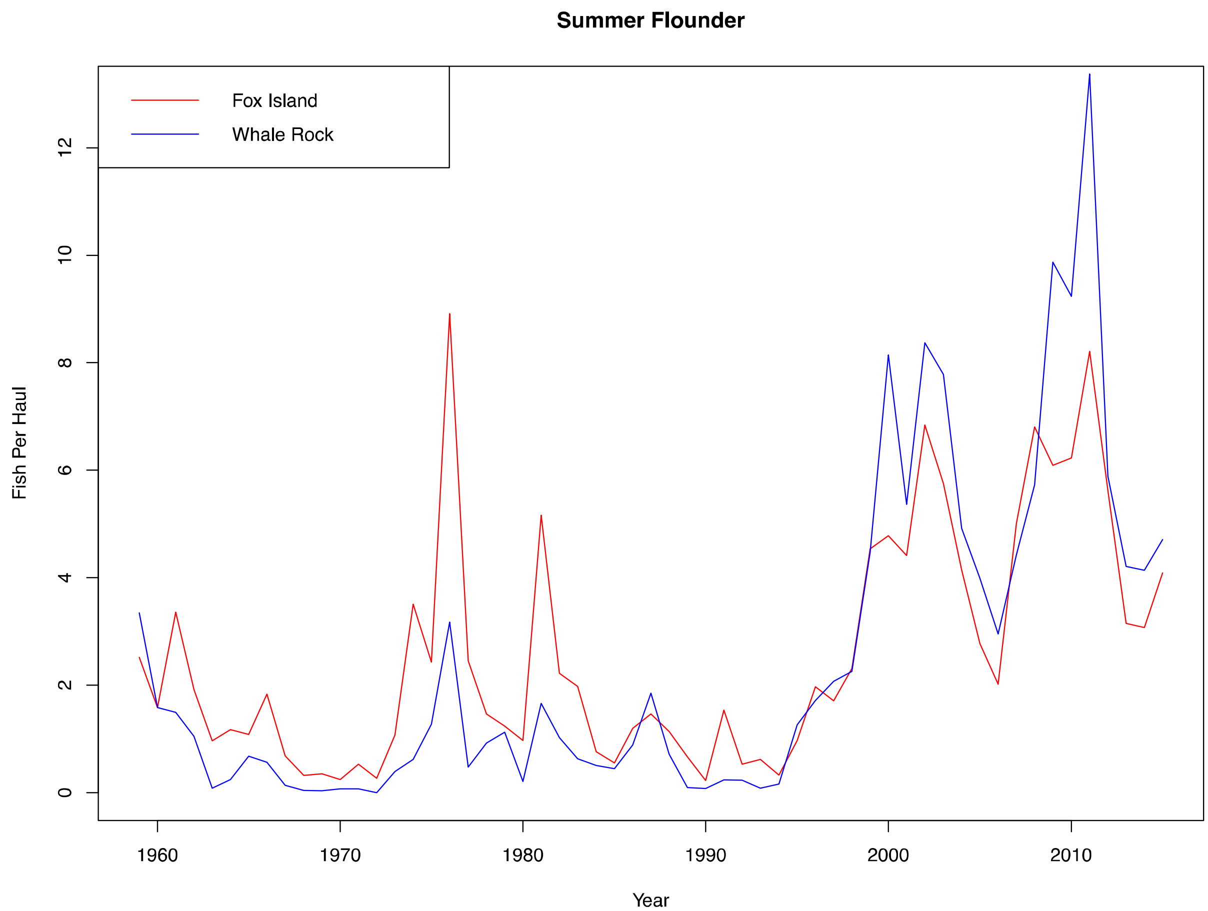


Figure 4 – Survey data for entire time series for summer flounder at both sampling stations (Fox Island and Whale Rock).

.

Black Sea Bass

Black sea bass are another important recreational species caught consistently by the survey. The population of black sea bass has increased dramatically during the time period of the survey much like summer flounder, and also shows a fair amount of variability in the most recent time period (Figure 5). Black sea bass are caught at both sampling stations pretty consistently. The survey information will be reviewed during the stock assessment process for black sea bass.

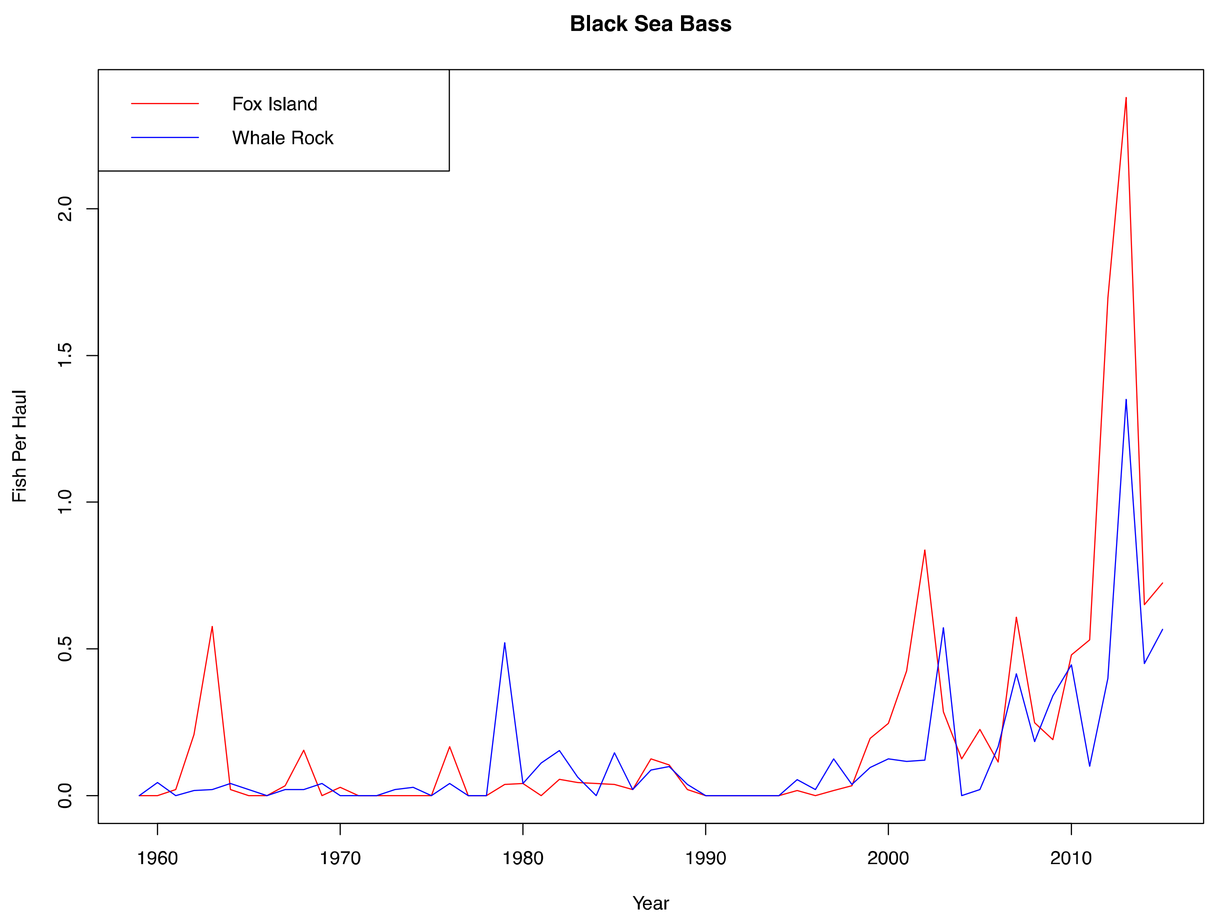


Figure 5 – Survey data for entire time series for black sea bass at both sampling stations (Fox Island and Whale Rock).

Scup

Scup is another of the Mid-Atlantic species caught consistently by the survey, along with summer flounder, black sea bass, bluefish, and menhaden. The population of scup has increased dramatically during the time period of the survey much like summer flounder and black sea bass, showing a high degree of variability going all the way back to the mid 1970s (Figure 6). Scup are caught at both sampling stations pretty consistently, though the Fox Island station catches a much higher magnitude than does the Whale Rock station. Some of this variability and magnitude difference for scup is driven by high recruitment events, the young of the year recruits being susceptible to the trawl gear. The survey information will be reviewed during the stock assessment process for scup.

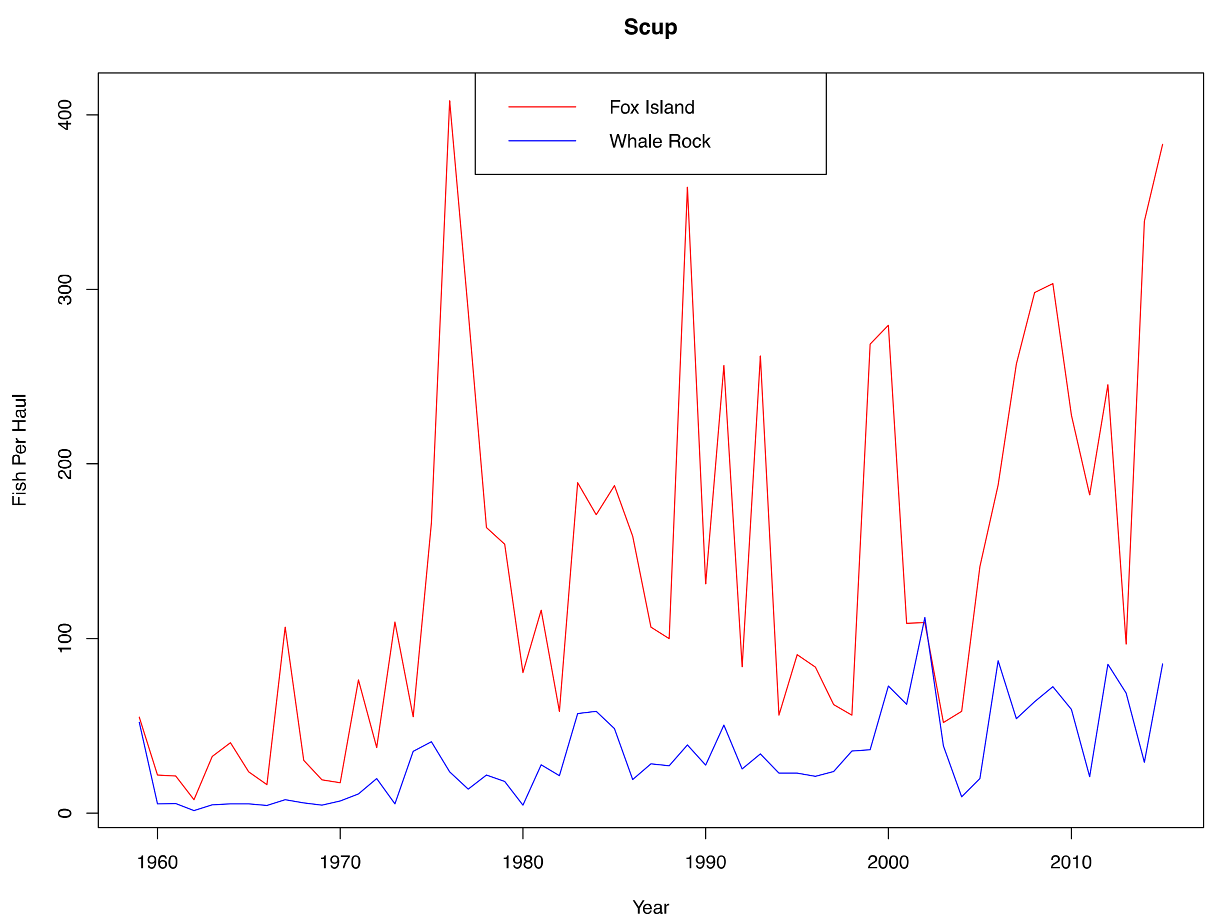


Figure 6 – Survey data for entire time series for scup at both sampling stations (Fox Island and Whale Rock).

Bluefish

Bluefish is another of the Mid-Atlantic species caught consistently by the survey. The population of bluefish increased during the middle of the time period of the survey, but has since declined, with some potential improvement in recent years. There is high variability for this species in the survey data, again mainly due to catching young of the year bluefish as opposed to adults (Figure 7). Bluefish are caught at both sampling stations pretty consistently.

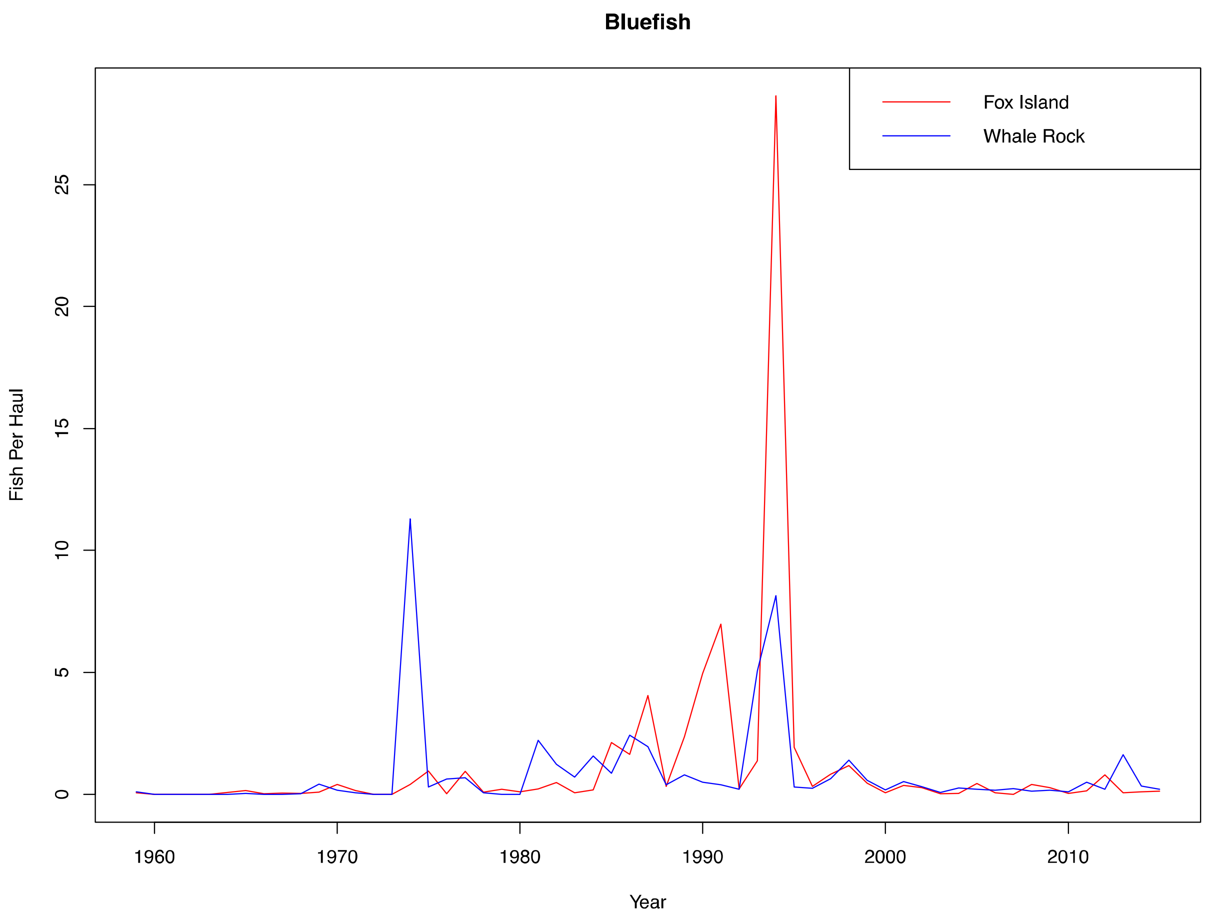


Figure 7 – Survey data for entire time series for bluefish at both sampling stations (Fox Island and Whale Rock).

Weakfish

Weakfish is another of the Mid-Atlantic species caught consistently by the survey, as weakfish use Narrgansett Bay as a nursery habitat. The population of weakfish has been variable through the time period of the survey with periods of high abundance and periods of very low abundance. Higher abundance was observed at Whale Rock in 2014 and 2015. There is high variability for this species in the survey data, again mainly due to catching young of the year weakfish as opposed to adults (Figure 8), so this survey is probably a better indicator of recruitment than adult population size. Weakfish are caught at both sampling stations pretty consistently.

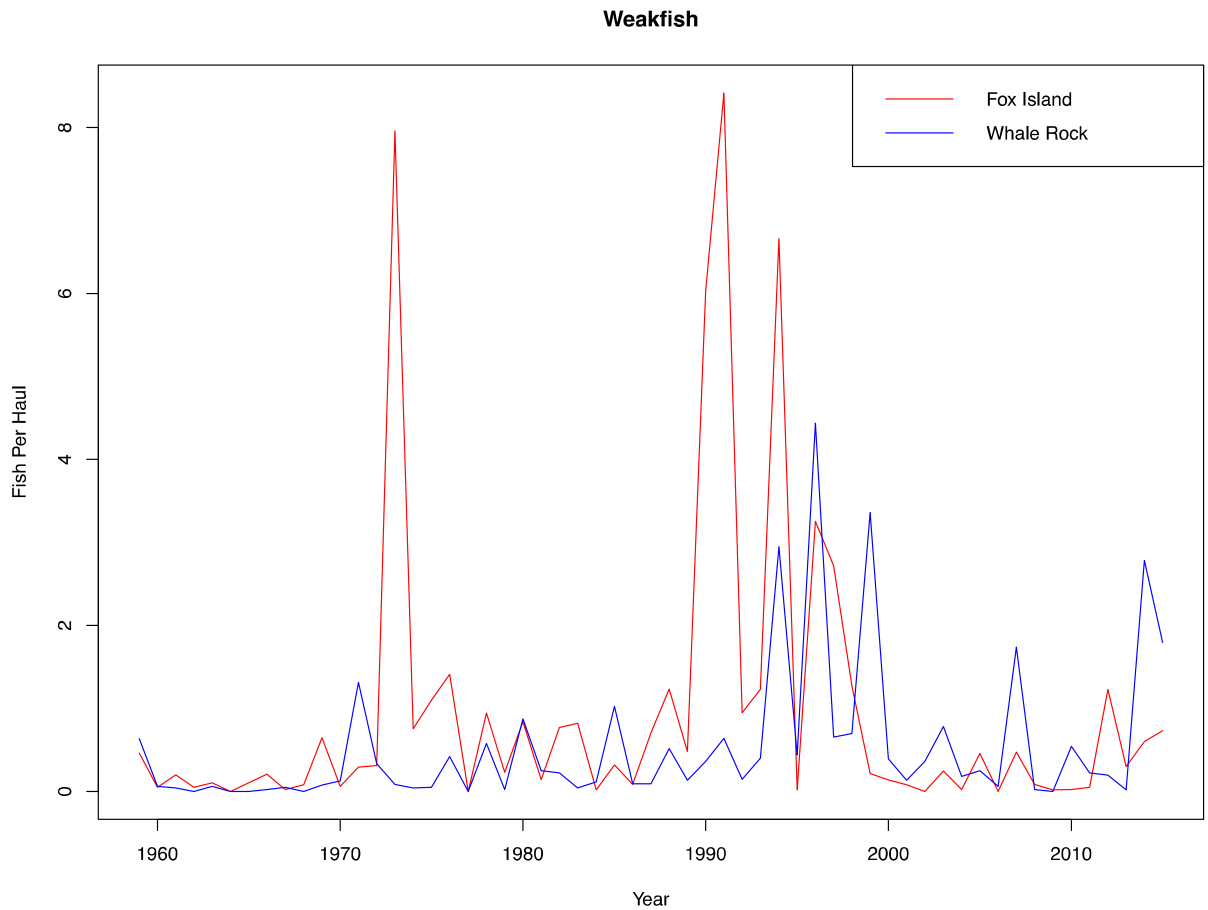


Figure 8 – Survey data for entire time series for weakfish at both sampling stations (Fox Island and Whale Rock).

Striped Bass

Striped bass is probably the premier recreational species caught by the survey. The catch of striped bass has been variable throughout the time period of the survey, peaking between 1990 and 2010. There is high variability for this species in the survey data, but the survey catches both juveniles and adults (Figure 9). Striped bass are caught in greater abundance and frequency at Fox Island than at Whale Rock.

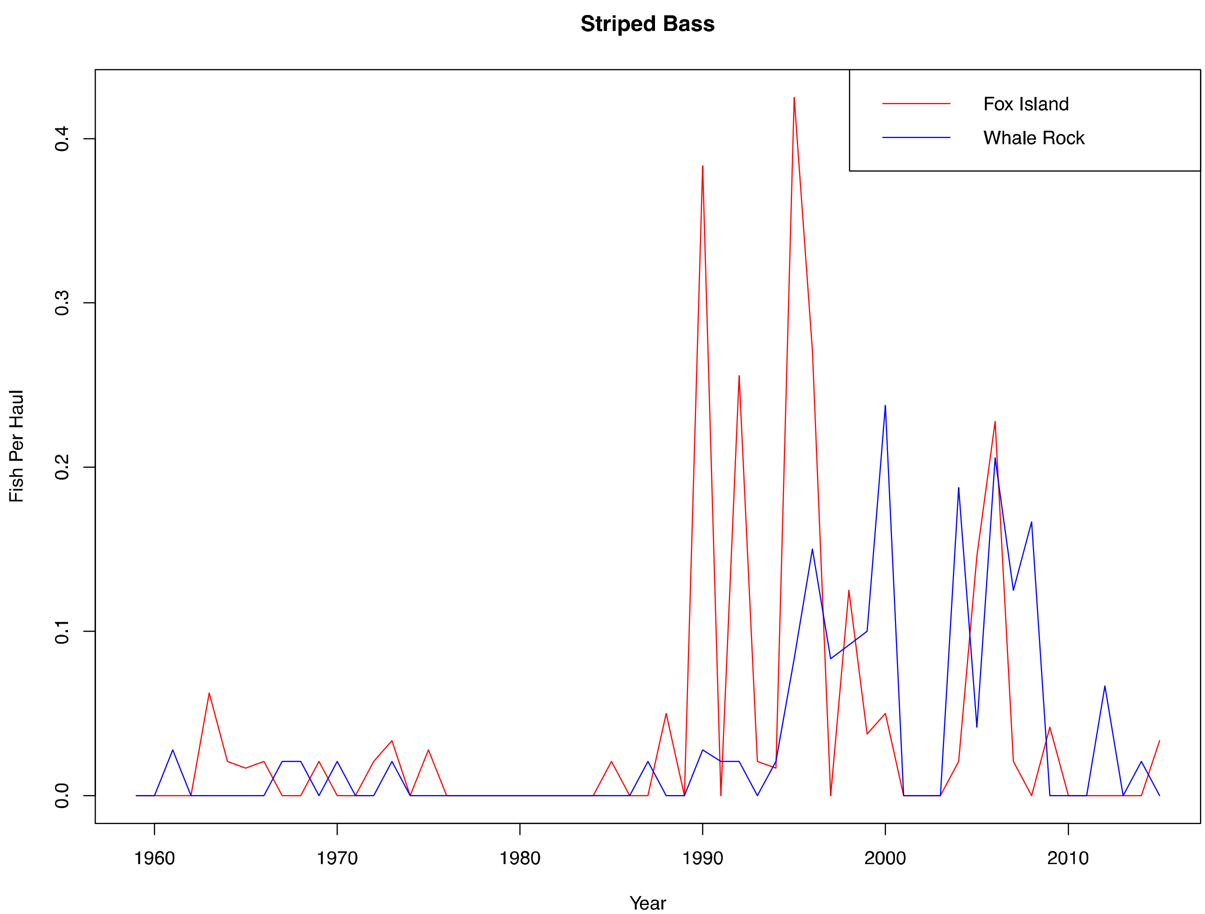


Figure 9 – Survey data for entire time series for striped bass at both sampling stations (Fox Island and Whale Rock).

Menhaden

Menhaden is another of the Mid-Atlantic species caught consistently by the survey. The catch of menhaden has been variable throughout the time period of the survey, mainly due to the schooling pelagic nature of this species. There is high variability for this species in the survey data, but the survey mainly catches juveniles (Figure 10). Menhaden are caught in greater abundance and frequency at Fox Island than at Whale Rock. The survey information was reviewed during the stock assessment process for menhaden.

