

**ASSESSMENT OF RECREATIONALLY IMPORTANT  
FINFISH STOCKS IN RHODE ISLAND WATERS**

COASTAL FISHERY RESOURCE ASSESSMENT  
TRAWL SURVEY  
2022

PERFORMANCE REPORT  
F-61-R SEGMENT 21  
JOBS 1 AND 2



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Division of Marine Fisheries

March 2022

Annual Performance Report

STATE: Rhode Island

PROJECT NUMBER: F-61-R  
SEGMENT NUMBER: 21

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, 2022 – December 31, 2022.

PROJECT SUMMARY: Job 1, summary accomplished:

A: 156 twenty-minute bottom trawls were successfully completed.

B: Data on weight, length, sex and numbers were gathered on 66 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 2022

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) 2022

PROJECT SUMMARY: Job 2, summary accomplished:

A: 44, twenty-minute tows were successfully completed during the Spring 2022 survey (26 NB. – 6 RIS – 12 BIS).

B: 44, twenty-minute tow were successfully completed during the Fall 2022 survey (26 NB. – 6 RIS – 12 BIS)

C: Data on weight, length, sex and numbers were gathered on

62 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 2022.

SCHEDULE OF PROGRESS: On schedule.

SIGNIFICANT DEVIATIONS: None

JOBS 1 & 2

RECOMMENDATIONS: Continuation of both the Monthly and Seasonal Trawl surveys into 2023, 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: 156 tows were completed during 2022 Job 1 (Monthly survey). 66 species accounted for a combined weight of 9065.12 kgs. and 537,747 length measurements being added to the existing Narragansett Bay monthly trawl data set  
By contrast, 88 tows were completed during 2022 Job 2 (Seasonal survey) 62 species accounted for a combined weight of 6035.38 kgs. and 458,031 length measurements added to the existing seasonal data set.

With the completion of the 2022 surveys, combined survey(s) Jobs (1&2) data now reflects the completion of 7,781 tows with data collected on 150 species over the entire timeseries.

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Principal Investigator  
Date

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RIDEM – Division of Marine Fisheries  
Date

## 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), 7,781 tows have been conducted within Rhode Island territorial waters with data collected on 150 species. This performance report reflects the efforts of the 2022 survey year as it relates to the past 43 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. 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

<b>Area</b>	<b>Stratum</b>	<b>Area nm<sup>2</sup></b>	<b>Depth Range (m)</b>
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 (g/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**