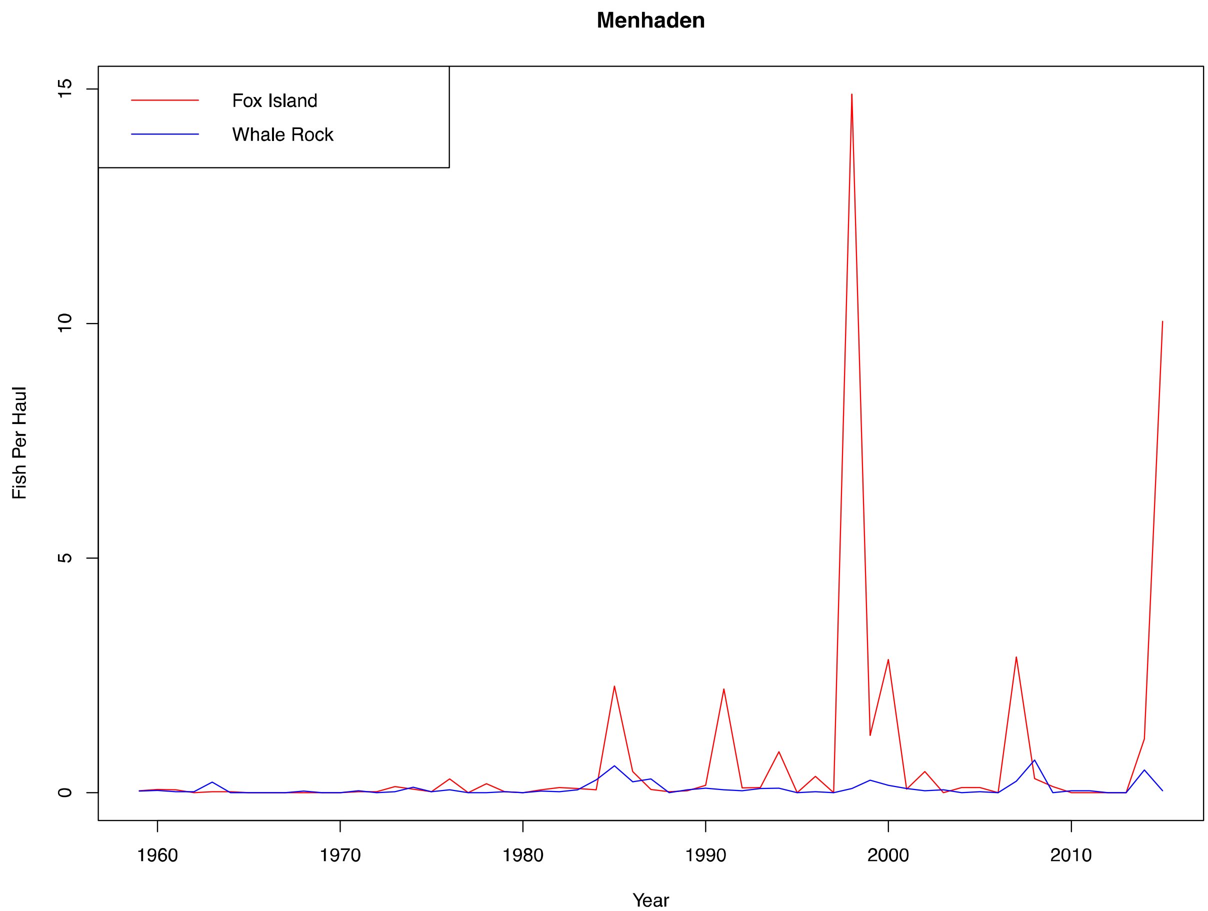


Figure 9 – Survey data for entire time series for menhaden at both sampling stations (Fox Island and Whale Rock)

Comparative Study between the two surveys

This following information represents an initial investigation in to the comparability of the GSO Fish Trawl and the RIDEM Coastal Fishery Resource Assessment Trawl Survey. Both surveys have strengths and weaknesses. For strengthsof the GSO survey, it has one of the longest time series on the east coast, it has high definition in the sampling design (every week), and has had a high degree of consistency through time. Weaknesses of the GSO trawl are that it is spatially limited and that the data collected has varied through time by way of species information. For the RIDEM survey, the strengths are good spatial coverage of RI state waters, a relatively long time series of data (though not as long as URI survey), and the data collected has been consistent through time. Weaknesses for the DEM survey include that the equipment has changed through time adding some inconsistency to the survey design, the data collected on non target species has been lacking (though continues to improve, and the monthly component was not added until the 90s.

The time period of 1990 through 2014 was selected for the comparative analysis. The data was organized and differentiated by species and station to make sure the comparisons were occurring across similar pieces of information. The two items that were analyzed were abundance data, which was reviewed and compared, and the time series of abundance through time, which was analyzed for correlation across trends. The analysis was focused on 4 important species; summer flounder, scup, black sea bass, and lobster. The dataset was analyzed in two ways for comparative abundance. One method was to use a standard statistical procedure, a so called frequentist approach, and this was followed by a Bayesian statistical approach to see how robust the comparative analyses were. Both analyses examined differences in means of abundance between the GSO and RIDEM survey datasets.

Abundance was analyzed using a negative binomial generalized linear model. The model used to determine significance of survey to the abundance estimate was:

$$\text{Abundance} \sim \text{Survey}$$

Where Abundance = # fish or lobster, and Survey = categorical designation of each survey.

For this analysis, for each species, it was found that survey was a significant effect in the model (Figures 10 - 13).

The Bayesian approach used an informative but flexible prior for Monte Carlo (MC) sampling, a gamma distribution. The distribution parameters used catch and tow information from entire dataset in the analysis. The analysis was run by splitting the dataset in to GSO and RIDEM survey datasets, and then a MC simulation with 10,000 samples with following form was run:

$$\text{rgamma}(S, a+yi, b+xi)$$

Where a = prior catch (used total for both surveys), yi = catch (GSO and DFW), b = prior # tows (used total for both surveys), xi = # tows (GSO and RIDEM), and S = number MC samples.

Results of the analysis are shown in Figures 14 – 17, which indicate that there are differences in the abundance of species caught by the two surveys.

Finally, a trend analysis was conducted by reviewing the time series abundance trend of the DEM and GSO trawl surveys. The analysis indicated that there was high correlation in trends for summer flounder, lobster and black sea bass, but this agreement was less apparent for scup (Table 2, Figure 18).

The overall conclusion is that there are significant differences in the magnitude of the catch of these four species between the GSO and DFW surveys. This conclusion holds for both the frequentist and Bayesian approaches. Despite abundance differences, the surveys are highly correlated as far as the trends in population trajectory for all species except scup. Due to the correlation in trends, but differences in abundance, a calibration factor would need to be developed to integrate the two surveys in to a single time series of information. Extensions of this analysis can be made to test whether there are differences in the length frequency or weights of species caught in addition to the number caught.

Table 2 – Correlation analysis by species for the two surveys

		GSO			
		Fluke	**Scup**	**Lobster**	**Black Sea Bass**
DFW	**Fluke**	**0.74**			
	Scup		**0.35**		
	Lobster			**0.87**	
	Black Sea Bass				**0.50**

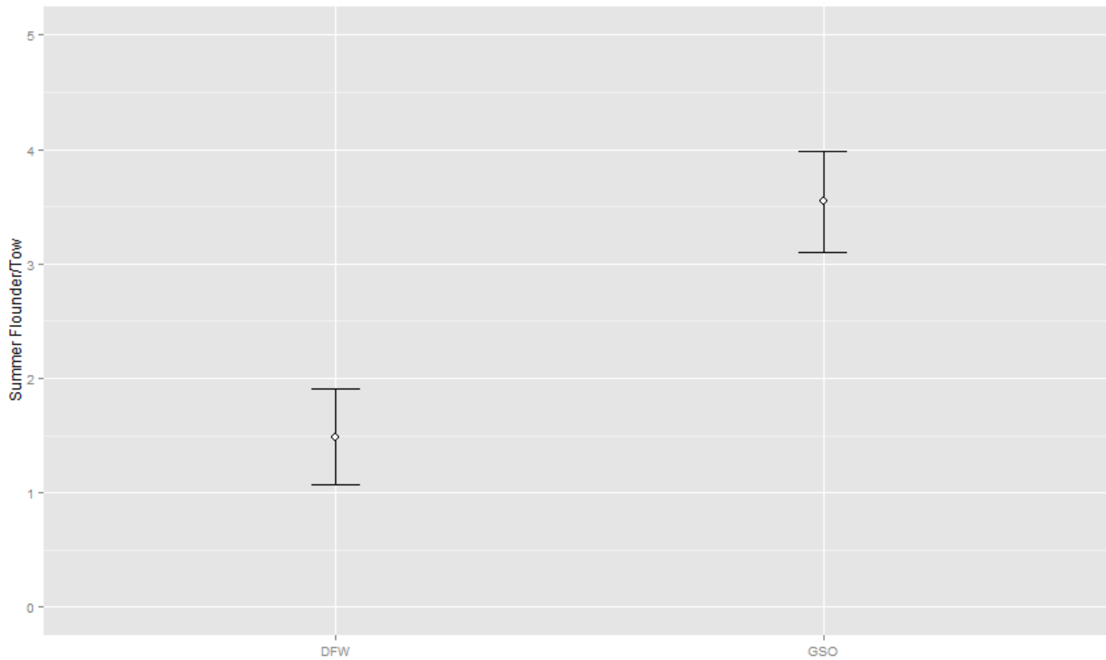


Figure 10 – Mean abundance and 95% confidence interval for the two surveys for summer flounder using a negative binomial generalized linear model.

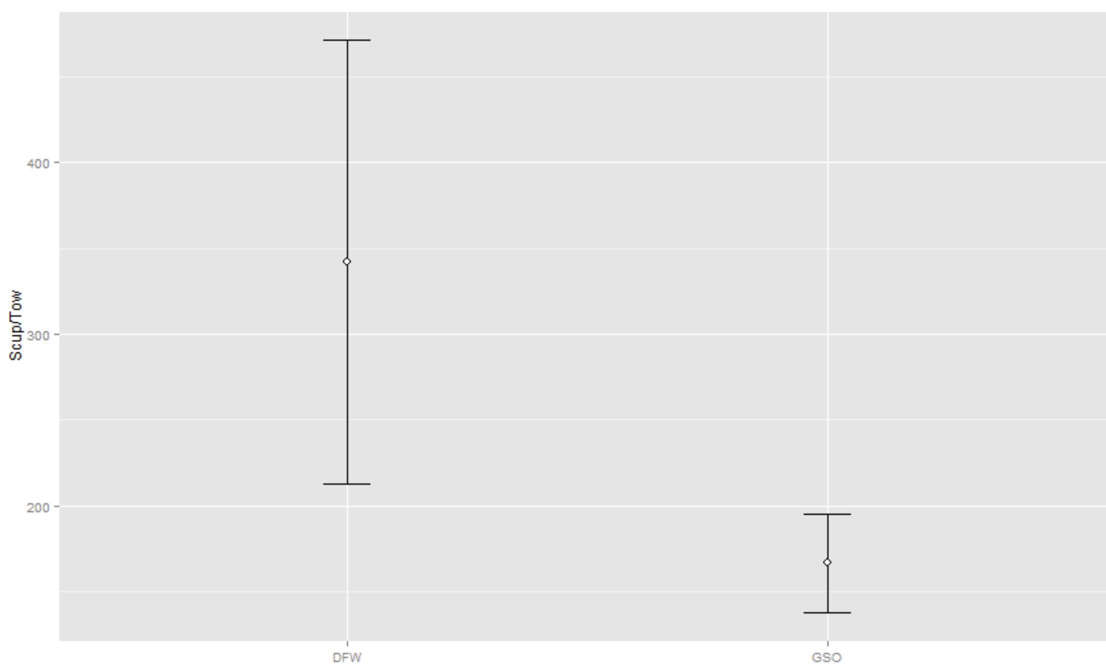


Figure 11 – Mean abundance and 95% confidence interval for the two surveys for scup using a negative binomial generalized linear model.

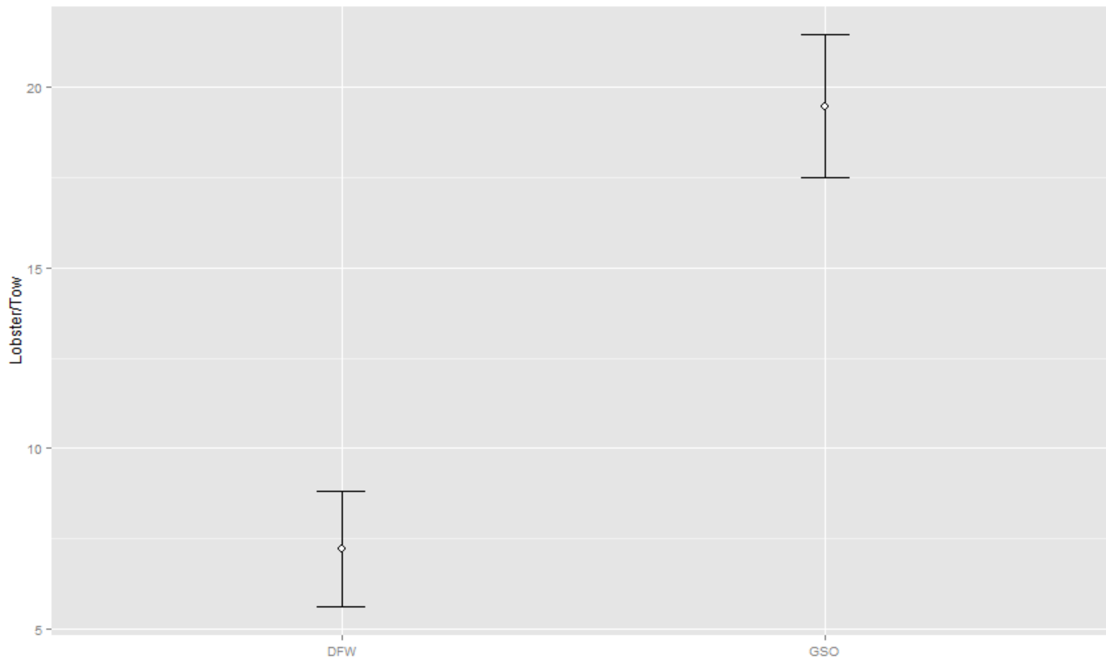


Figure 12 – Mean abundance and 95% confidence interval for the two surveys for lobster using a negative binomial generalized linear model.

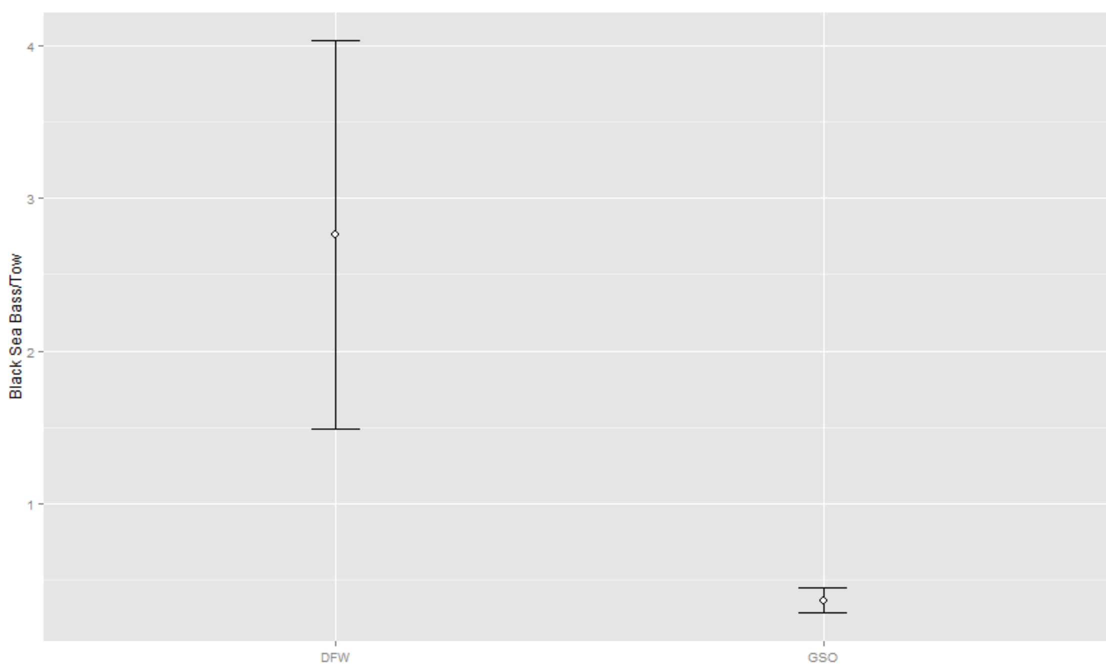


Figure 13 – Mean abundance and 95% confidence interval for the two surveys for black sea bass using a negative binomial generalized linear model.

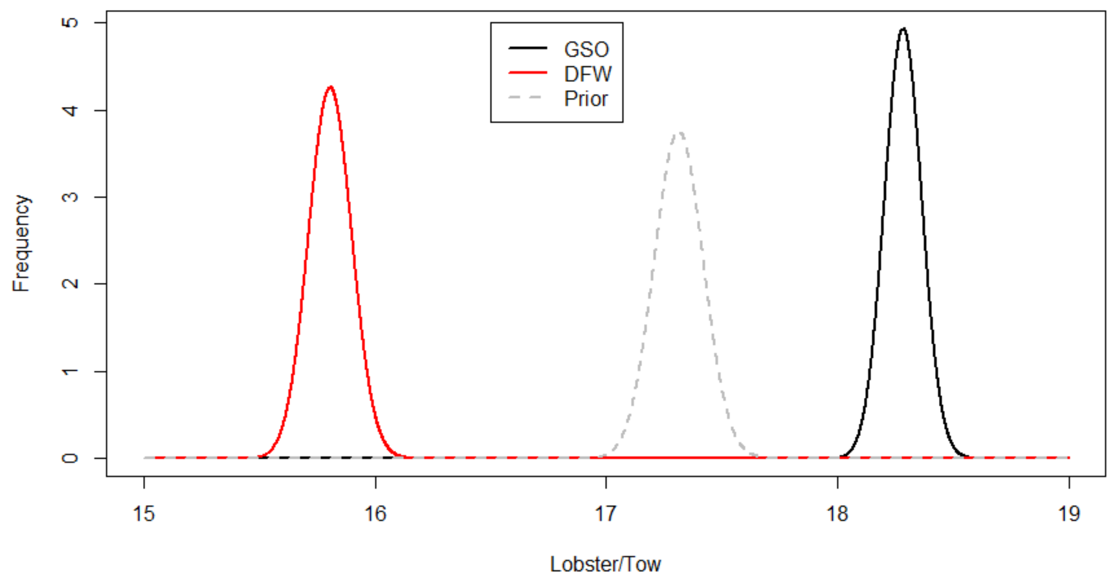


Figure 14 – Mean abundance distribution as produced by MC sampling and assumed prior for the two surveys for lobster.

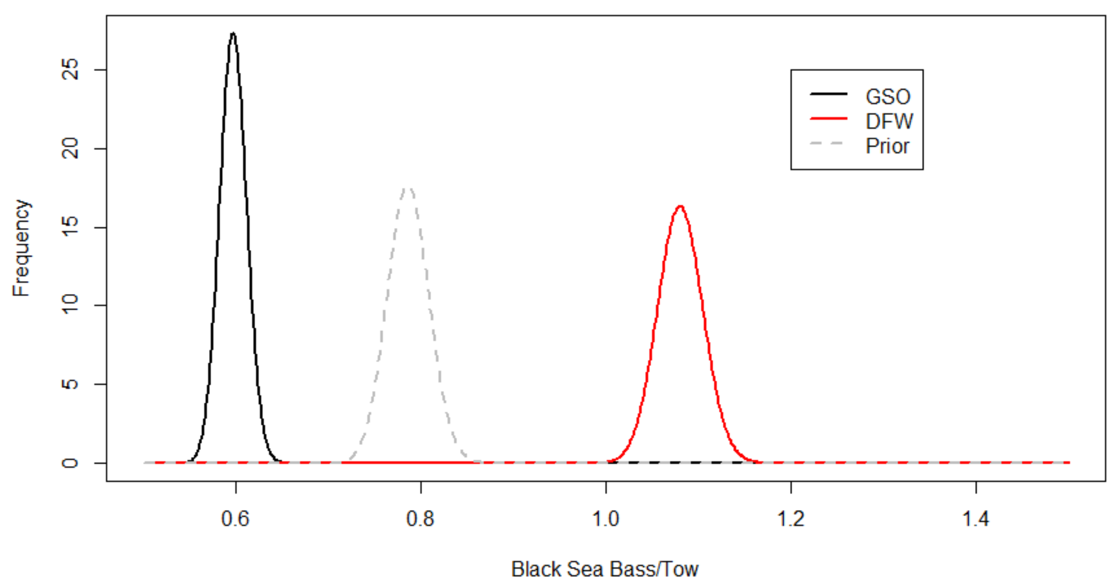


Figure 15 – Mean abundance distribution as produced by MC sampling and assumed prior for the two surveys for black sea bass.

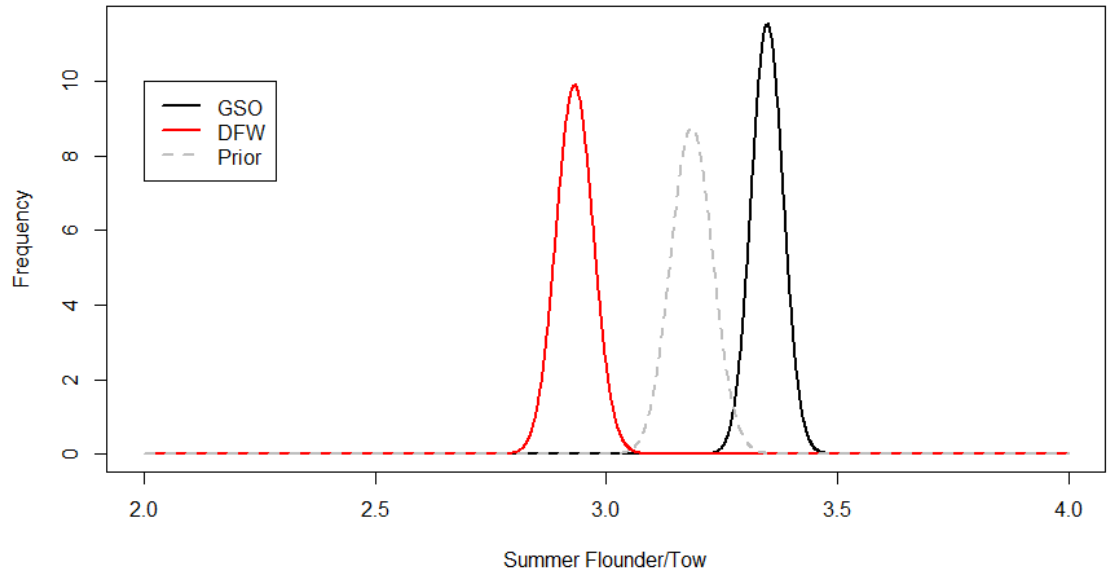


Figure 16 – Mean abundance distribution as produced by MC sampling and assumed prior for the two surveys for summer flounder.

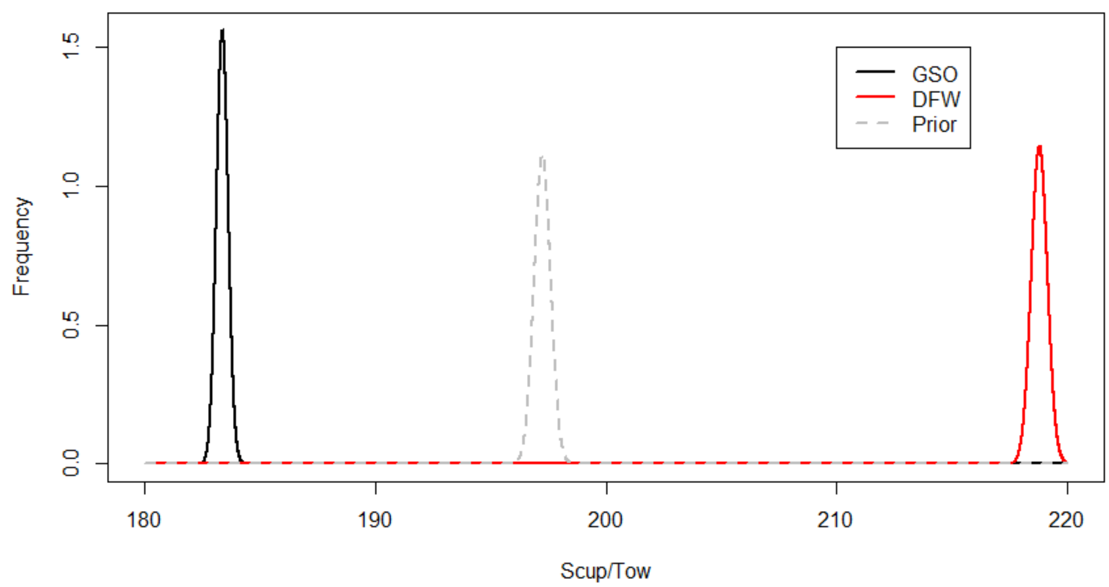


Figure 17 – Mean abundance distribution as produced by MC sampling and assumed prior for the two surveys for scup.

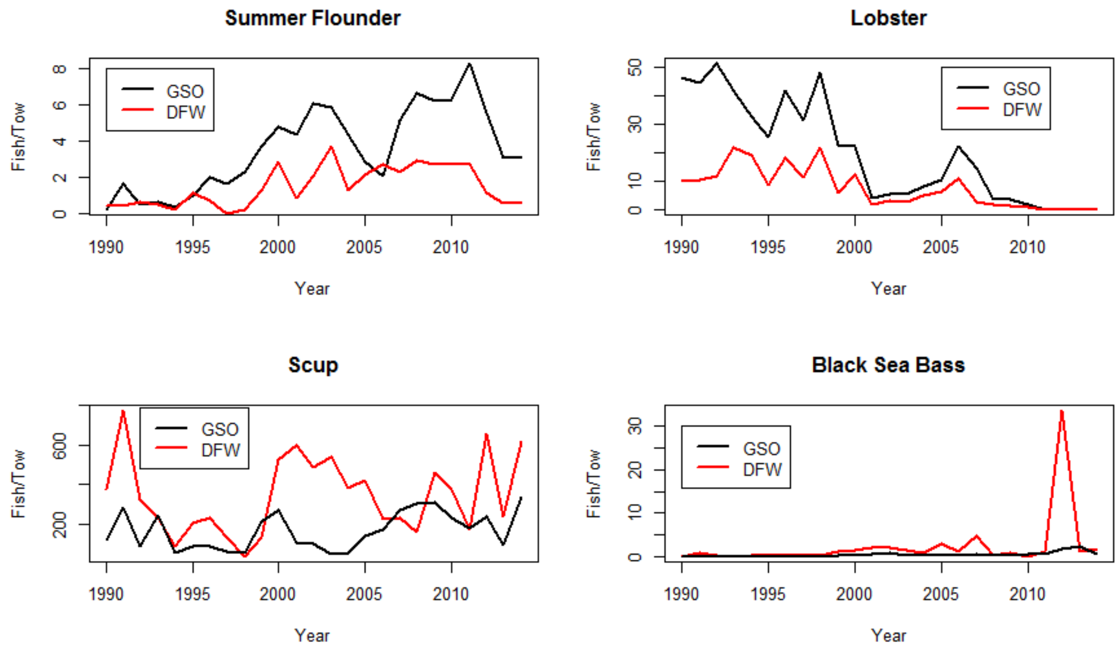


Figure 18 – Time series of information for the four species analyzed across the two surveys.

List of References Using these Survey Data:

Worm, B., Hilborn, R., Baum, J.K., Branch, T.A., Collie, J.S., Costello, C., Fogarty, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jenkins, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A.A., Watson, R., Zeller, D. 2009. Rebuilding Global Fisheries. Science 325: 578-585.

Collie, J.S., A.D. Wood, and H.P. Jeffries. 2008. Long-term shifts in the species composition of a coastal fish community. Canadian Journal of Fisheries and Aquatic Sciences 65: 1352-1365.

Gibson, M. 2008. Lobster settlement and abundance in Rhode Island: an evaluation of methoprene application and other factors potentially influencing early survival. Rhode Island Department of Environmental Management, Division of Fish and Wildlife. June, 2008.

Atlantic States Marine Fisheries Commission. 2006. Tautog stock assessment for peer review. Stock assessment report No. 06-02 (supplement). January, 2006. Available online at http://www.asmfc.org

Atlantic States Marine Fisheries Commission. 2005. American lobster stock assessment for peer review. Stock assessment report No. 06-03 (supplement). August, 2005. Available online at http://www.asmfc.org

Oviatt, C.A. 2004. The changing ecology of temperate coastal waters during a warming trend. Estuaries 27: 895-904.

Oviatt, C., S. Olsen, M. Andrews, J. Collie, T. Lynn, and K. Raposa. 2003. A century of fishing and fish fluctuations in Narragansett Bay. Reviews in Fisheries Science 11: 1-22.

Jeffries, H.P. 2000. Rhode Island's ever-changing Narragansett Bay. Maritimes 42(4): 3-6.

Taylor, D.L., and J.S. Collie. 2000. Sampling the bay over the long term. Maritimes 42(4): 7-9.

Jeffries, H.P., and M. Terceiro. 1985. Cycle of changing abundances in the fishes of the Narragansett Bay area. Marine Ecology Progress Series 25: 239-244.

Jeffries, H.P., and W.C. Johnson. 1974. Seasonal distributions in the bottom fishes of the Narragansett Bay area: seven-year variations in the abundances of winter flounder (Pseudopleuronectes americanus). Journal of the Fisheries Research Board of Canada 31: 1057-1066.

Appendix 1: Fish Kill reports from Job 6A:

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
DIVISION OF FISH & WILDLIFE / MARINE FISHERIES
Three Fort Wetherill Road
Jamestown, Rhode Island 02835

Results of RIDEM BlueCrab Kill Investigation ,

Kickamuit River 8/7/2015

Chris Deacutis & Richard Satchwill

Report

RIDEM staff (C. Deacutis) received a forwarded email from Angelo Liberti and Brian Zalewsky of RIDEM DWR that indicated a potential bluecrab kill in the Kickamuit River based on visual observations told to Ms. Ann Morrill, 1st VP of Kickamuit River Council (see attached email 8-6-15). No boats were available at the time of the report. RIDEM staff (C. Deacutis & R. Satchwill) left the next morning (8-7-15) and measured water quality (DO/Sal/Temp) in the Kickamuit River and just outside in Mount Hope Bay and made observations and looked for dead bluecrabs in the vicinity of the northern docks. Two water samples were taken in the northern half of the tidal river, where the water had a greenish cast. The below Table 1. and associated station map (Fig. 12) includes the readings of that survey. Each staion has two station names because we usually took a data snapshot of the bottom DO; followed by data snapshot of the surface (see Table 1 data). At each snapshot, the GPS was recorded with a marked point. If the boat drifted, a third point was sometimes taken. For example, the 1st two sampling stations have 3 points each due to slight drift.

Results indicated D.O. readings were normal (99-100+%), with only one reading at the surface showing a slight depression (station point 12; 4.0.mg/L). All bottom readings at all stations were normal and would not be a problem to any marine organisms. Microscopic examination of the two water samples indicated that a moderate to high phytoplankton bloom of mixed species of dinoflagellates was occurring in the northernmost station in the upper river. No problematic species were observed in the samples.

RIDEM examined the area around the northern docks (where the dead crabs were reported), but the high turbidity of the water blocked visual observations. DO readings at the docks (both the No. and So end of the river) were normal at surface and bottom. RIDEM staff swept the bottom around the northern dock with a long-handled net, but found nothing.

Heather Stoffel of URI reported to RIDEM that DO readings at the Mount Hope Bay Buoy are not showing signs of hypoxia. Angelo Liberti of RIDEM received confirmation that the Kickamuit Reservoir is no longer used by the Bristol County Water Authority, and no application of copper sulfate or herbicides has been permitted in at least two years. Sharon DeMeo of US EPA Boston contacted Meredith Simas at the Brayton Powr Plant, and forwarded to Angelo Liberti, Chief of Warer Resources, information on use of Spectrus CT1300 (see appendix of attached emails). Apparently, there has been no use of this product since 7/21/15, and levels were non-detectable at the discharge during use. The cooling towers had chlorination treatment, but discharge met permit requirements (half of the concentration allowable ; 0.0375 vs .065 mg/L limit). Larval porcelain crabs were observed in the Kickamuit during the DO survey, corroborating that the river was not in a toxic condition on 8-7-15. The results all suggest whatever was observed, it did not involve toxics or low D.O. There is a small possibility that the algae bloom respiration is depressing the DO in the late eve/early morning (non photosynthesizing period), but the daytime oxygen levels (> 4.5-5 mg/L) suggest this is a low likelihood. The only way to be sure would be to deploy a YSI overnight at the bottom (we do not have equipment available for deployment at this time).

The person reporting the crabs did not see them but passed on the observations of the young man who told her about them. Unfortunately, we do not have any samples or pictures of the blue crabs seen, so we cannot provide specific explanations as to these observations. Unless we get further information with hard evidence or at least pictures showing clear evidence of whole body dead crabs, we have no proof this was even an actual mortality event. Based on the field evidence, we suspect it may in fact be a misidentification of adult molts as dead crabs.

It would be useful to deploy a YSI at the bottom of the deepest hole over a period of several days to a week if one were available, just to get a picture of the Day:Night variability in DO in this area. Unfortunately, we do not have a unit we can deploy without losing access to a meter that would be needed for another fish/organism mortality event. If funds are available in the future, it would be useful to obtain or borrow a YSI and deploy it for 1 week in a similar hot summer month (August) at the deepest point in the northern Kickamuit (best) or at the deepest northernmost dock site.

Fig. 1. Station 1-3 outside Kickamuit River mouth 8/7/2015.

Fig. 2. Station 4-6 near Kickamuit River mouth

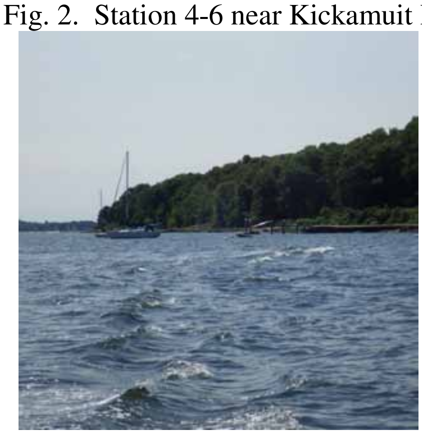


Fig. 3. Station 7-8 inside mouth of Kickamuit River

Fig. 4. Station 9-10 mid Kickamuit deep hole (10-12')

Fig. 5. Station 11-12

Fig. 6. Station13. Near wetlands in northern end of Kickamuit tidal River

Fig. 7. Water sample 1 taken at wetland-creek site. Water not too green + wake not too colored.

Fig. 8. Water sample 2 taken at northernmost station 16-17. Water very green with dinoflagellate + other phytoplankton bloom.

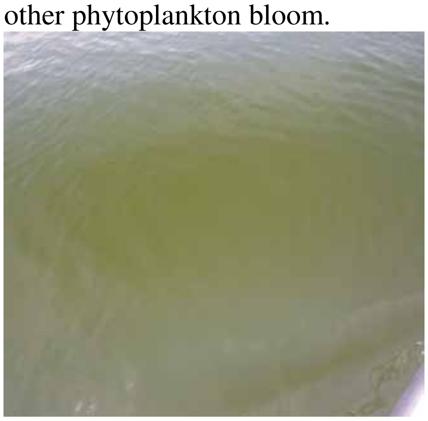


Fig.9. Northernmost station 16-17.

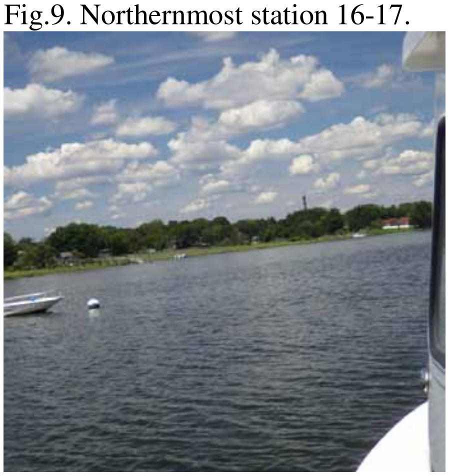


Fig. 10. Northern dock sample station 18.

Fig.11. Southernmost dock station 19.

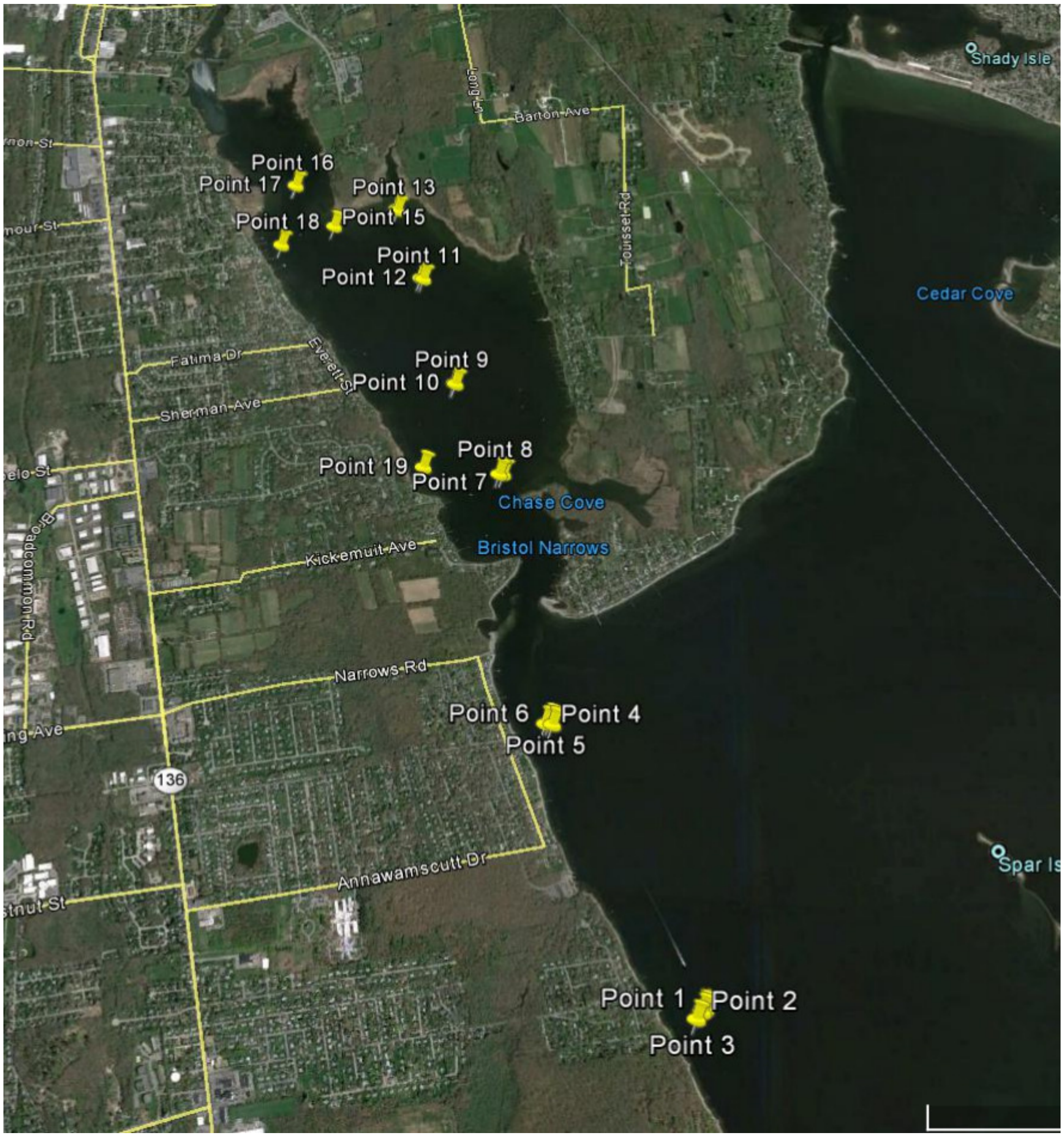


Fig.12. Sampling stations on the Kickamuit River

Station #	DATE	TIME	Depth (m)	% Sat	DO mg/L	Sal	T (C)	Chl a	Type	Comment
1	08/07/15	11:18 AM	3.74	77.50	5.25	29.00	24.86	6.15	bottom	
3	08/07/15	11:21 AM	0.25	77.90	5.28	29.06	25.10	8.33	surface	
4	08/07/15	11:32 AM	6.15	86.30	5.89	28.95	24.68	5.52	bottom	
5	08/07/15	11:42 AM	0.28	97.30	6.56	29.04	25.37	9.00	surface	
7	08/07/15	11:44 AM	4.52	100.40	6.83	28.94	24.92	13.73	bottom	
8	08/07/15	11:44 AM	0.24	98.30	6.61	28.93	25.36	9.35	surface	
9	08/07/15	11:48 AM	5.93	90.20	6.14	28.94	24.88	9.47	bottom	
10	08/07/15	11:50 AM	0.38	85.20	5.78	28.92	25.07	9.23	surface	
11	08/07/15	11:56 AM	2.78	66.90	4.54	29.11	24.96	4.95	bottom	
12	08/07/15	11:56 AM	0.57	59.80	4.04	29.02	25.24	11.07	surface	
12	08/07/15	11:57 AM	0.42	70.30	4.74	28.93	25.42	8.64	surface	
13	08/07/15	12:02 PM	1.46	89.70	6.05	29.14	25.27	9.80	bottom	
13	08/07/15	12:03 PM	0.29	87.50	5.87	28.89	25.74	8.68	surface	water sample #1
15	08/07/15	12:10 PM	2.13	80.80	5.47	28.88	25.18	11.02	bottom	
15	08/07/15	12:11 PM	0.38	76.80	5.15	28.81	25.69	13.08	surface	
16	08/07/15	12:16 PM	1.60	103.30	6.97	28.83	25.37	15.38	bottom	
17	08/07/15	12:17 PM	0.35	97.20	6.52	28.81	25.69	12.08	surface	water sample #2
18	08/07/15	12:26 PM	1.45	99.90	6.74	28.60	25.45	10.57	bottom	
18	08/07/15	12:26 PM	0.46	99.00	6.64	28.60	25.50	8.68	surface	
19	08/07/15	12:41 PM	0.44	102.50	6.87	28.89	25.75	8.92	surface	
19	08/07/15	12:41 PM	0.95	99.80	6.71	28.90	25.40	9.93	bottom	

Data Table 1. Dissolved oxygen surface and bottom in the Kickamuit River 8/7/2015 (see Fig.12 for map).

Appendix
Email notifications and information exchanges on the Kickamuit River Survey.

Deacutis, Christopher (DEM)

From:	Deacutis, Christopher (DEM)
Sent:	Thursday, August 06, 2015 3:11 PM
To:	Liberti, Angelo (DEM)
Subject:	RE: DEAD Blue crabs in the Kickemuit River --Brayton Point Power PLANT??? Please help.

Angelo

I go hold of a boat + capt. for tomorrow so we will take a trip up the river in the morning to check out the DO

Chris

Chris Deacutis, Ph.D.
Sup. Environmental Scientist
RIDEM Fish & Wildlife
3 Fort Wetherill Road
Jamestown, RI 02835

Tel: 401-423-1939 Fax 401-423-1925
Email Christopher.deacutis@dem.ri.gov

From: Liberti, Angelo (DEM)
Sent: Thursday, August 06, 2015 2:37 PM
To: Deacutis, Christopher (DEM)
Cc: Zalewsky, Brian (DEM)
Subject: RE: DEAD Blue crabs in the Kickemuit River --Brayton Point Power PLANT??? Please help.

To my knowledge, Bristol County Water Authority as not used the Kickemuit Reservoir for several years so I doubt they are applying copper sulfate.

I just checked with Liz Lopes-Duguay in DEM Agriculture and she confirmed that it's been at least two years since they have submitted an aquatic herbicide application.

Angelo

From: Deacutis, Christopher (DEM)
Sent: Thursday, August 06, 2015 2:33 PM
To: Liberti, Angelo (DEM)
Subject: RE: DEAD Blue crabs in the Kickemuit River --Brayton Point Power PLANT??? Please help.

I just got a copy from Brian. May be DO (but could also be Cu application to the reservoir above the Kickamuit...do they do applications on the reservoir?).
I've seen low DO in that exact spot years ago (where the FW comes into the top of the Kickamuit). Highly doubtful it has anything to do with the distant Brayton plant.
Let me know if more reports show up and I will try to take DO readings from the shore in the upper Kickamuit tomorrow...

Chris

1

From: Liberti, Angelo (DEM)
Sent: Friday, August 07, 2015 3:54 PM
To: Deacutis, Christopher (DEM)
Subject: FW: Dead Blue Crabs in the Kickemuit River

From: DeMeo, Sharon M. [mailto:Demeo.Sharon@epa.gov]
Sent: Friday, August 07, 2015 3:42 PM
To: Liberti, Angelo (DEM)
Cc: Webster, David; Houlihan, Damien; Nagle, John
Subject: Dead Blue Crabs in the Kickemuit River

Hi Angelo,

As requested, EPA has looked into the issue of whether Brayton Point recently used/discharged Spectrus CT1300. This morning I spoke with Meredith Simas, the Environmental and Chemistry Manager at Brayton Point. She indicated that the last Spectrus treatment occurred on July 21st and that the level was non-detectable prior to discharge. The permit limit is 0.2 ppm.

Chlorination of the cooling towers also occurred this past week but all monitoring showed discharge levels below permit limits, as shown in the table below.

Date	8/1/2015	8/2/2015	8/3/2015	8/4/2015	8/5/2015	8/6/2015	Ave. Daily Limit	Ave. Monthly Limit	Max. Daily Limit
Internal Outfall 003 - free available chlorine (FAC) results	ND	ND	0.04	0.03	ND	ND	0.2 mg/L		0.5 mg/L
Outfall 001 - discharge canal - total residual oxidants (TRO) results	ND	ND	0.03	0.02	ND	ND		0.0375 mg/L	0.065 mg/L

Meredith has also inquired whether Normandeau conducted any beach seines this past week and if the dissolved oxygen levels were low. At this time we have not heard back from them. In addition, we received information from another source that the Bristol Harbor Master was looking into possible sewerage dumping in the Kickemuit River a couple weeks ago. If true, this could be contributing to an algal bloom. We will let you know if we gain further information regarding this matter. Feel free to call David Webster at 617-918-1791 if you have any questions concerning the content of this email.

Regards,

Deacutis, Christopher (DEM)

From:	Heath Stoffel <stoffelh@hotmail.com>
Sent:	Saturday, August 08, 2015 8:35 AM
To:	Chris Deacutis; Chris Deacutis; Deacutis, Christopher (DEM)
Subject:	Fwd: DEAD Blue crabs in the Kickemuit River --Brayton Point Power PLANT??? Please help.

Have you seen this? We were not seeing low DO As of 8/3 at buoy. Going out to MH for nutrient sampling.
Let me know if you need anything.
Heather

Sent from my iPhone

Begin forwarded message:

> **From:** Candace Oviatt <coviatt@uri.edu>
> **Date:** August 8, 2015, 7:19:07 AM EDT
> **To:** Heath Stoffel <stoffelh@hotmail.com>
> **Subject: Fwd: DEAD Blue crabs in the Kickemuit River --Brayton Point Power PLANT??? Please help.**
>
> Hi Heather,
> Do we have any info on oxygen in Kickemuit?
> Candace
>
> ---------- Forwarded message ----------
> From: Veronica Berounsky <vmberounsky@uri.edu>
> Date: Sat, Aug 8, 2015 at 2:21 AM
> Subject: Fwd: DEAD Blue crabs in the Kickemuit River --Brayton Point Power PLANT??? Please help.
> To: Candace Oviatt <coviatt@uri.edu>, Sheldon Pratt <spratt@gso.uri.edu>
>
> Here's alittle more info about the blue crabs......
> Veronica
>
> Sent from my iPod,
> sorry for brevity and typos!
>
> Begin forwarded message:
>
> From: David Urban <durbn23@gmail.com>
> Date: August 7, 2015 6:22:53 PM EDT
> To: Veronica Berounsky <vmberounsky@mail.uri.edu>
> Subject: Fwd: DEAD Blue crabs in the Kickemuit River --Brayton Point Power PLANT??? Please help.

FISH KILL INVESTIGATION REPORT FORM

Additional Comments: Largest kill area was between Bucklin Pt and state pier upper Seekonk – dead fish on shoreline; some fish alive and swimming in circles.

1 **Date:**	2 **Time of Arrival:** 1315	3. **Waterbody Location:**	4. **Person reporting:**
5/26/15	**Total Time spent at site** ~2.5 hrs	Seekonk River	Name: Eric Schneider + Dennis Erkan Phone: 423-1933 Address: 3 Ft Wetherill Rd Jamestown, RI Affiliation: RIDEM F&W

5. **# of fish Killed**: _____
Incident Size:
Minor <100 □
Moderate 100-1000 X
Major >1000 □

6. **Dimensions of fish kill**:
__________ by __________
From Gano St boat ramp to Rt 95 bridge in upper Seekonk River

7. **Fish Species Affected:** **Fish Size**

	Species	Same	Different	Range
1.	__Atlantic Menhaden (adult) ______________	Same X□	Different □	Range _12___ to ~14_ in.
2.	________________________________	Same □	Different □	Range ____ to ____ in.
3.	________________________________	Same □	Different □	Range ____ to ____ in.
4.	________________________________	Same □	Different □	Range ____ to ____ in
5.	________________________________	Same □	Different □	Range ____ to ____ in.
6.	________________________________	Same □	Different □	Range ____ to ____ in.

7a. **Other Species Affected:**

	Species	Dead	Dying	Lethargic	Live
1,	_____none seen _______________________	Dead □	Dying □	Lethargic □	Live □
2.	________________________________	Dead □	Dying □	Lethargic □	Live □
3.	________________________________	Dead □	Dying □	Lethargic □	Live □

8. **Fish Species Not Affected**
____
____
____
____

Temp (F) ~75 F
Cloud Cover (%) clear
Precipitation (%) 0
Wind Speed (mph) 5-10mph
Wind direction - out of So

10. **Water Quality:**
Temp (C): _~18 C Surf_; 16 C Bottom__
pH: _______________
DO: _7-9mg Surf; 2-0.6 mg/Lbttm_____________
Conductivity: _________
Salinity: NA__________
Chlorine: ___________

11. **Water Condition:**
Turbid □
Sediment Loading □
Colored: __________ □
Odor: __________ □
Tidal Stage: _hi tide______
SAV/ macroalgae ______ □

12. **Fish Condition:**

Dying □	Discoloration □	Increased respiration □	Emaciated □
Gills flared □	Odd fin position □	Eyes sunken in □	Spasms, convulsions □
Red/pink gills □	Swimming at surface □	Eyes bulging □	Erratic Swimming X
Gill clubbing □	Equilibrium loss X □	Bloated □	Lethargy □
Excessive mucus □	Trying to get out of water □	Mouth agape □	Hemorrhaging □
Lesions □		Hypersensitivity □	Spine curved □

Other X_ many recent dead _+ circle swim__ Run samples for:______________________________

13. **Symptoms/Conditions**	**Possible Cause**	**Possible Source**	**Source present?**	
• Fish coming to surface gulping for air X□ • Low dissolved oxygen X□	Oxygen depletion (+ spinning disease?)	Sewage Treatment Plan	Yes X□	No □
		Livestock Feedlot	Yes □	No □
		Irrigation/De-icing Runoff	Yes □	No □
		Decaying Plant Matter	Yes □	No □
		Dying Algal Bloom	Yes □	No □
• Fish coming to surface gulping for air □ • Adequate dissolved oxygen □	Early oxygen depletion with slow re-oxygenation	Ammonia Chemicals	Yes □	No □
		Livestock Feedlot	Yes □	No □
• Fish swimming erratically X□ • Fish moving upstream to avoid something in water □	Chemical pollution	Heavy Metal Plant	Yes □	No □
		Chemical Waste Facility	Yes □	No □
		Sewage Treatment Plant	Yes □	No □
• Fish dying or dead after heavy rain □	Pesticide, herbicide washed out/runoff	Farms, Crop fields	Yes □	No □
		Aerial Crop Sprayer	Yes □	No □
		Man/mechanical Sprayer	Yes □	No □
• Fish coming to surface gulping for air □	Oxygen depletion	Dredging/ Marina activity	Yes □	No □
• Low pH □ Good clarity □ Orange Discoloration □	Acid	Coal/Strip Mining	Yes □	No □

• Fish dying below a dam or industrial plant □	Turbines or thermal shock	Heated water	Yes □	No □
• Kill restricted to one species or size class X□	Spawning stress, disease	Pathogens, WQ poor	Yes X□	No □

14. **Documentation and Samples**:
Photos taken □X
Water samples □ Number: ______________ Sent to: ______________________ Tested For: _____________________
Fish Samples □ Number: ______________ Sent to: ______________________ Tested For: _____________________

15. **Prepared By**:
Chris Deacutis

Fish-Counting Record

Date: ____5-26-2015____ **Time: Start __1:15 PM__ Finish _3:45PM Name of investigator(s):Eric Schneider + Dennis Erkan__**

Location/Waterbody Name: Seekonk River______ Area Sampled: (Entire) Length/Area From Gano Ramp to Rt 95 overpass_____

(Transects) # of Transects **__1 long transect_____ Transect # _______ Notes: ran up Seekonk w/ cts as go along. Dead fish strewn along scum line + on shoreline**

SPECIES

Mi		Atl Menhaden					
1		~ 1 fish every 50 /sq ft		Air Temp ~ 75 degr F (PORTS)			
2		Most dead between Bucklin & Rt 95 overpass, Pawtucket RI	Fish ct increases to 1 fish/25sq ft North of Bucklin	Water Temp PORTS @Prov ~ 60 F			
3		Total kill est :600-800					
4			NOTE: kill continuing through the week based on phone calls / reports				

-

Fish Kill/Incident Notification

Date of Kill/Incident: 5-26-14 (ongoing + 1 day earlier -Memorial Day -5/25/15 based on phone calls)

Date Reported: 5-25-2015 Time Reported: email forwarded 5/26/15

Name of Reporter: _Pawtucket Resident_Veronika Fitzgerald [mailto:vzfitzgerald@yahoo.com

Address: Phone:

Organization Associated With: Pawtucket Resident

Water(s) Involved: Seekonk River

Specific Location (bridge, highway/state road, landmark, park, etc.): Below Rt 95 and dam In Pawtucket

Suspected Reason For Fish Kill/incident (natural / pollution): Low oxygen although may also involve "spinning" disease

Location of Source: N/A

Name of Alleged Polluter (if applicable): N/A

Address: Phone:

Species Involved: adult Atlantic Menhaden

Fish Affected? X Yes ______ No

Approximate Number: 600-800 Still Dying? X Yes ______ No Some ~ 5_%

Additional Comments: Most dead menhaden in upper Seekonk north of Bucklin Pt, especially in State pier area and North Snapshot on the Bay – NBC Phillipsdale dock site (in channel) shows decr in DO (~3-3.5 mg/L DO) soon after this survey (5/27/15) suggesting low DO water started up river and is slowly being pushed down river

---

Persons and Agencies Notified To Respond:

	NAME	DATE/TIME	PHONE	REPORT SENT TO
1.	Eric Schneider DEMF&W	5-26-15	423-1933	____ Yes __X__ No
2.	Dennis Erkan DEMF&W	5-26-15	423-1932	____ Yes __X__ No

Division of Enforcement Notified at (401) 222-3070 ____ Yes ______ No

Report Prepared By: Chris Deacutis DEM F&W Further Action Needed? ______Yes X No

Fig. 1. Atlantic Menhaden adult –alive but swimming erratically in circle (5-26-15 Seekonk River).

Fig. 2. ~100 dead, decaying menhaden in along shore at Pier #2 Pawtucket (5-26-15 Seekonk River).

Site_No.	Date	Time (sc	Lat	Lon	Depth from Surface (at high tide)	Temp_C	DO_Sat	DO_mg/L	Site_Decript	Observations
1	5/26/2015	1400	41.854220	-71.374170	-	-	-	-	North of WWTF, Eastern shore (east of channel).	Fish appeared to be gasping for air at surface. They would surface, swim on side and jump out of water for 5-20 sec then descend. Most seem to recover (and swim off) after some time on surface. We could also see fish swimming through water (0.3-0.5m down from surface).
2	5/26/2015	1410	41.858520	-71.713765	1	18.4	95	8.5	200' North of Can #22	Density of fish surfacing and dead at 1 fish/ 50-100 ft2
2	5/26/2015	1410	41.858520	-71.713765	4	15.9	22	2.16	- same -	- same -
3	5/26/2015	1420	41.864500	-71.378110	1	18.3	76	7.2	- same -	Density of fish surfacing and dead estimated at 1 fish / 25 ft2
3	5/26/2015	1420	41.864500	-71.378110	3	16.3	29	2.8	-	- same -
3	5/26/2015	1420	41.864500	-71.378110	4	15.5	8.8	0.65	-	- same -
4	5/26/2015	1425	41.865830	-71.379100	-	-	-	-	Under High Tension wires	Fish dead/dying in water. Dead fish at: 1 fish / 25 ft2. some swimming near surface, stressed, gulping, and dead. Took pics + video
5	5/26/2015	1425	41.868640	-71.379860	-	-	-	-	State Pier	Dead fish (80 - 100) located in rip-rap at south end of state pier. Additional fish in rocks and on shore just south. Observations at high tide and some fish have been dead at least 1 day. Similar est. of dead fish: 1 fish / 25 ft2
6	5/26/2015	1435	41.873210	-71.384840	1	19.5	103.8	9.53	Under Rt 95 Bridge Pawtucket	Someone observed catching striped bass just south of bridge.
6	5/26/2015	1435	41.873210	-71.384840	3.5	15.8	8.1	0.84	Under Rt 95 Bridge Pawtucket	Someone observed catching striped bass just south of bridge.

Data Table 5-26-2015 D.O. and temperature + comments for each station (Sal. not available this day). See below for station map

Summary : This was a medium sized kill of single species fish kill (adult Atl. Menhaden) (400 to< 1000) first reported 5/25/15. Cause appears to be related to low D.O. (0.6-0.8 mg/L) in bottom water in the upper Seekonk River near or above the state pier, but circular swimming by many fish still alive also suggests a possible interaction with disease (Atl. Menhaden spinning disease). There is an odd sudden low flow event on the Blackstone just before the D.O. incident is reported (5/25/25) which is likely linked to dam operations (Fig.4). Low D.O. water may have increased in volume due to the sudden loss in riverflow, leaving stagnant water in the area of a large menhaden school below the last dam. We also need to consider the possibility of a synergistic relationship where infected fish may become more susceptible to low D.O. Neighboring states (especially CT) are reporting similar incidents with adult menhaden in circling swim behavior and high mortality around Memorial Day (5/25/15-see p.9) and are investigating whirling / spinning disease as a potential factor in their early-season kill (most kills occur in mid-late summer when the water is much warmer and low DO is more common). We have not submitted any samples for disease analysis at this point. Kill is expected to continue until the area has been well flushed (possibly during heavy rains of 6/1-2/2015)

Fig. 3. Map of stations , Seekonk River 5/26/15

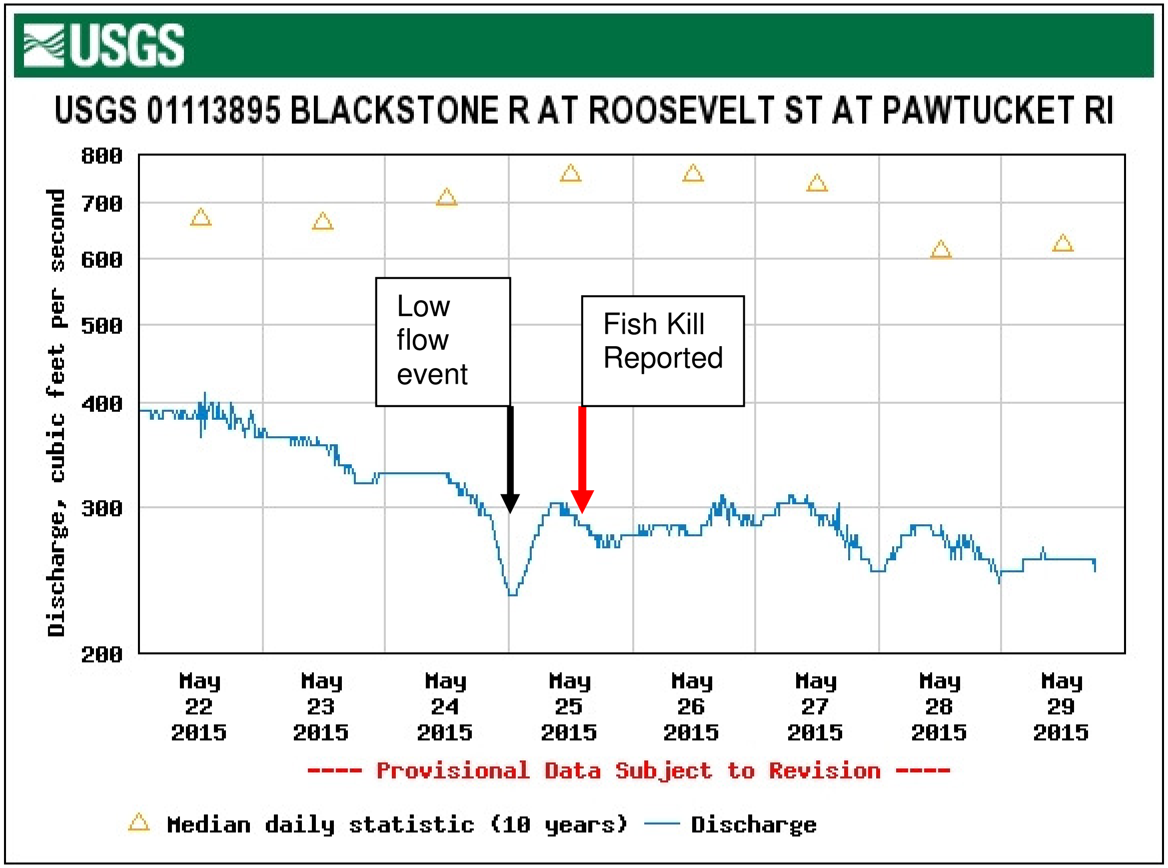


Fig. 4. USGS river flow in cfs May 22-May 29, 2015. Note odd low flow event midnight May 24, 2015.

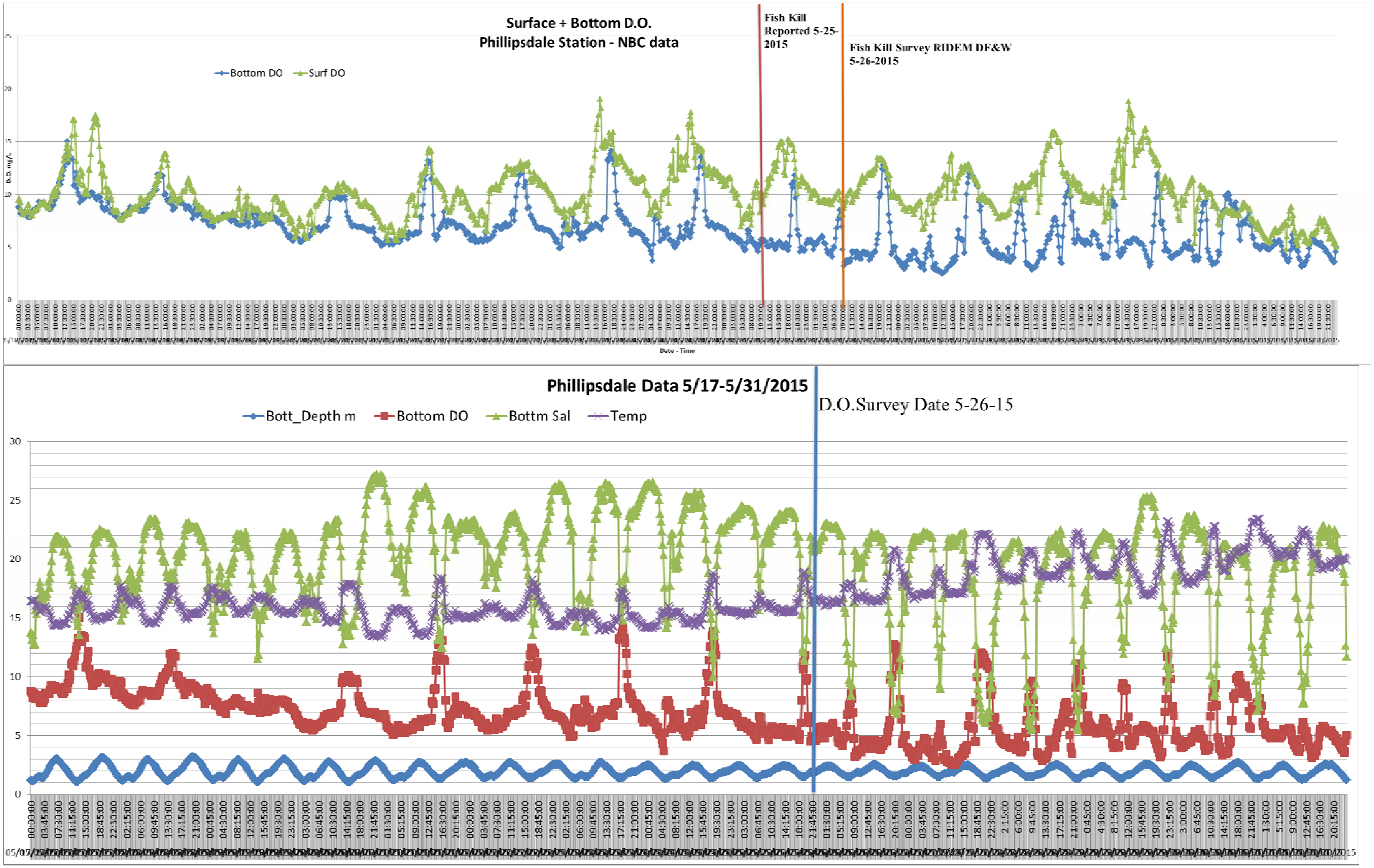


Fig. 5. Upper graph :Surface and Bottom D.O. (mg/L) 5/17/15 to 5/31/15 ; Lower graph: Bottom D.O. (mg/L) graphed with tide (depth), salinity, and temperature. All data from NBC Phillipsdale pier site surface (~1m) and bottom (1 m off bottom).

Menhaden die-off in Thames, other state waters being investigated by DEEP

By Judy Benson Published in “TheDay” , New London, CT May 28. 2015 4:47PM Updated May 28. 2015 11:48PM

Hundreds to thousands of Atlantic menhaden have been dying in the Thames River, the lower Connecticut River, Clinton harbor and the Quinnipiac River over the past week, prompting the state Department of Energy and Environmental Protection to launch a study of potential causes.

David Simpson, director of the Marine Fisheries Division of DEEP, said Thursday that the probable cause of the fish kill is a virus that causes “whirling” or “spinning” disease that spreads quickly through schools of menhaden, a common forage fish also called bunker. “They’ve been exhibiting the classic whirling behavior, where they swim in a circular pattern and pivot on their tail,” Simpson said. “They die in three to five days.” Simpson said he started getting calls from fishermen and boaters over the weekend who noticed dead fish in the water and others swimming in circles.
On Wednesday he collected samples of the dead fish for analysis. In the Thames, the dead fish have been reported in several locations between the Naval Submarine Base in Groton and Norwich harbor. “I’m still getting calls,” Simpson said.

In Norwich harbor on Thursday, several of the dead fish could be seen floating near the docks and riprap along the shore. Simpson said most of the dead 10- to 14-inch fish are sinking to the bottom rather than floating or washing up on shore. Mike Valentine, Norwich harbormaster, said he first heard about the fish kill from boaters who noticed dead fish while traveling upriver on the Thames over the weekend. “A few of them have come in with the tide, and I’ve also seen them doing that whirling thing,” Valentine said.

Mass die-offs are common whenever there is an abundance of menhaden, especially during the summer months when bluefish chase schools into sheltered waters with low levels of dissolved oxygen, Simpson said. “The tightly packed schools rapidly use up the oxygen in the water and suffocate,” he said. Since the recent fish kill occurred early in the season before warmer water temperatures lower levels of dissolved oxygen, the virus is the most likely cause, he said. But the investigation is continuing.

Menhaden are an important forage fish for wildlife and also an important commercial fish. About 400 million pounds are harvested annually, mostly in the Chesapeake Bay and New Jersey, and processed into animal feed and fish oil and used as bait for lobster, crab and other fisheries. Simpson said there is also a small commercial and recreational menhaden fishery in Connecticut. “They’re the most heavily harvested fish on the East Coast,” Simpson said.
In 2013, the Atlantic States Marine Fisheries Commission set quotas on the menhaden fishery to limit the total catch and prevent overfishing. Since then, the population has grown significantly. “They’re more abundant now than at any time since the 1970s,” Simpson said. The virus, he said is probably “the collateral effect of high population density.”
The virus is not a threat to human health or other wildlife, he added.

DEEP urges anyone who witnesses a fish kill to contact the Marine Fisheries Division at (860) 434-6043 or by email at deep.marine.fisheries@ct.gov (mailto:deep.marine.fisheries@ct.gov).
j.benson@theday.com (mailto:j.benson@theday.com) http://www.theday.com/article/20150528/NWS01/150529229

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

DIVISION OF FISH & WILDLIFE / MARINE FISHERIES
Three Fort Wetherill Road
Jamestown, Rhode Island 02835

Data + information available for Fish Kill, Seekonk River July 2015

Executive Summary

This was initially a medium sized kill of several hundred adult menhaden investigated on 7/20/2015. However, it has been ongoing, and over the course of two weeks has involved over a thousand adult menhaden, making it a major fish kill (by 7/31/2015, several thousand menhaden estimated dead). Cause is extreme low dissolved oxygen (D.O.< 1.0 mg/L) concentrated in the bottom waters of the Seekonk River due to die off of a large dinoflagellate bloom in the Seekonk (Fig. 11) responding to excess nutrients (especially nitrogen) from various sources to the Seekonk. Circular swimming by some fish was reported and suggests a possible interaction with disease (whirling viral disease). Dr. Roxanne Smolowitz, marine pathologist at Roger Williams University and Dr. R.Getchell of Cornell are examining frozen specimens provided to them. The first kills were reported around 7/18-19/15. The low D.O. reached lethal levels (<1 mg/L) on 7/16 at the Phillipsdale area based on the NBC continuous monitoring station, and appears to have slowly moved north up the Seekonk with tidal cycles. As with the late May 2015 kill, there are also a series of dam-manipulated flow changes (low flow event and then sudden release) on the Blackstone based on flows at the Roosevelt Dam USGS gage just before the D.O. incident was reported (7/13-16/2015) (Fig.17). This type of flow alteration may increase the organic C load to the upper Seekonk from the lower Blackstone, although it is unclear if this would be a significant load increase. More importantly, Menhaden often congregate just below the Main St. dam at Pawtucket Falls at the top of the Seekonk during these low DO periods, and this flow manipulation is likely to exacerbate low DO by stopping reaeration when flows over the dam are halted, causing large concentrations of menhaden to be in an area likely to experience a sudden decrease in oxygen, especially in the late evening/early morning hours. This fish kill is likely to continue as long as new schools of menhaden are entering the Seekonk River until either a strong winded storm and heavy rains flush the area or a cooler weather pattern emerges to turn over the water and reaerate the bottom waters.

Report

RIDEM staff (C. Deacutis) received a phone call from Phil Edwards ~ 9:30AM on 8-17-15 relaying word of a fish kill reported to RIDEM DWR on 8-17-15. A Bucklin Point WWTF staff member reported that a large number of dead menhaden were scattered along the shoreline near the plant. No working boats were available to investigate (all the small trailerable boats are being used in the Salt Ponds on F&W work, the Parker is for wildlife uses only (bird census use)) and the remaining 2 boats are being repaired. Deacutis contacted Tom Uva of NBC to get more details. The staff has also reported the kill to him. He was in the process of dispatching his water quality monitoring group to measure DO at the surface and bottom of the river. DFW requested that his crew take pictures also and attempt to capture any live fish.

Pictures were received late on 8-17-15. They showed a large kill of adult menhaden along the eastern shore of the Seekonk near Bucklin point, with counts indicating a kill of several hundred in this area alone (see fig. XX) .

A second report (phone call) from Aaron Mello, RIDEM DWR was received by DFW on 8-18-15. He indicated he had taken a lunchtime ride to Blackstone Park along the Seekonk, where he saw hundreds of dead adult menhaden. He sent pictures he took to Deacutis. Based on the pictures, it appears this western side of the Seekonk is also covered with hundreds of dead adult menhaden (none seen alive).

Low river flows are a problem, causing low estuarine flow /flushing of the Seekonk. Unusual pulse flows of the Blackstone may be contribiting to additional organic carbon load by flushing algae and causing sudden stoppage of aeration over the last dam at the top of the Seekonk, causing D.O. to suddenly decrease in this area (especially at night). Fish have been seen to congregate in this normally-aerated area below the falls. WWTF loads are still significant nutrient sources on the lower Blackstone and the Seekonk Rivers, causing major algal blooms (see Fig. 17) and hypoxia generation. Water temperatures are high (24-26° C), causing bacteria to use up the bottom water oxygen rapidly.

Some fish have been observed swimming in circles, a behavior associated with a viral disease in New York (LIS). Four samples of live circle-swimming menhaden adults were taken by NBC and provided to RIDEM F&W on ice. These were taken by DEM to Dr Roxanna Smolowitz, who did a preliminary necropsy + sent samples to Cornell University for viral testing. Three of the four fish came out positive, but Dr. Rodman Getchell of the Cornell University Aquatic Animal Health Program did not believe the virus was lethal, but may be a side-effect of low DO stress. The report by Dr Smolowitz is attached at the end of this report.

Recommendations of corrective action needed: Continue to pursue decreases in nutrient loads from all sources including WWTFs to the Blackstone and Seekonk Rivers in order to reduce TP in the Blackstone River (FW algae are likely contributing to the organic load) and TN for the SW zone of the Seekonk. In addition, discussions are needed with FERC and hydropower generators since build up/ releases are occurring (not allowed under FERC license requirements for run-of-river conditions), and may be causing sudden aeration stoppage at the last dam on the Blackstone. A special study of the lower Blackstone + Seekonk is needed to examine what triggers large algal blooms in the Seekonk. This will likely include measuring DON and TN concentrations and loads directly to the Seekonk for pre and post significant rainfall events as well as nutrient and TOC and DOC from the Blackstone and Ten Mile from various sources during these situations.

Dead menhaden on eastern shore of Seekonk River, near the Bucklin Point WWTF, East Providence RI 8/17/2015.
Photos by J. Motta, NBC

FISH KILL INVESTIGATION REPORT FORM

Additional Comments: Menhaden (adult) kill state pier (School St.) upper Seekonk River - fish on shoreline – almost no oxygen depths >3'

1 **Date:** 7/20/15	2 **Time of Arrival:** 13:00 **Total Time spent at site** ~ 2 hrs	3. **Waterbody Location:** Seekonk River	4. **Person reporting:** Name: Chris Deacutis Phone: 423-1939 Address: 3 Ft Wetherill Rd Jamestown, RI Affiliation: RIDEM F&W
5. **# of fish Killed**: _____ Incident Size: Minor <100 □ Moderate 100-1000 X Major >1000 (later) X	6. **Dimensions of fish kill**: __________ by __________ From Pawtucket State Pier boat ramp (off School St) south through upper Seekonk	7. **Fish Species Affected:** **Fish Size** 1. __Atlantic Menhaden (adult) ______________ Same X□ Different □ Range _12 to ~14_ in. 2. ________________________________ Same □ Different □ Range ____ to ____ in. . ________________________________ Same □ Different □ Range ____ to ____ in. 7a. **Other Species Affected:** 1, _____none seen ________________________ Dead X□ Dying □ Lethargic □ Live □ 2. ________________________________ Dead □ Dying □ Lethargic □ Live □ 3. ________________________________ Dead □ Dying □ Lethargic □ Live □	
8. **Fish Species Not Affected** ____________________ __minnows in shallows___ ____________________	Air Temp (F) ~80 F (27C) Cloud Cover (%) clear Precipitation (%) 0 Wind Speed (mph) 7-10mph Wind direction - out of SW		
10. **Water Quality:** Temp (C): _~26 C Surf_; 23 C Bottom__ pH: ______________ DO: _7-9mg Surf; 2 to 0.8mg/ Lbttm_____ Conductivity: __________ Salinity: 8 to 21 psu____ Chlorine: ____________	11. **Water Condition:** Turbid □ Sediment Loading □ Colored: ___brown _ X□ Odor: ____________ □ Tidal Stage: _hi tide______ SAV/ macroalgae ______ □	12. **Fish Condition:** Dying □ Discoloration □ Increased respiration □ Emaciated □ Gills flared □ Odd fin position □ Eyes sunken in □ Spasms, convulsions □ Red/pink gills □ Swimming at surface □ Eyes bulging □ Erratic Swimming □ Gill clubbing □ Equilibrium loss □ Bloated □ Lethargy □ Excessive mucus □ Trying to get out of water □ Mouth agape □ Hemorrhaging □ Lesions □ Hypersensitivity □ Spine curved □ Other X_ **all recent dead** _(24-48h):______________________________	

13. **Symptoms/Conditions**	**Possible Cause**	**Possible Source**	**Source present?**	
• Fish coming to surface gulping for air □ • Low dissolved oxygen X□	Oxygen depletion - low to no oxygen below 1m	Sewage Treatment Plan	Yes X□	No □
		Livestock Feedlot	Yes □	No □
		Irrigation/De-icing Runoff	Yes □	No □
		Decaying Plant Matter	Yes □	No □
		Dying Algal Bloom	Yes X□	No □
• Fish coming to surface gulping for air □ • Adequate dissolved oxygen □	Early oxygen depletion with slow re-oxygenation	Ammonia Chemicals	Yes □	No □
		Livestock Feedlot	Yes □	No □
• Fish swimming erratically □ • Fish moving upstream to avoid something in water □	Chemical pollution	Heavy Metal Plant	Yes □	No □
		Chemical Waste Facility	Yes □	No □
		Sewage Treatment Plant	Yes □	No □
• Fish dying or dead after heavy rain □	Pesticide, herbicide washed out/runoff	Farms, Crop fields	Yes □	No □
		Aerial Crop Sprayer	Yes □	No □
		Man/mechanical Sprayer	Yes □	No □
• Fish coming to surface gulping for air □	Oxygen depletion	Dredging/ Marina activity	Yes □	No □
• Low pH □ Good clarity □ Orange Discoloration □	Acid	Coal/Strip Mining	Yes □	No □
• Fish dying below a dam or industrial plant □	Turbines or thermal shock	Heated water	Yes □	No □

• Kill restricted to one species or size class	X□	Spawning stress, disease	Pathogens, WQ poor	Yes X□	No □

14. **Documentation and Samples**:
Photos taken □X
Water samples □ Number: ______________ Sent to: ______________________ Tested For: _____________________
Fish Samples □ Number: ______________ Sent to: ______________________ Tested For: _____________________

15. **Prepared By**:
Chris Deacutis

Fish-Counting Record

Date: ____7-20-2015____ **Time: Start __1:00 PM__ Finish _3:00PM Name of investigator(s): Chris Deacutis__**

Location/Waterbody Name: Seekonk River______ Area Sampled: (upper) From Bishop Cove shoreline site – Sta 1 to State Pier Pawtucket (Sta 2)_

(Transects) # of Transects **__1 transect_____ Transect # _______ Notes: East shore of Seekonk w/ cts of dead fish strewn along shoreline = sta 1 (shore kill) latlong 41.869372° -71.380417° + boat ramp and pier Sta 2 (state pier) 41.869372° -71.380417°**

Mi or Sta		Atl Menhaden					
Sta 1	Transect along						
	Shore ~ 60' (19m)	60 menhaden dead sev. days	See on shore in grps-3-5				
2	State Pier at School St.,	20 menhaden dead at boat ramp					
	Pawtucket	Total kill estimate: several hundred over 7/17-18/15	NOTE: kill continuing through the week based on phone calls / reports	Count expected to be in the thousands since new schools coming into the river			

-

Fish Kill/Incident Notification

Date of Kill/Incident: 7-20-15 (ongoing – low DO starts 7/16/15 based on Phillipsdale data

Date Reported: ______7-19-2015_to enforcement______ Time Reported: __email_______________forwarded 7/20/15 – responded to 7/20/15

Name of Reporter: _Pawtucket Resident_ Matthew Banoub matt@a10energy.com ______

Address: ____835 School St Pawtucket__ Phone: ____ C: (508) 916-8649

Organization Associated With: ____Pawtucket industrial property owner___________________

Water(s) Involved: _____Seekonk River ____

Specific Location (bridge, highway/state road, landmark, park, etc.): ____835 School St Pawtucket +

Pawtucket state pier_

In Pawtucket, RI____

Suspected Reason For Fish Kill/incident (natural / pollution): __extreme low oxygen below ~3'- 5' + may be low at surface in eve. based on Phillipsdale data + may also involve "swirling" disease ________

Location of Source: ____________multiple sources of excess nutrients ________________

Name of Alleged Polluter (if applicable): ____N/A____

Address: _____________________________ Phone: _____________________________________

Species Involved: ______adult Atlantic Menhaden____

Fish Affected? __X__ Yes _____ No

Approximate Number: ____80 Still Dying? __X__ Yes ___No based on phone calls- continues Additional Comments: __Dead menhaden seen were in upper Seekonk north of Bucklin Pt, especially in State pier area and Bishop Cove area just south of that–– NBC Phillipsdale dock site (in channel) shows DO decreases to below 2 mg/L on 7/16/2015_______________________

Persons and Agencies Notified To Respond:

	NAME		DATE/TIME	PHONE	REPORT SENT TO
1.	__Chris Deacutis__	_DEMF&W__	__7-20-15_______	_423-1939______	____ Yes __X__ No

Division of Enforcement Notified at (401) 222-3070 ___X_ Yes _____ No

Report Prepared By: ___Chris Deacutis DEM F&W_____ Further Action Needed? ___Yes _X__ No

R.I. Department of Environmental Management

Division of Fish and Wildlife

Fort Wetherill Marine Laboratory

3 Ft. Wetherill Road

Jamestown, Rhode Island 02835

(401) 423-1920

Fish Kill Investigation Report

Prepared and submitted by: Christopher Deacutis RIDEM DF&W **Phone:** 423-1939

Name(s) of investigators/title: Chris Deacutis / Sup. Environmental Scientist **Phone:** 423-1939

additional photos of continuing kill 7/23 provided by

Joe Migliore, RIDEM DWR Principal Environmental Scientist 222-4700 X 7258

Body of water/ local name: Seekonk River

Nearest town/ county: Pawtucket, RI

Time and date of kill: 7/19/2015 **Approximate duration of kill:** ongoing as of 7/24/15

Time and date of investigation: 13:00 ; 7/20/2015

Extent of kill area: state pier & boat ramp, Pawtucket to Bishop Point on 7/20/15. Extended to Brown + Narr. boat clubhouses on 7/23/15 with dead fish to Bold Pt by 7/26/15

Suspected cause of kill/ description of how kill occurred: Extreme low D.O. below 3' in certain areas of Seekonk, especially in early A.M. period (2 - 5 AM). Condition continues and appears to worsen over the course of two weeks (7/16-31/2015). Flow manipulation in the Blackstone may have contributed to the addition of excessive organic matter (FW algae)(USGS gage data), but data from DEM DWR shows local WWTFs still dominate nutrient load . A large algal bloom is occurring in the upper Seekonk, sinking and decomposing, using up the oxygen in the bottom water below ~ 3' depth. There is little flushing in Seekonk River due to the low FW flows. Tides are only sloshing the water back and forth.

Alleged contamination source: Excess nutrients to the Seekonk River from various sources

Species affected: only adult Atlantic Menhaden, *Brevoortia tyrannus*, observed dead

Common & scientific name:	Total # affected:	Size range (inches):	Condition (dead/dying)
Atlantic Menhaden		12-14"	all dead at least 24 hrs on 7/20/15
Brevoortia tyrannus	orig kill 7/16-20 in low hundreds - later		
	ongoing kill 7/22-31/15 in the thousands		some seen swimming
			in circular fashion on
			other dates

Estimated total number of fish/inverts killed: Atl. Menhaden adults - est of sev. 1000 over 2 weeks

Symptoms of distressed fish: most dead on shoreline with some swimming in circular motion

(possible viral effect under stress of low D.O.)

Necropsy observations: NBC takes samples of 4 live fish swimming in circles at surface, freezes submitted to Dr. Smolowitz, RWU for analysis 7/28/15

Water conditions observed: hot weather, calm , low winds

Water quality measurements: D.O. very low (< 2 mg/L below ~ 1.5 -2 m

Documentation collected (Y or N): **Witness statements:** **No - phone conversations with sev.witnesses**

Photographs: **Yes** **Digital or film:** **Digital**

Samples collected and sent to lab (Y or N):			**Laboratory name:**	**Analysis run:**
Water	**Quantity**		RWU (Dr. Roxanne Smolowitz)	TBA
Fish/ inverts	**Quantity**	4 menhaden adults	subsamples sent to Cornell (Dr.Rod Getchell)	

Laboratory results indicate:

Additional comments: Low river flows are a problem, causing low estuarine flow /flushing of the Seekonk. Unusual pulse flows of the Blackstone may be contribiting to additional organic carbon load by flushing algae downstream to upper Seekonk river from Blackstone River, but WWTF loads are still significant nutrient sources on the lower Blackstone , causing major algal blooms and hypoxia generation.
Water temperatures are high (24-26° C), causing bacteria to use up the bottom water oxygen rapidly.

Recommendations of corrective action needed: Continue to pursue decreases in nutrients to Blackstone and Seekonk Rivers from WWTFs in order to reduce TP in the Blackstone River (since FW algae are likely contributing to the organic load) and TN for SW zone of the Seekonk. In addition, discussions are needed with FERC and hydropower generators since build up/ releases are occurring (not allowed under FERC license requirements for flow-of-river conditions). A special study of the lower Blackstone + Seekonk is needed to examine DON and TN concentrations and loads to the Seekonk for pre and post significant rainfall events as well as nutrient and TOC and DOC from the Blackstone and Ten Mile during these situations.

Report submitted to: various RIDEM staff

Date of submission:
initial summary via email 7 /22/2015
Draft Final Report 8/6/2015
Final Report / / 2015

Fig. 1. Dead Atlantic menhaden adults along shoreline of Seekonk River 7/20/15 at 835 School St. Pawtucket RI.

Fig. 2. Dead Atlantic menhaden along shoreline 7/20/15 Total count dead this shore = 60 dead over ~ 60' shore transect.

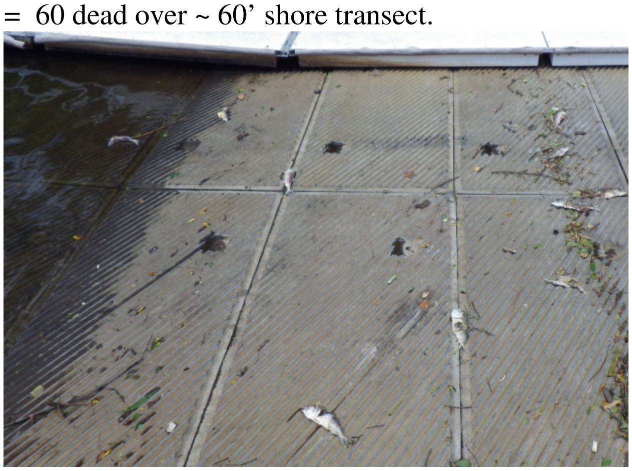
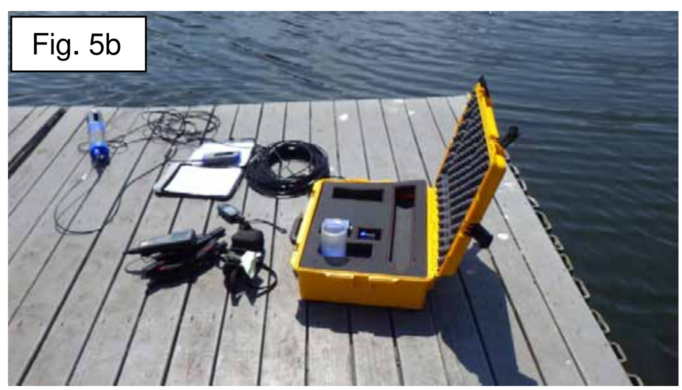


Fig. 3. Dead Atlantic menhaden adults at Pawtucket boat ramp and pier
Total count dead this area = 20.on the ramp.

Fig. 4. Dead Atlantic menhaden seen on opposite

Fig. 5a+. Sampling station 2 – floating pier

Fig. 5b



Sta5 b and boat ramp at State Pier, Pawtucket RI

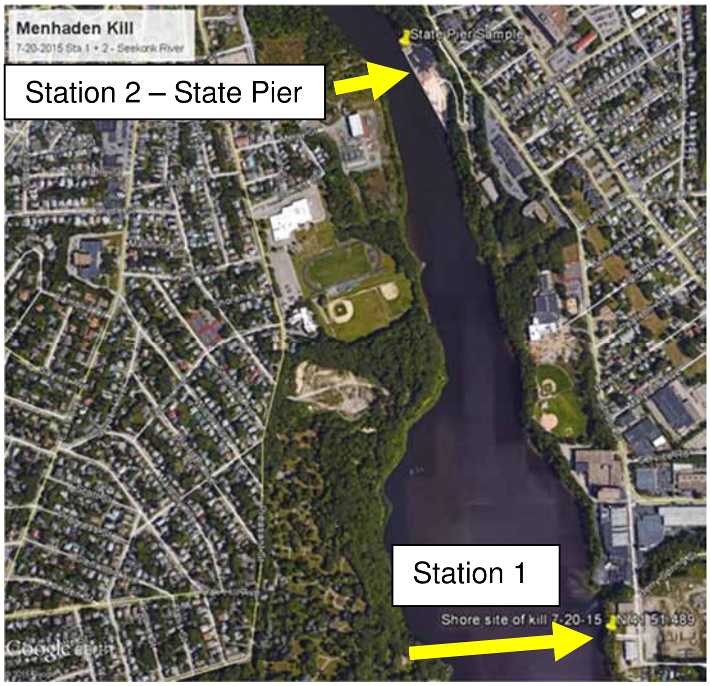


Fig.6. Sampling stations on the upper Seekonk River RIDEM Investigation 7/20/2015.

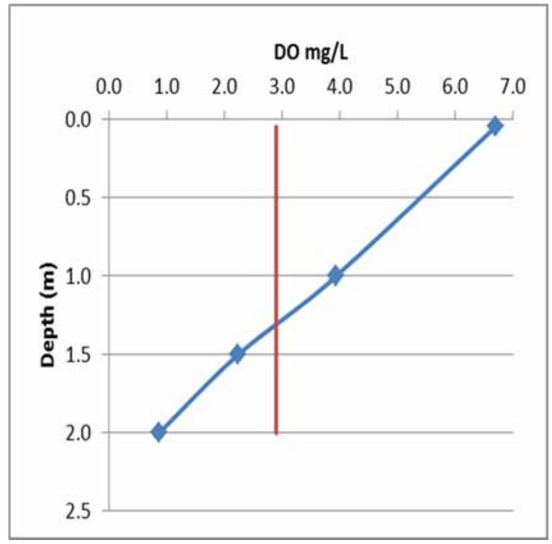


Fig. 7. Dissolved oxygen vs depth in meters at Pawtucket pier and boat ramp 7/20/2015. Redline is the state 24h oxygen criteria. The two deepest readings are below this level.

Site_No.	Date	Time (	Lat	Lon	Depth (m)	Salinity (psu)	Temp_C	DO_Sat %	DO_mg/L	Chl a (ug/L)	Site_Decription	Observations
1	7/20/2015	1300	41.858150	-71.374170	0.5	na-YSI	26.4	132.3	10.7	na-YSI	60' transect along upper Seekonk shoreline strewn w/ 60 dead menhaden	test water knee-deep w/ YSI-ODO - No menhaden seen alive -see living minnows swinning along shoreline
2	7/20/2015	1400	41.869372	-71.380417	0.1	8.00	26.3	90.3	6.7	8.0	Seekonk River State-Pawtucket City Pier & boat ramp	sample from outer floating dock in channel (~ 2.7m deep)
2	7/20/2015	1412	41.869372	-71.380417	1.0	18.75	24.3	55,23	3.9	2.2	same	no live fish seen
2	7/20/2015	1415	41.869372	-71.380417	1.5	20.70	23.7	30.1	2.2	71.0	same	2nd chl a reading of 53
2	7/20/2015	1420	41.869372	-71.380417	2.0	21.27	23.5	12.0	0.9	5.4	same	

Data Table 1. Dissolved Oxygen (D.O.), salinity, temperature , chl a for 7-20-2015 Seekonk stations with comments for each station (see Fig. 7 for map).

WQ Data from Tom Uva, Narragansett Bay Commission Monitoring Surveys
D.O. Survey 7/21/2015 Staff involved : John Motta, Christine Comeau, Pamela Reitsma, Nora Lough, others. Surveys were conducted on 7/22 + 23/2015 as part of NBCs normal biweekly water quality surveys on the Seekonk-Providence Rivers. These include bacteria + water column profiles of salinity, temperature, and dissolved oxygen using a SeaBird 19+ with fast-response DO sensor (SBE 43) at various stations (see map Fig. 8).

Results of NBC 7/21/15 survey of Seekonk River
Water column profiles of dissolved oxygen, salinity and temperature completed by NBC on 7/21/15 showed a severe low oxygen event with lowest oxygen levels in bottom water (3-6') down to approximately Crook Point, with low DO at the bottom of the channel down to India Point. Edgewood shoals boat turning basin bottom water also had very low DO (1.2 mg/L; typical for this area). The ship channel in the upper Providence River was low (2.8 mg/L), but not as low as in the Seekonk, and centered on water between 6-15' depth, with deeper water actually having higher DO (4.4. mg,data not shown), sugesting this low DO water may be generated in the Seekonk River based on its slightly lower salinity. By Conimicut Point, even the ship channel is at 3.9 mg/L, so the low oxygen water seems to be concentrated on 7/21/2015 in the Seekonk River bottom waters.

Fig. 8 Photos of dead menhaden along Seekonk shoreline between the Brown Boat House and the Narragansett Boat House. 7/21/15 (source: Tom Uva, NBC)

Fig. 9. Photos of dead menhaden along shore south below Henderson Bridge side of Seekonk on 7/24/15 (source: J. Migliore, RIDEM)

Fig. 10 Station map for NBC water quality samples 7-21-15 including oxygen. (from T.Uva)

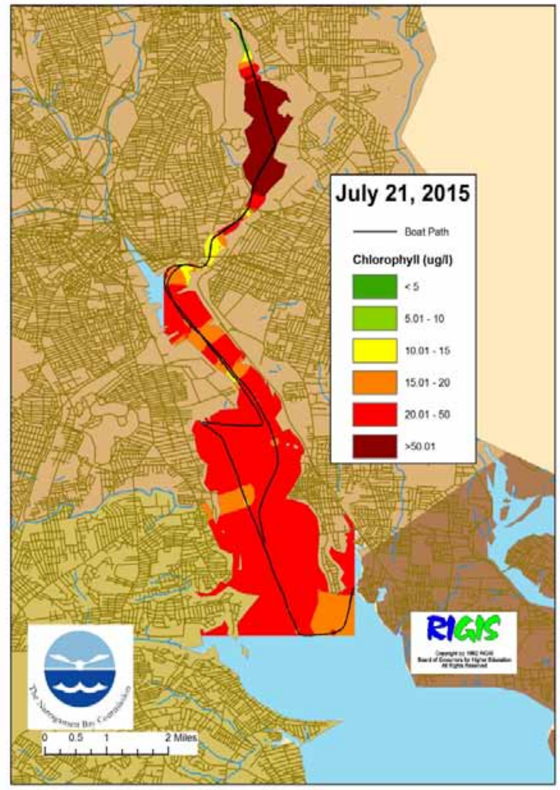
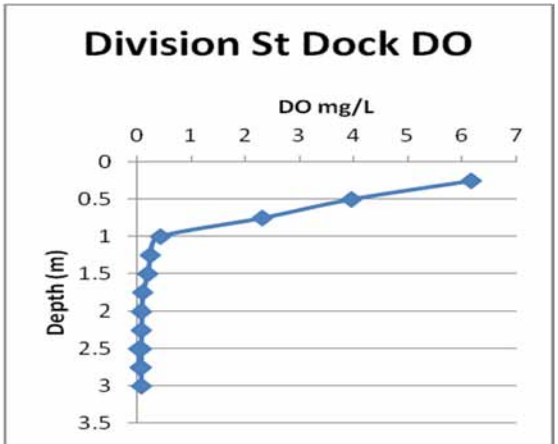
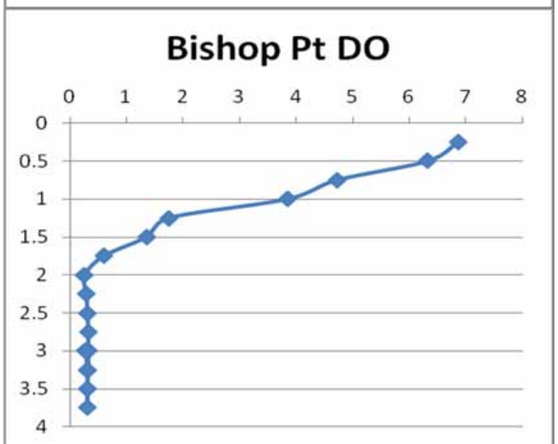
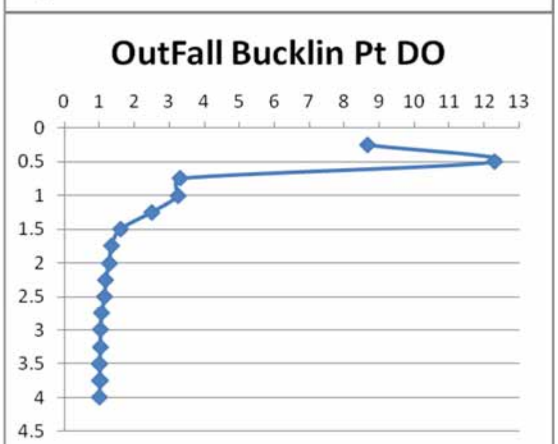
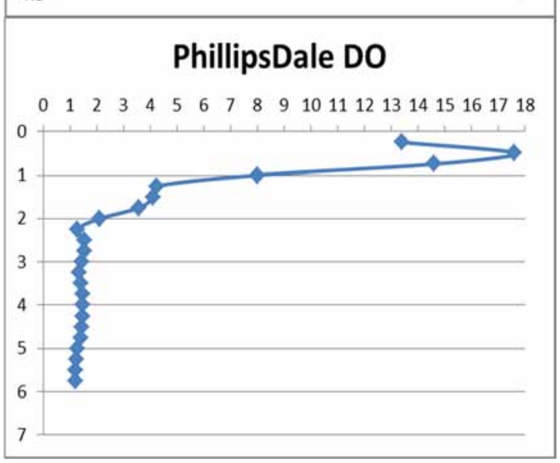


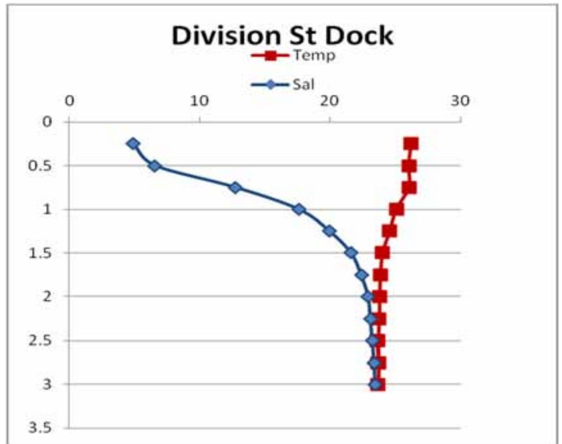
Fig.11. Chlorophyll fluorescence levels from dataflow 7/21/15

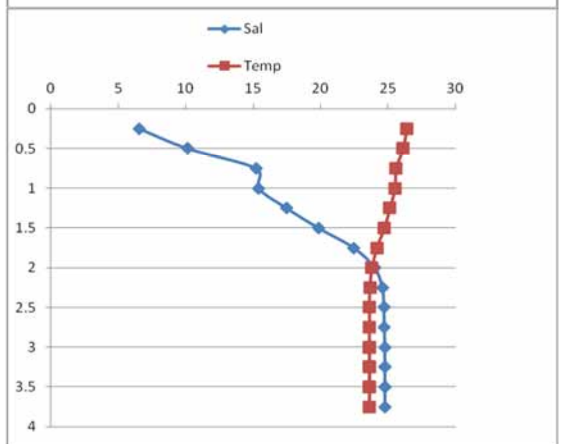

Division St Dock DO
DO mg/L
Depth (m)

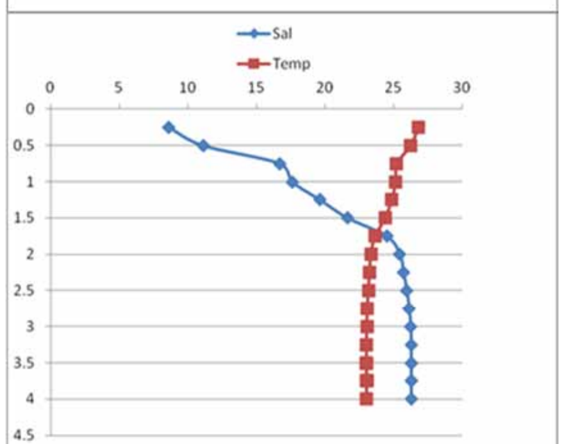

Bishop Pt DO

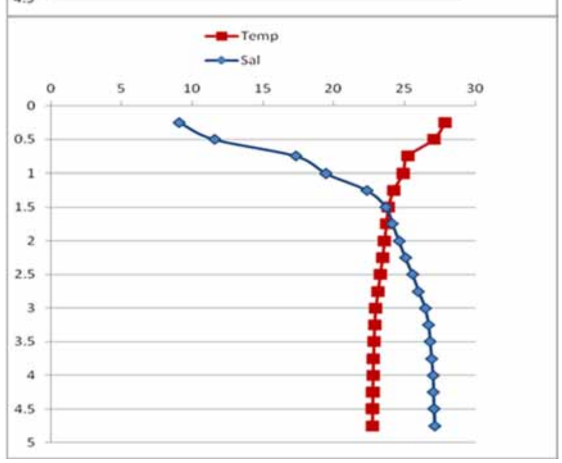

OutFall Bucklin Pt DO

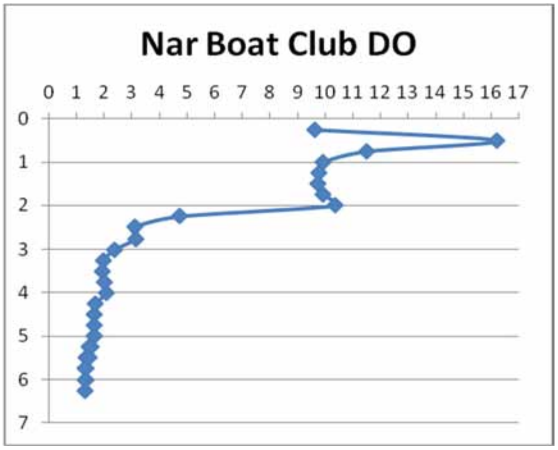

PhillipsDale DO

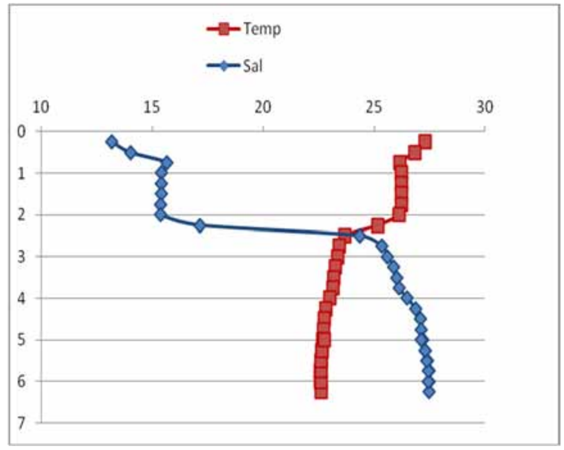

Division St Dock
Temp
Sal

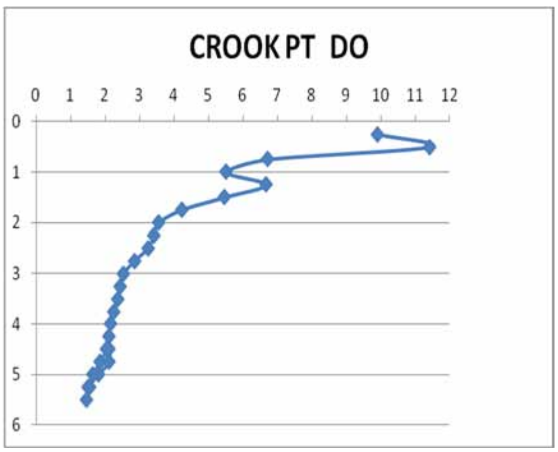

Sal
Temp

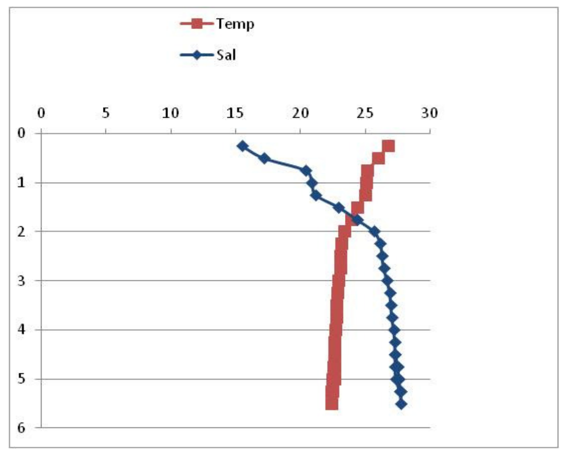

Sal
Temp

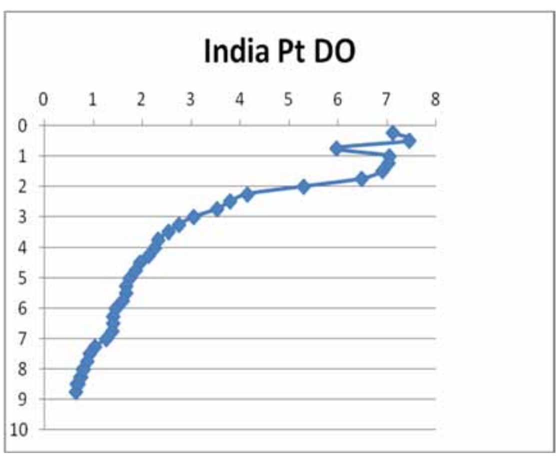

Temp
Sal

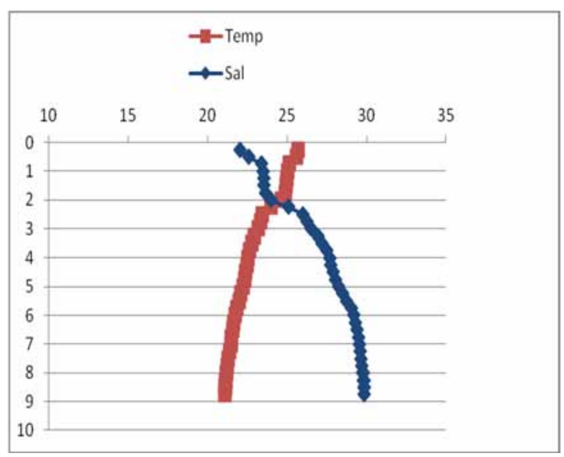








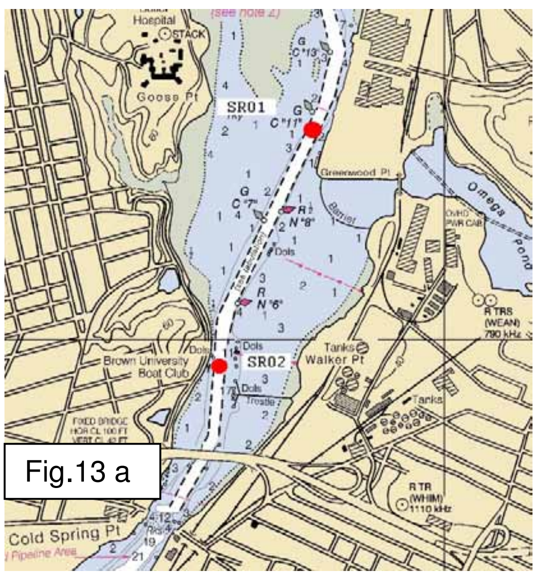


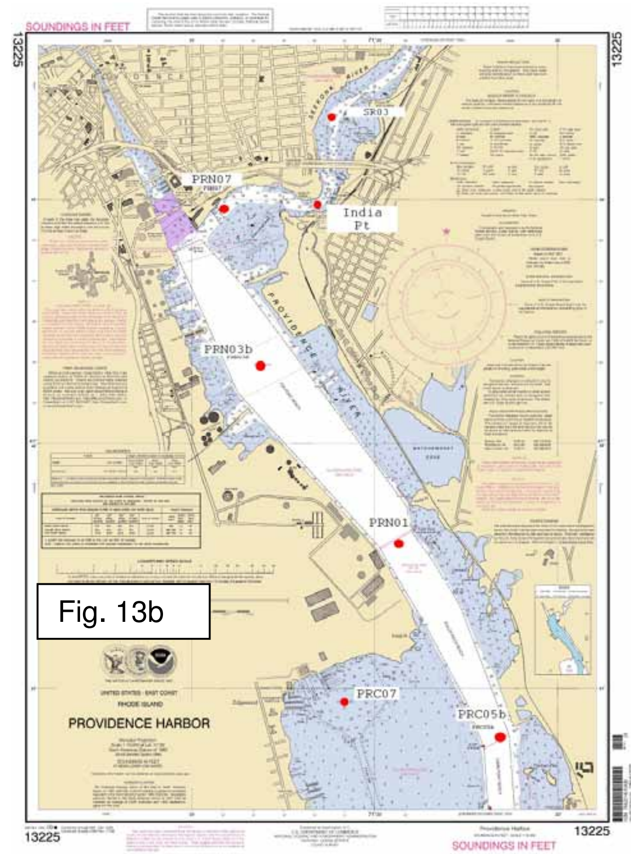


Figs 12. NBC survey results 7/21/15 D.O. levels vs depth Left side; Salinity and Temperature Right Side (data from Tom Uva) . Sta Map Fig.8.

Results of Brown Univ./URI/Save the Bay DO Volunteer survey 7/22/15

The “Day Tripper” monthly volunteer survey was completed on 7/28/2015 and covered the upper third of Narragansett Bay. Dr. David Murray of Brown University provided RIDEM with the raw data + a slightly processed file. (Note:there are no funds for student interns, etc, for this volunteer program so processing and mapping of raw data is not possible at this time).
Although the data only go halfway up the Seekonk for their survey, their results help in understanding the Seekonk conditions relative to the upper Providence River. Their results indicated that as of 7/28/15, the Seekonk River was still severely depleted in DO below about 1.5 -2 m , but the Providence River is not as critically depleted except at the Port Edgewood boat turning basin and below about 8-12 m in the ship channel.





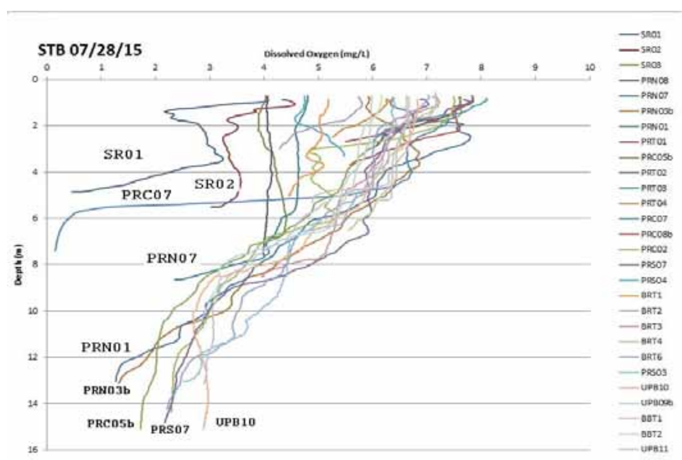


Fig. 14. DO water column profiles of stations Showing stations with lowest DO values.

Fig. 13 a+b. DO survey stations in Seekonk-Upper Providence River 7/28/15 by Save the Bay-URI-Brown University.

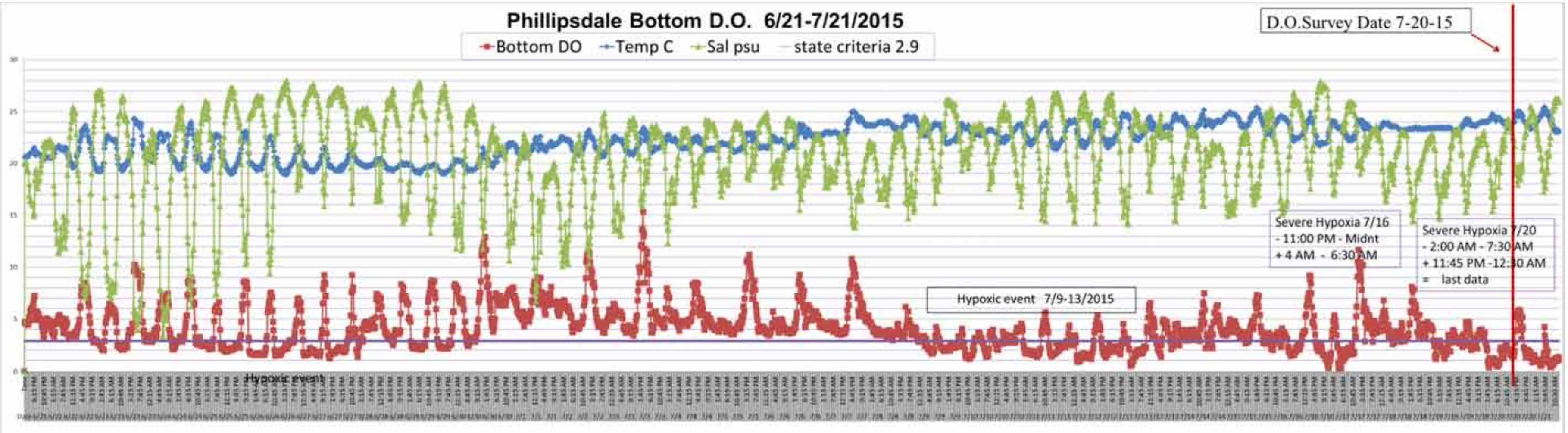


Fig. 14.Long term bottom D. O. (mg/L) Record . 6/21/15 to 7/21/15. Data from NBC Phillipsdale Landing pier site bottom (1 m off bottom). Low D.O. events tend to be cooler, saltier water in the channel

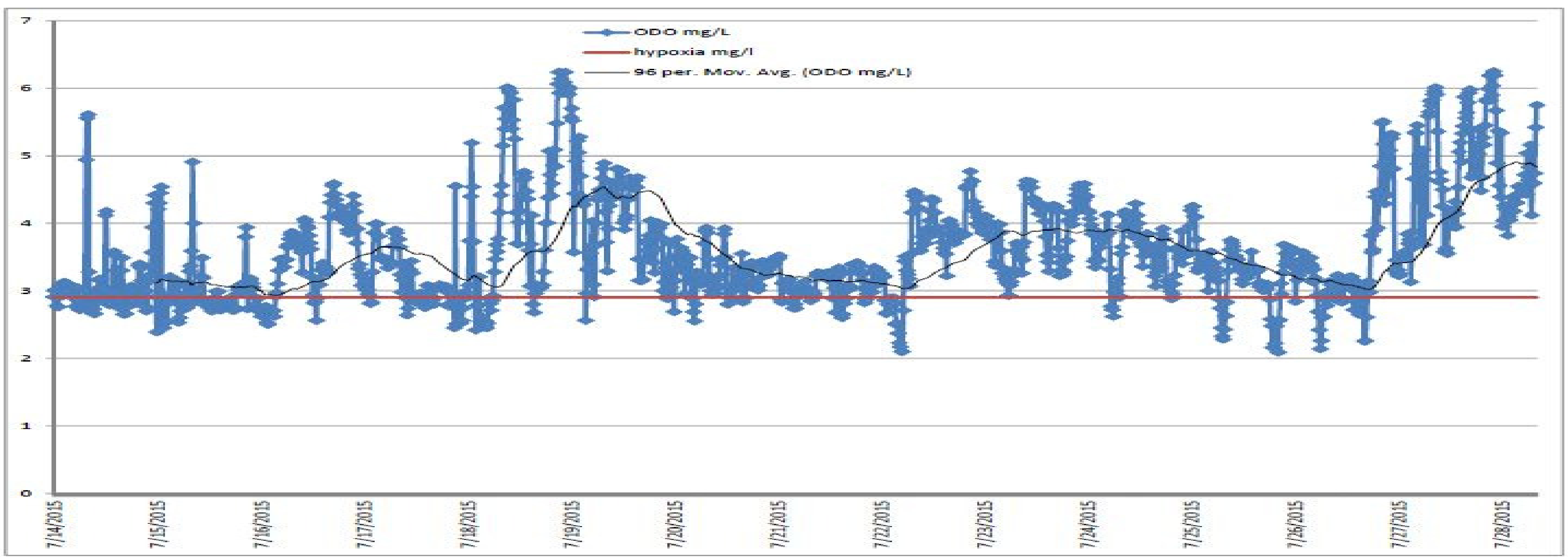


Fig.15. Bullocks Reach Bottom NBC YSI station Bottom D.O. in mg/L for 7-14-21-2015 shown here. Figure from H. Stoffel, URI.

DO levels show hypoxia has not been as severe in the Bullocks Reach area of the lower Providence River.

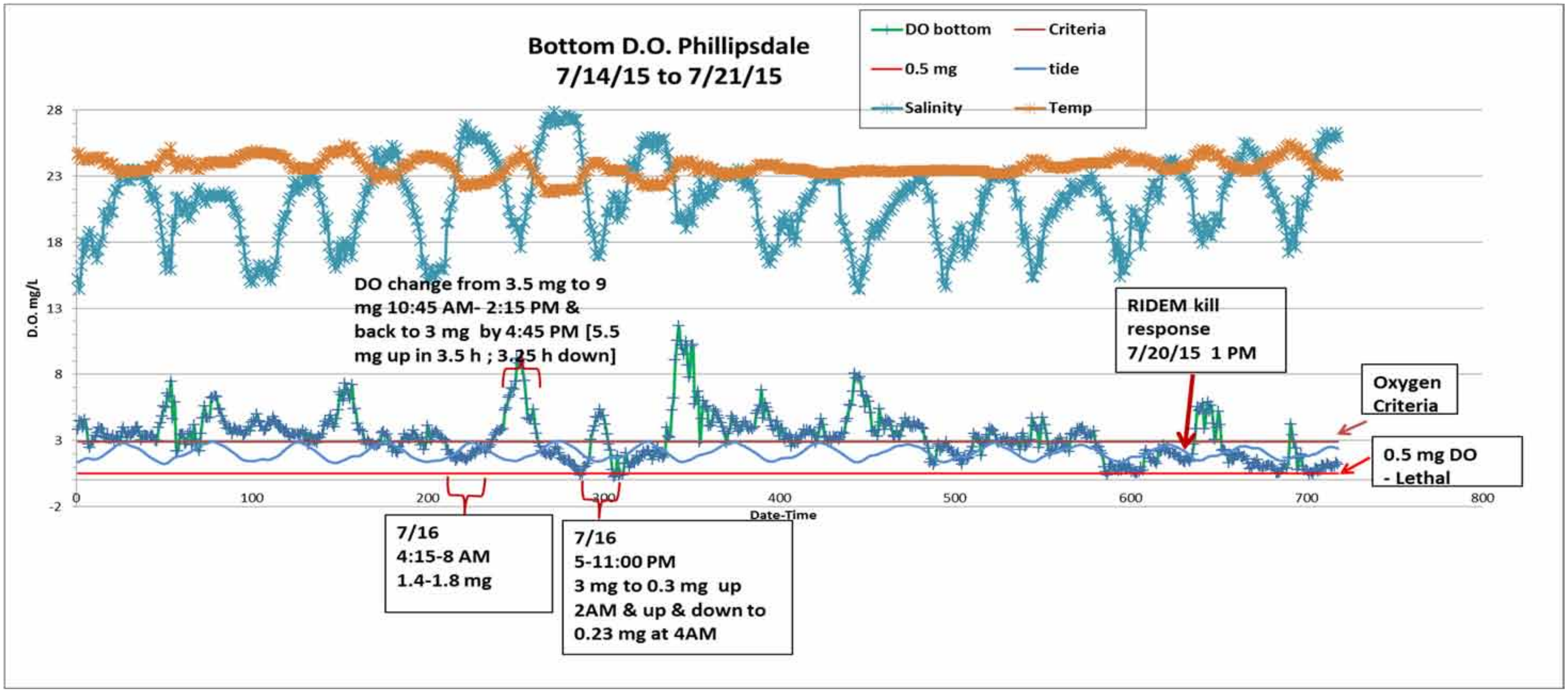


Fig.16. Shorter Term examination of D.O. Phillipsdale NBC YSI station. Bottom D.O. , salinity temperature and tide 7-14 to 7-21-2015. Brown line is state WQ Oxygen (24h) criteria , red line is immediately lethal to most fish. Data from NBC.

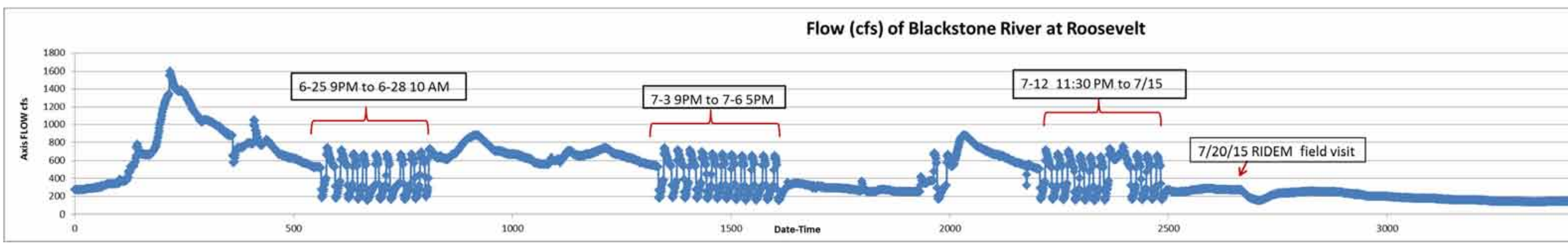


Fig.17. Blackstone River flow (cfs) at Roosevelt St. 6-20-15 to 7-29-15. Flow altered periods shown. USGS flow data

Roger Williams University
Feinstein College of Arts & Sciences

One Old Ferry Road, Bristol, Rhode Island 02809-2921
401.254.1040 • 401.254.3853 Fax • www.rwu.edu

RWU Case No. 4462

Menhaden

Submitted: July 27, 2015

Submitted by: Chris Deacutis, Sup. Environmental Scientist, RIDEM Fish and Wildlife

Date of Report: August 20, 2015

Necropsy Report

Four frozen menhaden were presented for necropsy. Animals were slowly thawed in the refrigerator overnight then on the necropsy table for approximately 2 hours. All four fish were noted with unusual behaviors, primarily spinning, before collection.
Frozen tissue does not allow for a thorough examination of fish at necropsy so not all systems were examined in the detail usually conducted when moribund or fresh dead animals are presented.

Examination of all fish grossly showed mild hemorrhage/reddening in the skin, specifically of the dorsal nose and base of the fins. Low numbers of anchor worms (Lernaea copepods) were noted on fish 2 and fish 3, primarily at the base of the first dorsal fin. Fish 4 showed approximately 12 anchor worms attached at various locations along the length of the body. Gills on all fish appeared finely delineated but were dark red to brown upon examination. One animal showed an anchor worm head attached to one filament on the left gill.

Internally, no specific masses or abnormalities were noted in any organ. Three of four fish contained some food in the stomach. All contained normal amounts of bile in the gall bladder. Diffuse deep reddening of the peritoneum and serosae of the internal abdomen were present in all four animals. In two/four animals, 5 to 10 ml of light red fluid was removed. Three of four animals appeared to be male and one of four appeared to be an "out of season" female.

Samples of kidney, liver and heart were collected from each fish for histological evaluation and for virus detection. Samples for viral detection were shipped to the laboratory of Dr. Rod Getchell, Cornell University.

Viral examination showed strong cytopathic effect (CPE) in cultures of Bluegill fry fibroblasts (BF2) but none in Carp Epithelioma papulosum cultures (EPC) in three of the four fish. Fish 2 collected from the school street dock was negative for CPE (not noted as spinning in the submission information). These findings do show strong similarity to those describe in the 1980 paper by Stephens et al. They also matches findings from similarly acting/moribund menhaden from a recent mortality event in NY. While the IPN-like virus has not yet been isolated and identified from these two recent mortality events, it is very possibly the same virus is present in both cases (isolation and molecular identification is ongoing at Cornell).

Summary: Fish show a low level infection with anchor worms which while potentially stressful to the fish is probably not the cause of morbidity and mortality. The diffuse reddening noted in the abdomen most likely resulted from handling before freezing followed by freezing then thawing. But, could also be partly, or wholly, due to hemorrhage associated with viral infection.

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
DIVISION OF FISH & WILDLIFE / MARINE FISHERIES
Three Fort Wetherill Road
Jamestown, Rhode Island 02835

Data + information on Fish Kill, Seekonk River 8/18/2015

Report

RIDEM staff (C. Deacutis) received a phone call from Phil Edwards ~ 9:30AM on 8-17-15 relaying word of a fish kill reported to RIDEM DWR on 8-17-15. A Bucklin Point WWTF staff member reported that a large number of dead menhaden were scattered along the shoreline near the plant. No working boats were available to investigate (all the small trailerable boats were being used in the Salt Ponds on F&W work) and the remaining 2 boats were being repaired. Deacutis contacted Tom Uva of NBC to get more details. The NBC staff has also reported the kill to Mr. Uva. He was in the process of dispatching the NBC water quality monitoring group to measure DO at the surface and bottom of the river. DFW requested that his crew take pictures also and attempt to capture any live fish.

Pictures were received late on 8-17-15. They showed a large kill of adult menhaden along the eastern shore of the Seekonk near Bucklin point, with counts indicating a kill of several hundred in this area alone (see Fig.1) .

A second report (phone call) from Aaron Mello, RIDEM DWR was received by DFW on 8-18-15. He indicated he had taken a lunchtime ride to Blackstone Park along the Seekonk, where he saw hundreds of dead adult menhaden. He sent pictures he took to Deacutis. Based on the pictures, it appears this western side of the Seekonk is also covered with hundreds of dead adult menhaden (none seen alive, see Fig. 2.).

Blackstone river flow is lower than it was in July 2015, mainly in the 100-150 cfs range, with occasional spikes to about 200 cfs, possibly due to thunderstorms releasing significant rainfall in the watershed during this period (Fig. 3). The low flow continues to be a problem, as noted in the report of the 7-20-15 kill, because it leads to low estuarine flow /flushing of the Seekonk. In addition, water temperatures have increased since 7-20, and are now at the 23-26 degr C range.

The total kill, based on witnessess, is in the high hundreds to just over one thousand adult menhaden
The kill is most likely to have actually occurred during early morning of 8/16. The surface and bottom YSI data from Phillipsdale (NBC station) show an unusual convergence of surface and bottom DO levels around 8/15, and dissolved oxygen dropped below 1.0 mg/L even at the surface on 8/16 around 1:00 AM (see Fig.5). This level would be lethal to menhaden anywhere in the water column. Once again, there was a sudden significant rise and fall in the Blackstone flow at Roosevelt dam just before this kill (8/15/15 at ~midnight) which may have contributed to the sudden mixing event (see Fig. 3). Worcester MA NOAA NWS station recorded a precipitation event on Aug 15 of 1.67", so this spike might be associated with a short term rain event in the watershed. This flow increased the salinity stratification in the river. The surface reached a low of 11.75 psu at the surface at 1:30 AM on 8/15, while the bottom was at 26 psu, sealing off the water column, not allowing oxygen to mix down into the higher salinity bottom waters.

Recommendations of corrective action needed: Continue to pursue decreases in nutrient loads from all sources including WWTFs to the Blackstone and Seekonk Rivers in order to reduce TP in the Blackstone River (FW algae are likely contributing to the organic load) and TN for the SW zone of the Seekonk. As discussed in the previous report, discussions are needed with FERC and hydropower generators concerning any head build up/ release operations (not allowed under FERC license requirements for run-of-river conditions. A special study of the lower Blackstone + Seekonk is needed to examine what triggers large algal blooms and stratification as well as temperature ranges involved in rapid severe hypoxia development in the Seekonk (i.e., do temperatures need to be over 25 C to reach severe hypoxic levels?). Such a study should include measuring temperature and salinity of the water column along with DON and TN concentrations and loads directly to the Seekonk for pre and post significant rainfall events as well as nutrient and TOC and DOC from the Blackstone and Ten Mile from various sources during these situations.

Fig. 1. Dead adult menhaden on eastern shore of Seekonk River, just north of Phillipsdale landing, East Providence RI 8/17/2015. Photos by J. Motta, NBC

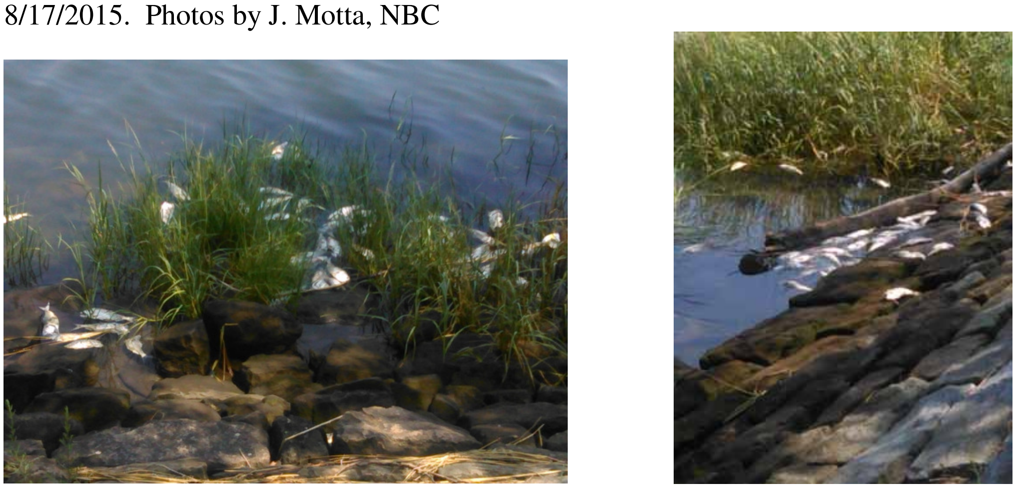


Fig. 2. Dead adult menhaden on the western shore of the Seekonk at Blackstone Park 8/18/15. Photos by Aaron Mello, RIDEM DWR.

Fish Kill/Incident Notification

Date of Kill/Incident: 8-17-15 (low DO starts ~ 8/16/15 ~ 1:00 AM based on Phillipsdale D.O. data

Date Reported: _____8-17-2015_ TimeReported: phone call 9:30AM - from Phil Edwards RIDEM DFW 7/17/15 +DEM DWR ~ 9:30AM

Name of Reporter: _Phil Edwards RIDEM Phone 789-7481 Address: __DEM DFW Great Swamp Field HQ

Organization Associated With: ___RIDEM Div. Fish & Wildlife (FreshWater section)__________________

Water(s) Involved: _Seekonk River , East Providence,RI

Specific Location (bridge, highway/state road, landmark, park, etc.): ____eastern shore by Bucklin Point WWTF in East Providence, RI

Suspected Reason For Fish Kill/incident (natural / pollution): extreme low oxygen at bottom + low at surface early AM 8/16/15 based on Phillipsdale data

Location of Source: ____________multiple sources of excess nutrients + density stratification due temperature + salinity difference surface vs bottom water

Name of Alleged Polluter (if applicable): ____N/A____

Species Involved: ______adult Atlantic Menhaden____

Fish Affected? __X__ Yes _____ No

Approximate Number: _High_100's to 1000 Still Dying? __ Yes _X_No based on phone calls- Additional Comments: __Dead menhaden seen were in middle Seekonk around Bucklin Pt and on western shore at Blackstone Park– NBC Phillipsdale dock site (in channel) shows DO decreases to below 1 mg/L on 8/16/2015 around 1:00 AM_________________

Persons and Agencies Notified To Respond:

	NAME		DATE/TIME	PHONE	REPORT SENT TO
1.	__Chris Deacutis__	_DEMF&W__	__8-17-15_______	_423-1939______	____ Yes __X__ No

Division of Enforcement Notified at (401) 222-3070 __X__ Yes _____ No
Report Prepared By: ___Chris Deacutis DEM F&W_____ Further Action Needed? ___Yes _X__ No

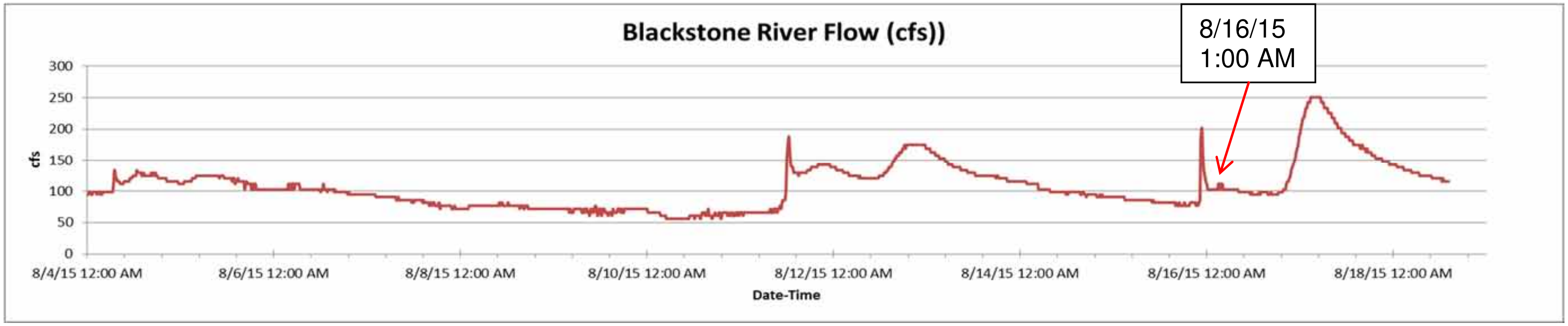


Fig. 3. Blackstone River flow (cfs) at Roosevelt St. 8-4 to 8-18-2015. Note flow surge at midnight 8/16/2015. USGS flow data

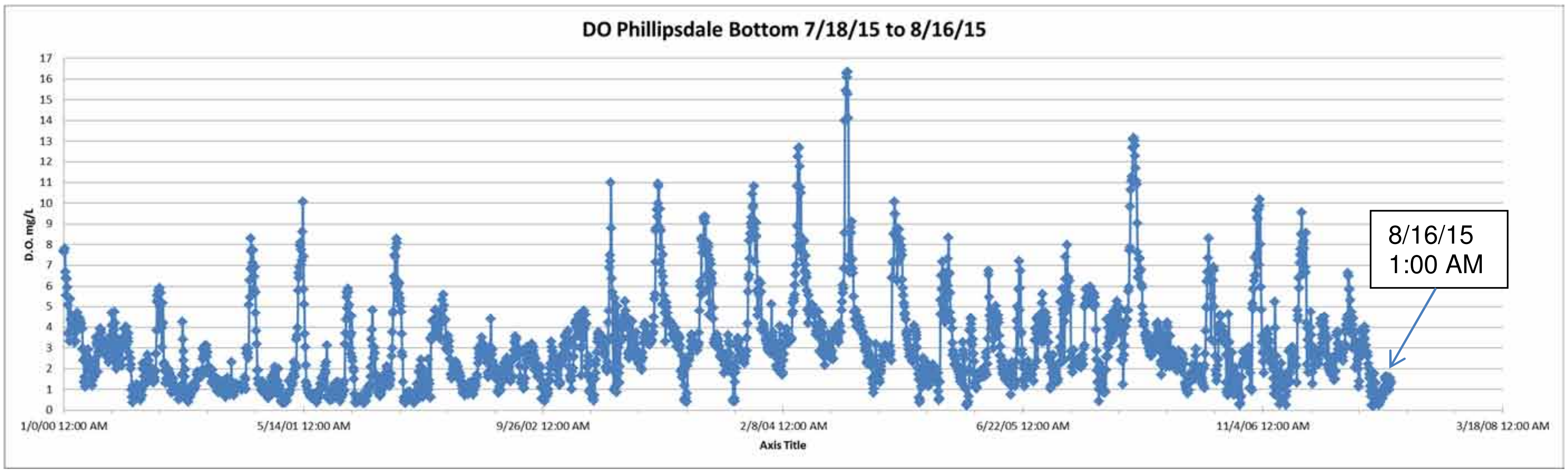


Fig.4. Phillipsdale YSI station Bottom D.O. in mg/L for 7-18 to8-16-2015 shown here. Data from NBC Snapshot website 8-17-2015
Extreme swings in DO from 7-30 to 8-14-15 and severe low DO levels (<1 mg/L = lethal to menhaden) on 8-16-2015 around 1:00 AM and persists for several hours.Each mark on horizontal axis is ~24 h, larger mark is 5 days.

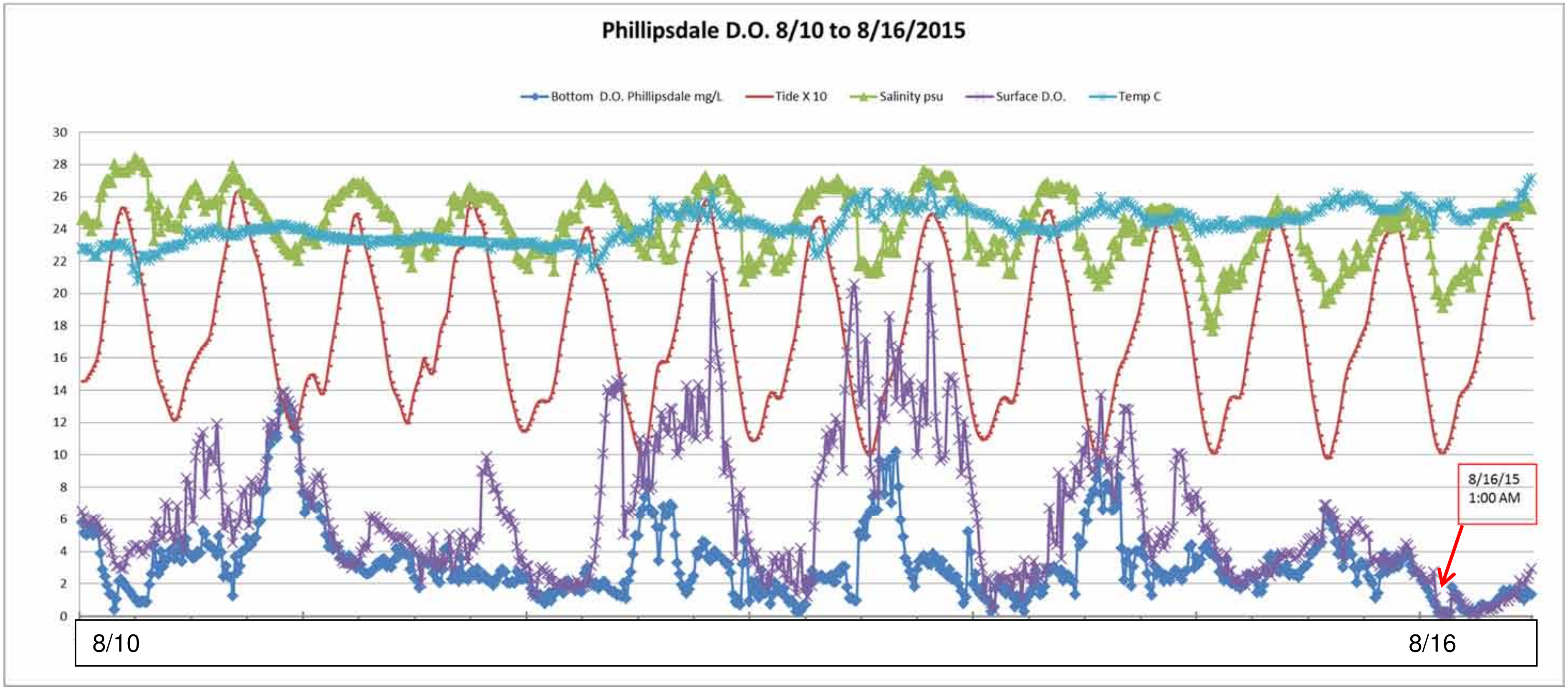


Fig. 5. Shorter Term examination of D.O. Phillipsdale NBC YSI station (Long tics approximately 24 h). Surface + Bottom D.O. , salinity, temperature and tide (x10 to depict tide on the graph) for 8/10 to 8/16/2015. Higher bottom DO tends to occur on low tides, while bottom DO tends to decrease on high tides. Note *surface* DO drops to < 1 mg/L (along with bottom DO) on 8/16 around 1:00 AM . This would be a lethal condition for menhaden even on the surface.

.

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
DIVISION OF FISH & WILDLIFE / MARINE FISHERIES
Three Fort Wetherill Road
Jamestown, Rhode Island 02835

Data + information available for Fish Kill Investigation at Nanaquaket Gut, Tiverton, RI September 3, 2015

Summary Report

RIDEM staff (E. Schneider) received a phone call from a water quality volunteer sampler in Tiverton RI (G Plunkett) concerning a number of adult dead menhaden + live schooling menhaden in the northern end of Nanaquacket Pond . Two staff members (W. Helt and B. Galligan) were sent to investigate and take DO readings. They found approximately 38 adult menhaden dead at least 24 h, mostly in the lower Sin & Flesh Brook area where it joins the Gut at Highland Road (est. of 50 dead assuming can't see all the dead along shore or mid-pond). The DO in this area was depressed (Sta A-E ~ 4 mg/L), and was likely lower in the early pre-dawn hours. The Gut area itself had reasonable DO levels (Sta G-H ~ 5.4 mg\l).

There is no evidence of significant pollution. We suspect this was a natural kill. The menhaden appear to have gotten caught in the upper area after having gone through the culvert at a high tide period. We believe this was the cause of the mortality. The brook is at very low flows at this time (as is most of RI), and this area is likely flushed only by the tidal regime, which may not flush the area well, allowing for stagnation and hypoxia to set in. A local witness mentioned he had seen a number of fish kills in this area and noted that local avian predators like osprey come to this spot to forage.

We have no recommendations for this area other than to have the town consider widening the culvert beneath Highland Rd to increase flushing to the area of the lower brook.

FISH KILL INVESTIGATION REPORT FORM

Additional Comments: Small Menhaden (adult) kill at headwaters of Nannaquacket Pond, Tiverton RI

1 **Date:** 9/3/15	2 **Time of Arrival:** 10:50 AM **Total Time spent at site** ~ 2 hrs	3. **Waterbody Location:** Nanaquaket Pond "Gut"	4. **Person reporting:** Name: Will Helt + Bryan Galligan Phone: 423-1947 Address: 3 Ft Wetherill Rd Jamestown, RI Affiliation: RIDEM F&W

5. **# of fish Killed**: _____

Incident Size:
- Minor <100 X☐
- Moderate 100-1000 ☐
- Major >1000 (later) ☐

6. **Dimensions of fish kill**:

__________ by __________

Mainly at north end of gut

7. **Fish Species Affected:** **Fish Size**

1. __Atlantic Menhaden (adult) ______________ Same X☐ Different ☐ Range _12 to ~14_ in.
2. ____ Same ☐ Different ☐ Range ____ to ____ in.
. ____ Same ☐ Different ☐ Range ____ to ____ in.

7a. **Other Species Affected:**

1, _____none seen ________________________ Dead X☐ Dying ☐ Lethargic ☐ Live ☐
2. ____ Dead ☐ Dying ☐ Lethargic ☐ Live ☐
3. ____ Dead ☐ Dying ☐ Lethargic ☐ Live ☐

8. **Fish Species Not Affected**

____

__minnows in shallows___

____

Air Temp (F) ~82-85 F

Cloud Cover (%)

Precipitation (%) 0

Wind Speed (mph) light

Wind direction -

10. **Water Quality:**
- Temp (C): _~25-26 C
- pH: ______________
- DO: _4-5.4 mg bottom (1.5-3.5 m depth)
- Conductivity: __________
- Salinity: 6 (surf) to 28 psu_(bottom)___
- Chlorine: ______________

11. **Water Condition:**
- Turbid ☐
- Sediment Loading ☐
- Colored: ___ ☐
- Odor: ____________ ☐
- Tidal Stage: _~ hi tide____
- SAV/ macroalgae ______ ☐

12. **Fish Condition:**

Dying ☐	Discoloration ☐	Increased respiration ☐	Emaciated ☐
Gills flared ☐	Odd fin position ☐	Eyes sunken in ☐	Spasms, convulsions ☐
Red/pink gills ☐	Swimming at surface ☐	Eyes bulging ☐	Erratic Swimming ☐
Gill clubbing ☐	Equilibrium loss ☐	Bloated ☐	Lethargy ☐
Excessive mucus ☐	Trying to get out of water ☐	Mouth agape ☐	Hemorrhaging ☐
Lesions ☐		Hypersensitivity ☐	Spine curved ☐

Other X_ **all recent dead** _(24-36h):_______________________________

13. **Symptoms/Conditions**	**Possible Cause**	**Possible Source**	**Source present?**	
• Fish coming to surface gulping for air ☐ • Low dissolved oxygen X☐	Oxygen depletion - low oxygen in eve/early AM	Sewage Treatment Plan	Yes ☐	No ☐
		Livestock Feedlot	Yes ☐	No ☐
		Irrigation/De-icing Runoff	Yes ☐	No ☐
		Decaying Plant Matter	Yes ☐	No ☐
		Dying Algal Bloom	Yes ☐	No ☐
• Fish coming to surface gulping for air ☐ • Adequate dissolved oxygen ☐	Early oxygen depletion with slow re-oxygenation	Ammonia Chemicals	Yes ☐	No ☐
		Livestock Feedlot	Yes ☐	No ☐
• Fish swimming erratically ☐ • Fish moving upstream to avoid something in water ☐	Chemical pollution	Heavy Metal Plant	Yes ☐	No ☐
		Chemical Waste Facility	Yes ☐	No ☐
		Sewage Treatment Plant	Yes ☐	No ☐
• Fish dying or dead after heavy rain ☐	Pesticide, herbicide washed out/runoff	Farms, Crop fields	Yes ☐	No ☐
		Aerial Crop Sprayer	Yes ☐	No ☐
		Man/mechanical Sprayer	Yes ☐	No ☐
• Fish coming to surface gulping for air ☐	Oxygen depletion	Dredging/ Marina activity	Yes ☐	No ☐
• Low pH ☐ Good clarity ☐ Orange Discoloration ☐	Acid	Coal/Strip Mining	Yes ☐	No ☐
• Fish dying below a dam or industrial plant ☐	Turbines or thermal shock	Heated water	Yes ☐	No ☐
• Kill restricted to one species or size class X☐	Spawning stress, disease	Pathogens, WQ poor	Yes ☐	No ☐

14. **Documentation and Samples**:
Photos taken ☐X
Water samples ☐ Number: ______________ Sent to: ______________________ Tested For: _____________________
Fish Samples ☐ Number: ______________ Sent to: ______________________ Tested For: _____________________

15. **Prepared By**:
Will Helt & Chris Deacutis

Fish-Counting Record

Date: ____9-3-2015____ **Time:** **Start** __**11:00 AM**__ **Finish** _**1:00PM** **Name of investigator(s): Will Helt + Bryan Galligan**

Location/Waterbody Name: Nanaquaket Gut_____ **Area Sampled:** (upper) _north end of Gut both sides of Highland Rd (see map)_

(Transects) # of Transects __**0 transect**_____ **Transect #** _______ **Notes:** count dead fish entire north end Gut

Fish Kill/Incident Notification

Date of Kill/Incident: 9-3-15

Mi or Sta		Atl Menhaden					
Nanaquaket Pond							
No. end of Gut		38 menhaden counted	See on shore (see photos)				

-

Date Reported: _____9-3-2015_ to E. Schneider Time Reported: ________________________

Name of Reporter: _Tiverton Resident_/ volunteer WQ monitor Gary Plunkett gplunkett@cox.net

Address: ____ __ Phone: ____ (401) 633-2037

Organization Associated With: ____URI Watershed Watch monitoring program_________________

Water(s) Involved: _____Nanaquaket Pond where Sin and Flesh Brook enters the Gut____

Specific Location (bridge, highway/state road, landmark, park, etc.): ____intersection of Highland and Bridgeport Rds, Tiverton, RI

Suspected Reason For Fish Kill/incident (natural / pollution): __low oxygen in early AM (~1-5 AM) hrs due low flows and poor tidal flushing in the area – menhaden school caught in Sin & Flesh Brook above the gut at low tide and could not leave the area due low flows________

Location of Source: ____________unknown – may be natural situation due low flows July 2015 and poor flushing + large menhaden pop. In Bay_____

Name of Alleged Polluter (if applicable): ____N/A____

Address: ____________________________ Phone: ____________________________________

Species Involved: ______adult Atlantic Menhaden____

Fish Affected? __X__ Yes _____ No

Approximate Number: ____38 Still Dying? ___ Yes _X_No Additional Comments: ______________

Persons and Agencies Notified To Respond:

NAME		DATE/TIME	PHONE	REPORT SENT TO
1. __Will Helm + Bryan Gallagher_	_DEMF&W__	__9-3-15_______	_423-1947______	____ Yes __X__ No

Division of Enforcement Notified at (401) 222-3070 ___X_ Yes _____ No

Report Prepared By: ___Will Helm + Chris Deacutis DEM F&W_____ Further Action Needed? ___Yes _X__ No

R.I. Department of Environmental Management

Division of Fish and Wildlife
Fort Wetherill Marine Laboratory
3 Ft. Wetherill Road
Jamestown, Rhode Island 02835
(401) 423-1920

Fish Kill Investigation Report

Prepared and submitted by: Will Helm + C. Deacutis **Phone:** 423-1939

Name(s) of investigators/title: Fish Specialist (W.H.) **Phone:** 423-1947

Sup. Environm. Scientist (CD)

Body of water/ local name: Nanaquaket Pond

Nearest town/ county: Tiverton, RI

Time and date of kill: 9/3/2015 **Approximate duration of kill:** hrs ??

Time and date of investigation: 9/3/2015

Extent of kill area: area of the north end of Gut, Nanaquaket Pond

Suspected cause of kill/ description of how kill occurred:

Low DO due low brook flows + poor flushing

Alleged contamination source: none known

Species affected:

Common & scientific name:	Total # affected:	Size range (inches):	Condition (dead/dying)
Atlantic Menhaden	38	8-12 "	dead
Brevoortia tyrannus			

Estimated total number of fish/inverts killed: 38-50 (some may be on bottom)

Symptoms of distressed fish: all dead

Necropsy observations: -warm water (26 C)

Water conditions observed:

Water quality measurements: DO at 4 mg /L on bottom (2-3 m depth) = low DO but not low enough to kill

Documentation collected (Y or N): **Witness statements:** witness noted frequent kills here recently

Photographs: X **Digital or film:**

Samples collected and sent to lab (Y or N):				**Laboratory name:**	**Analysis run:**
Water		**Quantity**			
Fish/ inverts		**Quantity**			

Laboratory results indicate:

Additional comments:

Recommendations of corrective action needed: none

area needs flushing and FW flows

Report submitted to: RIDEM **Date of submission:** 9/15/2015

Fig. 1. Tidal culvert opening on Main Rd at Sta 1 between the Gut and northern end of Nanaquaket Pond , looking SW towards Nannaquaket Rd bridge.

Fig. 3 Culvert at Sta 2. looking NE towards the Gut at tidal opening from Nanaquaket Pond.

Fig. 2. Juvenile Atlantic menhaden school at tidal culvert Sta 2 facing toward the Gut 9/3/15

Fig. 4. Sta 3 looking towards small culvert between Sin & Flesh brook and the Gut

Fig. 5. Station 4. Dead Atlantic menhaden adults looking back towards Brook culvert connection with the Gut.

Fig. 7. Sta 5. Ares of Sin & Flesh Brook

Fig. 6. Sta 4. Several dead Atlantic menhaden at end of Sin & Flesh Brook above the Gut area. Total count dead this shore ~ 38 .

Fig. 8. Sta 5. School of unstressed fish (Menidia?) above clamshell bottom NE Gut area.

Fig. 9. Sta 7 E side of Gut . Two dead menhaden caught at surface, probably washed out from other side of culvert above the Gut.

Fig. 10. Sta 8. Two dead menhaden E side of Gut. Unclear if washed down or died here.

Maps of area and Station Maps

Fig.1. Nanaquaket Pond Tiverton, RI

Fig.2. Nanaquaket Pond north end + “The Gut”Tiverton, RI

Fig. 3 Photo Map Locations. Nanaquaket Gut 9-3-15

Fig.4. DO station locations . Nanaquaket Gut 9-3-15

Table 1. YSI Dissolved Oxygen (DO) Transect (see below map):

Data Table 1. Dissolved Oxygen (D.O.), salinity, temperature 9-3-2015 north end Nanaquaket Pond Gut (see map above for station locations).

	Coords		Surface				Bottom					Notes
Sample	Lat	Long	Temp (C)	DO Sat	DO (mg/L)	Sal. (ppt)	Temp (C)	DO Sat	DO (mg/L)	Sal. (ppt)	Depth (ft)	
A	41.61953	-71.20300	25.4	62.2%	4.3	22		4.4%			1.5	running water
B	41.61948	-71.20310	25.5	63.0%	4.98	15.5	25.7	60.4%	4.02	27.53	2.5	
C	41.61933	-71.20322	25.3	61.0%	4.95	6.5	25.8	64.5%	4.7	27.77	2.5	
D	41.61929	-71.20323	25.2	65.0%	5.4	6	25.5	62.8%	4.4	27.83	3	
E	41.61927	-71.20322	25.6	57.2%	4.6	4.5	25.6	48.3%	3.4	27.85	3.5	
F	41.61924	-71.20340	25.7	63.0%	4.5	25.99	25.8	80.7%	5.42	28.19	4.5	
G	41.61896	-71.20336	26	79.0%	5.38	26.3	25.8	75.0%	5.2	28.12	2	
H	41.61875	-71.20360	26.5	73.0%	5	26.65	25.9	76.0%	5.4	28.06	3	

Table 2. Photograph Locations: (Corresponds to below map)

Location	Photo # Range (RIMGxxxx)	
1	6092	6099
2	6100	6018
3	6019	6112
4	6113	6116
5	6117	6123
6	6124	6128
7	6129	6133
8	6134	6138
9	6138	6142

Witness Statement:

Witness noticed frequent fish kills lately. He guessed that they get stuck at low tide and succumb to freshwater input. He also stated that fish were actively swimming into cut, and death can sometimes be in the hundreds while osprey come to forage on the dead fish.

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
DIVISION OF FISH & WILDLIFE / MARINE FISHERIES
3 Fort Wetherill Road
Jamestown, Rhode Island 02835

Data + information available for Fish Kill Investigations at Pawtuxet Cove in September 2015

Executive Summary

On September 8, 2015, RIDEM received a call from a citizen water quality volunteer observing menhaden schools acting abnormal / stressed and/or with dead menhaden seen nearby during their water quality sampling from the Pawtuxet Village bridge. A staff member went to the site and recorded photos and videos and measured oxygen levels. There were large numbers of juvenile + adult menhaden at the falls at Pawtuxet River. Small numbers of adult dead menhaden were present on the remnants of the dam (in the tens). The DO was normal below the falls where the fish were congregating. A revisit to the site by RIDEM F&W staff on September 17 found the schools still at this site, but they were now mainly juvenile menhaden, with few adults. In all cases, some fish in the schools acted stressed, showing odd swimming behavior, sometimes turning on their side. The second visit found low numbers of dead adult and juvenile menhaden scattered around the Pawtuxet cove. The small kill (less than 100 adults) apparently took place approximately the week of 9/7/15 based on information from local citizens. A water quality survey done by NBC field staff found normal DO levels in the cove the previous day (9/16/15), with a slight depression to 3 mg/L at the pycnocline at 1 m depth, and higher DO below this. Oxygen levels may be more depressed in early morning hours (3-6AM). On September 21, RIDEM received a call from a homeowner on Pawtuxet Cove indicating that large numbers of small silvery fish (juvenile menhaden) were scattered along the shores of Pawtuxet Cove, and were causing an unpleasant odor as well as attracting large numbers of seagulls which were leaving bird droppings on the cars and lawn furniture. We believe these incidents are driven by the large population of juvenile and adult menhaden still remaining in the Bay, along with large numbers of predatory species (bluefish, striped bass,etc). The predators are chasing the schools into shallow coves such as Pawtuxet Cove, causing stress and forcing these fish into areas with potentially poor evening DO levels, and significantly depleting their metabolic reserves by forcing them to remain in the river current. We expect the fish kills to continue in moderate to small numbers in this area until the weather changes to a windier, cooler pattern.

Report

Phil Edwards of RIDEM Division of Fish & Wildlife received a call from citizen water quality volunteers on September 8, 2015. The volunteer had observed large numbers of silvery fish (adult and juvenile menhaden) schools acting abnormal / stressed and/or with dead adult menhaden seen nearby during their water quality sampling from the Pawtuxet Village bridge. The message was passed on to Eric Schneider of DMF, who went out to investigate the incidents and to obtain D.O. readings in the vicinity.

Mr. Schneider found a large school of adult and juvenile menhaden was congregating at the bottom of the Pawtuxet falls in Warwick / Pawtuxet Cove. He took photos and videos and measured DO above and below the falls (see fig 1-4 for examples). DO was not a problem right at the falls, but was slightly depressed (3.07 mg/L) underneath the Rt1 bridge in a side eddy with a large school of juvenile menhaden (Table 1). There were a small number of decomposing bodies of adult menhaden in the vicinity (~15-20, dead at least several days), and the schooling juvenile fish beneath the bridge were showing signs of stress, occasionally turning on their side as they swam against the current. RIDEM staff continued making observations over the next 2 weeks. More photos and videos were taken on 9/17/15 (Fig. 5-10 for examples), and DO measurements taken by NBC field staff on 9/16 showed downstream measurements in Pawtuxet cove to be above 3.0 mg/L at depth, with a depression down to 3 mg/L at the pycnocline at ~ 1 m (~3') depth (Fig. 11-12). This same oxygen depression at ~ 1 m was seen in the two closest Providence River stations (Port Edgewood and Conimicut Point, Fig. 13-14).

Fish look stressed at the falls. Based on eyewitness statements from 9/17/15, these fish have been swimming against the Pawtuxet River current for several weeks, likely depleting their energy reserves and beginning to exceed their physiological tolerance. In addition, we suspect predators (bluefish) have harassed them during crepuscular feeding forays. We expect die offs to continue and possibly increase as the fish continue to expend energy reserves. RIDEM received a call 9/21/15 from a shoreline homeowner complaining that large numbers of dead small silvery fish were along all the shores of Pawtuxet Cove causing a terrible odor, and large numbers of seagulls were congregating in the area leaving droppings. A call was also received on 9/29/15 of dead juvenile menhaden in Pawtuxet Cove and Salter's Grove area. This is a continuation of the event that began in early September with the large schools congregating at the falls. We believe this is a natural event related to predators chasing menhaden into the cove, and the menhaden remaining at the falls in the lower salinity waters that the predators are likely to avoid. There is depressed (but not lethal) DO levels at the pycnocline downstream, but the data indicate the bottom waters are aerated with fresher seawater. Oxygen levels may be more depressed in early morning hours (3-6AM). We expect this situation to continue until we get a weather change with stronger winds and cooler temperatures, hopefully moving the predators out and allowing the menhaden schools to move down Bay.

FISH KILL INVESTIGATION REPORT FORM

Additional Comments: Small Menhaden (adult) kill at headwaters f Nannaquacket Pond, Tiverton RI

1 **Date:** 9/8/15 ; return 9/17/15	2 **Time of Arrival:** 11:15 AM **Total Time spent at site** ~ 3 hrs	3. **Waterbody Location:** Pawtuxet falls at Pawtuxet Village	4. **Person reporting:** Name: Eric Schneider 9/8; Chris Deacutis 9/17 Phone: 423-1933 ; 423-1939 Address: 3 Ft Wetherill Rd Jamestown, RI Affiliation: RIDEM F&W
5. **# of fish Killed**: _____ Incident Size: Minor <100 (9/8) X□ Moderate 100-1000 (9/17) X □ Major >1000 (later) □	6. **Dimensions of fish kill**: __________ by __________ Mainly at the falls but extends back to cove	7. **Fish Species Affected:** / **Fish Size** 1. __Atlantic Menhaden adult ______________ Same X□ Different □ Range _12 to ~14_ in. 2. ____________+ juveniles________________ Same X□ Different □ Range _3-4in. . ______________________________________ Same □ Different □ Range ____ to ____ in. 7a. **Other Species Affected:** 1, _____none seen ________________________ Dead X□ Dying X□ Lethargic □ Live X□ 2. ______________________________________ Dead □ Dying □ Lethargic □ Live □ 3. ______________________________________ Dead □ Dying □ Lethargic □ Live □	
8. **Fish Species Not Affected** __________________ __minnows in shallows___ ___some small stripers_______________	Air Temp (F) ~90 F (9/8/15) 85 F (9/17/15) Cloud Cover (%) 10% Precipitation (%) 0 Wind Speed (mph) 5 SW		
10. **Water Quality:** Temp (C): _~24.5 C pH: ______________ DO: _6.5 mg at falls Conductivity: _________ Salinity: 0.26 at falls__ Chlorine: ____________	11. **Water Condition:** Turbid □ Sediment Loading □ Colored: _clear__ □ Odor: ____________ □ Tidal Stage: _~ lowtide____ SAV/ macroalgae ______ □	12. **Fish Condition:** Dying □ Discoloration □ Increased respiration □ Emaciated □ Gills flared □ Odd fin position □ Eyes sunken in □ Spasms, convulsions □ Red/pink gills □ Swimming at surface □ Eyes bulging □ Erratic Swimming X □ Gill clubbing □ Equilibrium loss □ Bloated □ Lethargy □ Excessive mucus □ Trying to get out of water □ Mouth agape □ Hemorrhaging □ Lesions □ Hypersensitivity □ Spine curved □ Other :__some looking beat up w/ lesions due to rocks in the falls + some with parasites	

13. **Symptoms/Conditions**	**Possible Cause**	**Possible Source**	**Source present?**	
• Fish coming to surface gulping for air □ • Low dissolved oxygen (possibly downstream) X□	Oxygen depletion - possible low oxygen in eve/early AM	Sewage Treatment Plan	Yes X□	No □
		Livestock Feedlot	Yes □	No □
		Irrigation/De-icing Runoff	Yes □	No □
		Decaying Plant Matter	Yes □	No □
		Dying Algal Bloom	Yes □	No □
• Fish coming to surface gulping for air □ • Adequate dissolved oxygen at falls X □	Early oxygen depletion with slow re-oxygenation	Ammonia Chemicals	Yes □	No □
		Livestock Feedlot	Yes □	No □
• Fish swimming erratically X □ • Fish moving upstream to avoid something in water □	Chemical pollution	Heavy Metal Plant	Yes □	No □
		Chemical Waste Facility	Yes □	No □
		Sewage Treatment Plant	Yes □	No □
• Fish dying or dead after heavy rain □	Pesticide, herbicide washed out/runoff	Farms, Crop fields	Yes □	No □
		Aerial Crop Sprayer	Yes □	No □
		Man/mechanical Sprayer	Yes □	No □
• Fish coming to surface gulping for air □	Oxygen depletion	Dredging/ Marina activity	Yes □	No □
• Low pH □ Good clarity □ Orange Discoloration □	Acid	Coal/Strip Mining	Yes □	No □
• Fish dying below a dam or industrial plant □	Turbines or thermal shock	Heated water	Yes □	No □

• Kill restricted to one species or size class X□	Spawning stress, disease	Pathogens, WQ poor	Yes □	No □

14. **Documentation and Samples**:
Photos taken □X
Water samples □X Number: ______________ Sent to: ______________________ Tested For: _____________________
Fish Samples □ Number: ______________ Sent to: ______________________ Tested For: _____________________

15. **Prepared By**: Eric Schneider & Chris Deacutis

Fish-Counting Record

Date: _9-8 & 9-17-2015____ **Time: Start** __11:15 AM__ **Finish** _2:15PM **Investigator(s): Eric Schneider & Chris Deacutis**

Location/Waterbody Name: Pawtuxet Cove Warwick RI_____ Area Sampled: Pawtuxet cove at the falls + at the boathouse

(Transects) # of Transects **__0 transect_____ Transect # _______ Notes:**

h Kill/Incident Notification

Date of Kill/Incident: 9-8-15 & 9/17/15

Mi or Sta		Atl Menhaden					
9/8/15 Pawtuxet Falls		~15-20 adult menhaden counted	See on shore (see photos)				
9/17/15 Pawtuxet Falls + Cove		15-20 adult dead >36h + recent low hundreds of juv. Menhaden along shoreline	(see photos)				

-

Date Reported: _____9-8-2015_to E. Schneider Time Reported: _________________________

Name of Reporter: _watershed watch volunteer sampling at the falls

Address: ____ __ Phone: ____

Organization Associated With: ____URI Watershed Watch monitoring program__________________

Water(s) Involved: _____Pawtuxet Cove up to the falls ____

Specific Location (bridge, highway/state road, landmark, park, etc.): ____Pawtuxet falls at Pawtuxet Village, Rt 1 , Warwick, RI

Suspected Reason For Fish Kill/incident (natural / pollution): __physiological exhaustion + possible low oxygen in early AM (~1-5 AM) hrs downstream – menhaden school not leaving the falls (salinity 0.26) possibly due to predators in the cove________

Location of Source: ____________may be natural situation due predators chasing menhaden up the cove to the falls_____

Name of Alleged Polluter (if applicable): ____N/A____

Address: ____________________________ Phone: ____________________________________

Species Involved: ______adult and juvenile Atlantic Menhaden____

Fish Affected? __X__ Yes _____ No

Approximate Number: ___15-20 (9/8/15) Still Dying? __X_ Yes __No

Additional Comments: Follow up visit 9/17/15 finds _more dead (~ low 100's) juv menhaden on 9/17

Persons and Agencies Notified To Respond:

	NAME		DATE/TIME	PHONE	REPORT SENT TO
1.	__Eric Schneider + Chris Deacutis	_DEMF&W__	__9-8-15_+ 9/17/15______	_423-1933 ; 423-1939	___X_ Yes ____ No

Division of Enforcement Notified at (401) 222-3070 ____ Yes __X___ No

Report Prepared By: ___Eric Schneider + Chris Deacutis DEM F&W_____ Further Action Needed? ___Yes _X__ No

Witness Statements:

Witnesses on the bridge 9/17/15 noted that schools had been swimming against the current for weeks now.

One witness at the boat house 9/17/15 indicated that the adult menhaden had been dead for at least a week and juveniles were now dying.

Fig. 1. Adult menhaden schooling below Pawtuxet Falls 9/8/15.

Fig. 4. Dead adult menhaden on the rocks at the falls (East side of bridge). 9/8/15

Fig. 2. Dead adult Atlantic menhaden on rocks above the falls 9/8/15.

Fig. 5. Dead adult + juv. Atlantic menhaden next to the Aspray boat house boat access point. 9/17/15

Fig. 3. Juvenile menhaden below the Rt 1 Pawtuxet Village bridge. 9/8/15

Fig. 6. Schools of juvenile Atlantic menhaden Behind the boat house. 9/17/15

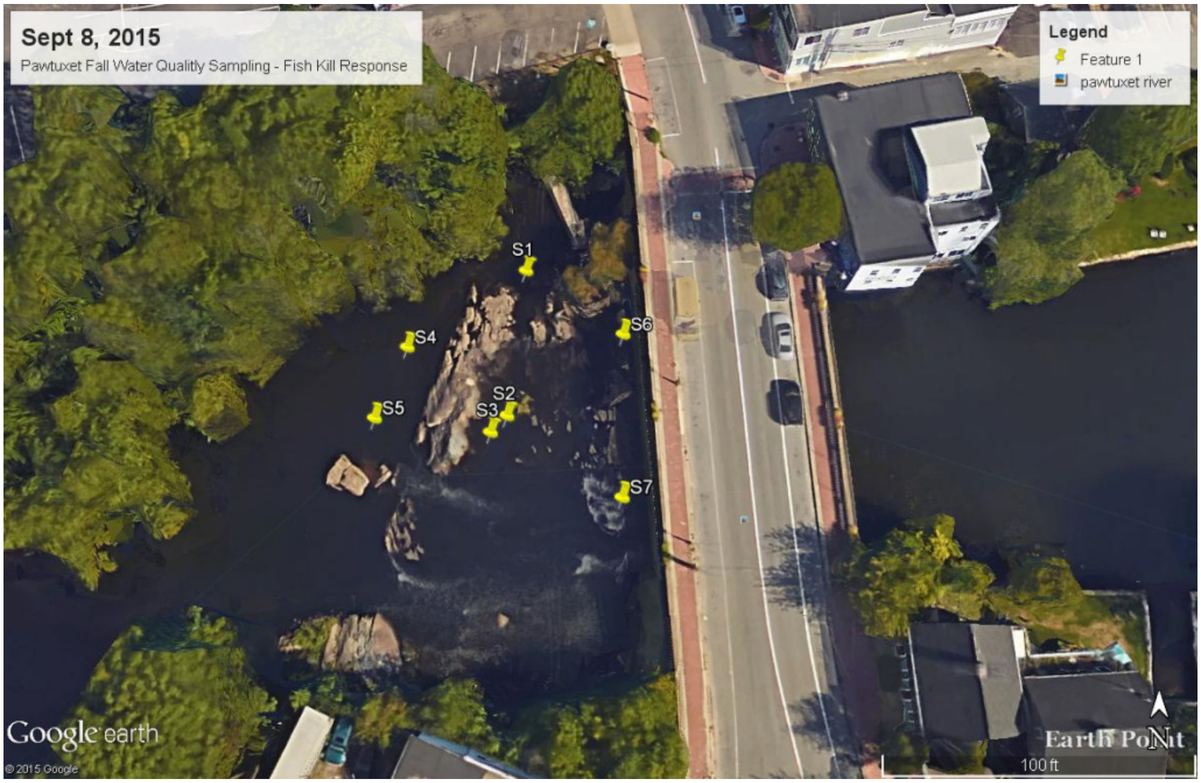
Fig. 7. Seagulls congregating in Pawtuxet cove.
9/17/15.

Fig. 8. Dense school of juvenile menhaden
North of falls on NW corner of bridge.
9/17/15

Fig. 9. Area of dense school of juvenile menhaden to north of the falls (north west side of bridge)

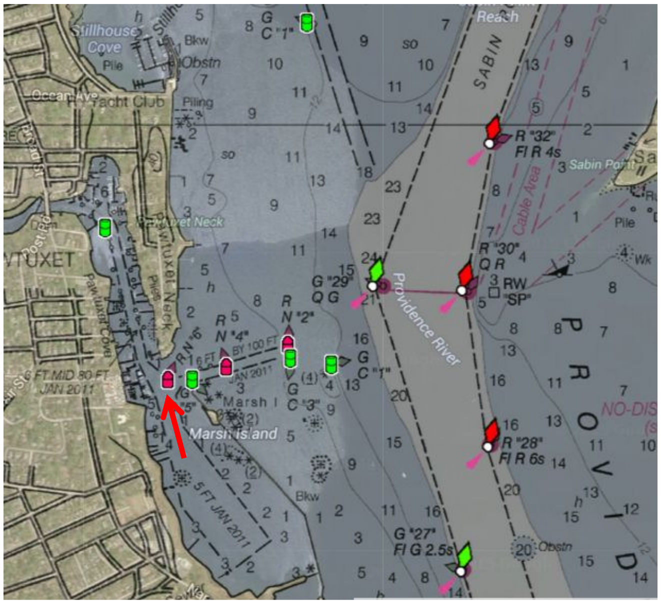
Fig. 10. East side of bridge in cove. School of juvenile menhaden swimming below the falls.
9/17/15

Maps of area and Station Maps



Map1. Pawtuxet falls bridge Rt 1, Pawtuxet Village Warwick, RI. Water quality stations sampled 9/8/15.

Map 2. Aspray Boat House in Pawtuxet Cove. Photos + videos taken on dock. 9/17/15.



Map 3. Seabird sampling sites by NBC on 9/16/15.

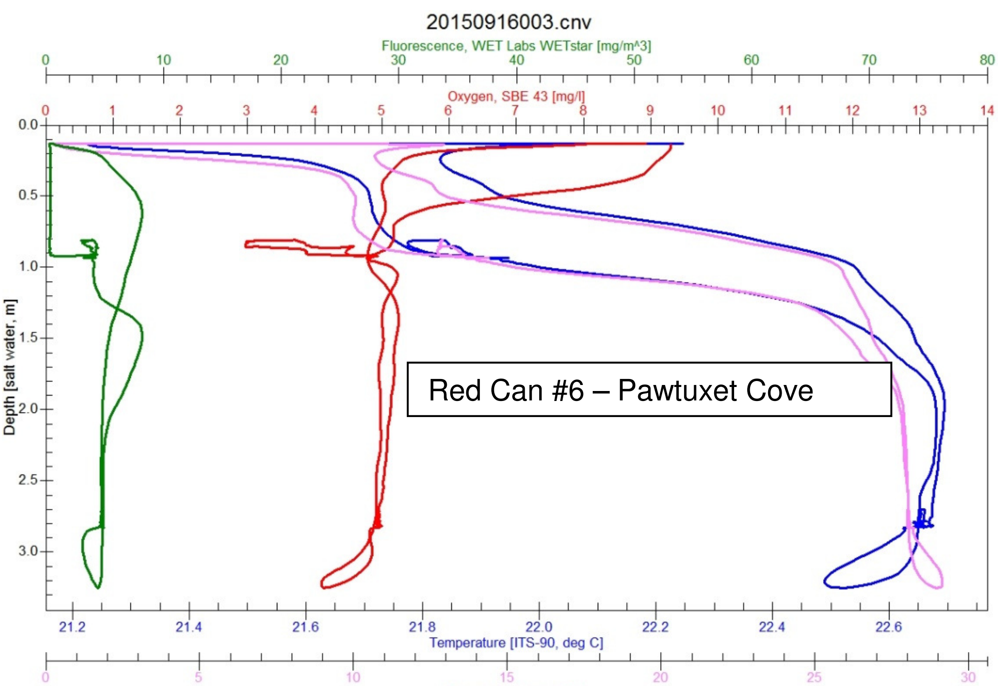


Fig.11. Seabird profile for red can #6 just inside entrance to Pawtuxet Cove channel 9/16/15. From NBC

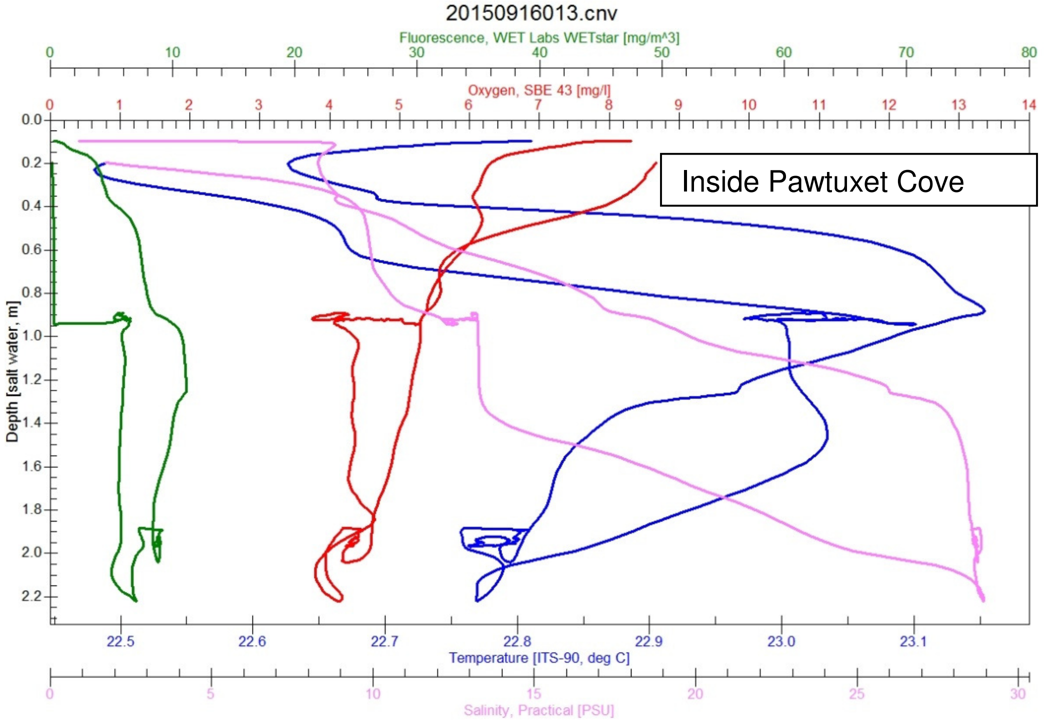


Fig.12. Seabird profile further inside Pawtuxet Cove 9/16/15. From NBC

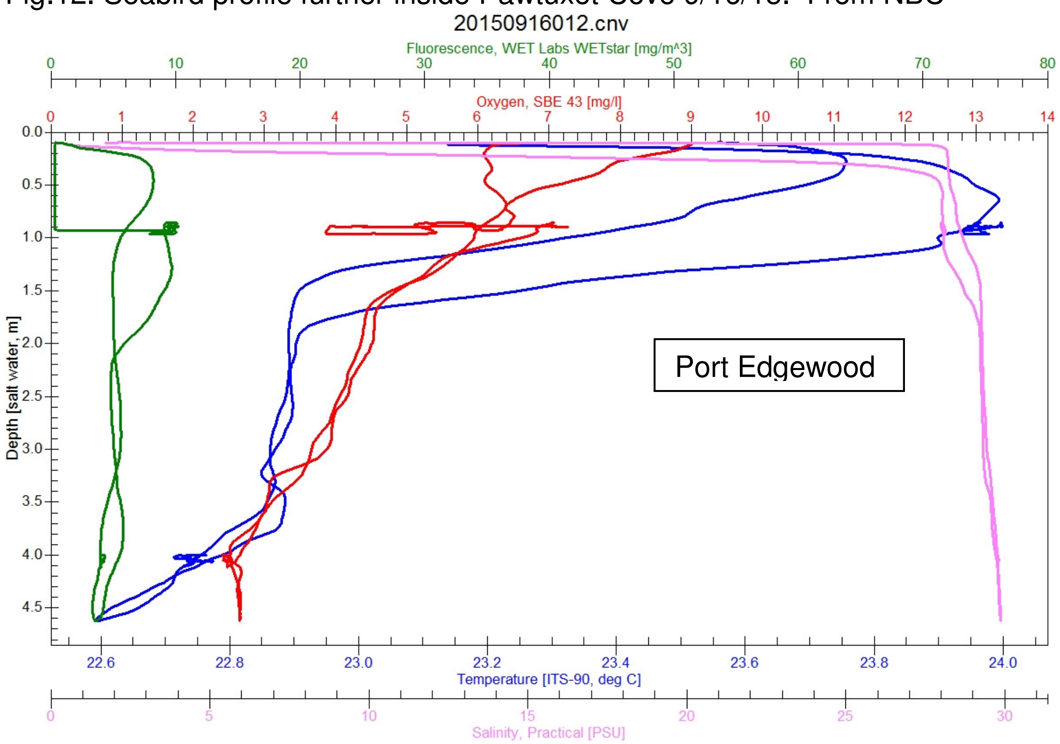


Fig.13. Seabird profile further north in Providence River (Port Edgewood) 9/16/15. From NBC

NOTE: Oxygen levels may be more depressed in early morning hours (3-6AM).

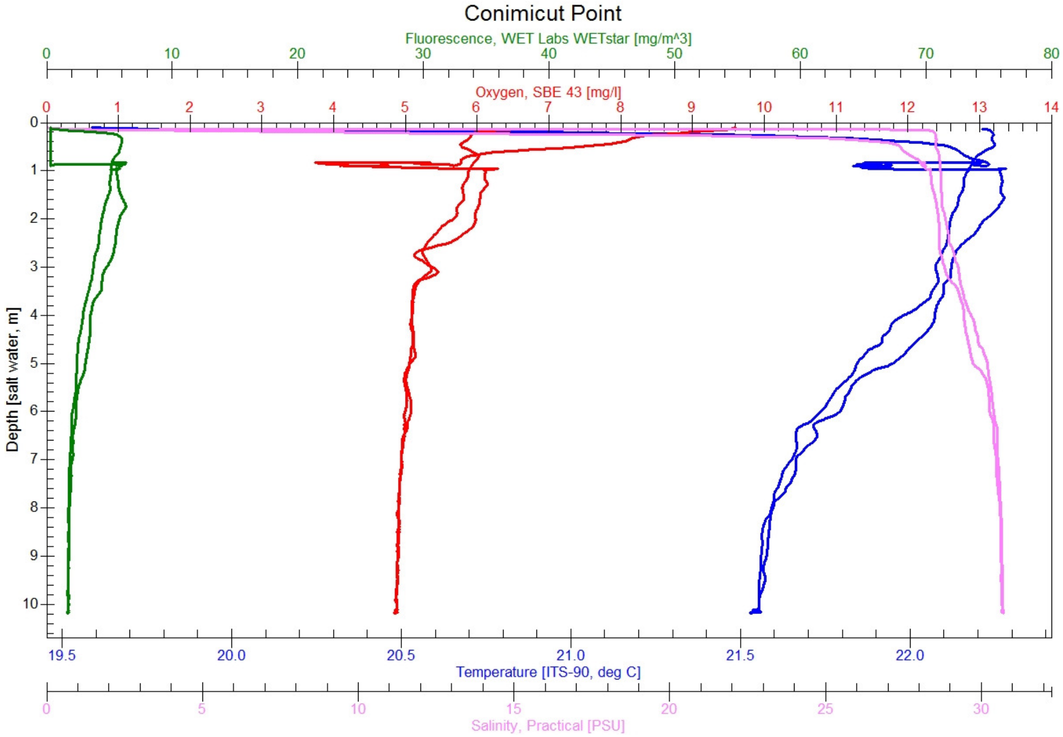


Fig.14. Seabird profile at Conimicut Point at mouth of the Providence River. 9/16/15. From NBC

	Surface				Bottom					Notes
Sample	Temp (C)	DO Sat	DO (mg/L)	Sal. (ppt)	Temp (C)	DO Sat	DO (mg/L)	Sal. (ppt)	Depth (ft)	
S1					25.3	78.2%	6.42	0.29	1.5	Out of flow
S2	24.5	78.1%	6.45	0.26	24.5	76.4%	6.8	0.26	1	Out of flow
S3	24.2	79.9%	6.7	0.03						
S4	24.4	71.3%	5.97	0.26	24.4	71.3%	5.97	0.26	3	S+B same
S5	24.4	78.2%	6.52	0.26	24.2	75.1%	6.32	0.26	3	
S6	24.5	59.1%	4.92	5.18	24.6	44.5%	3.07	15.0	3	Under bridge
S7	24.5	78.2%	7.3	0.01						In flow

Table 1. YSI Dissolved Oxygen (DO)

Data Table 1. Dissolved Oxygen (D.O.), salinity, temperature 9-8-2015 at Pawtuxet falls.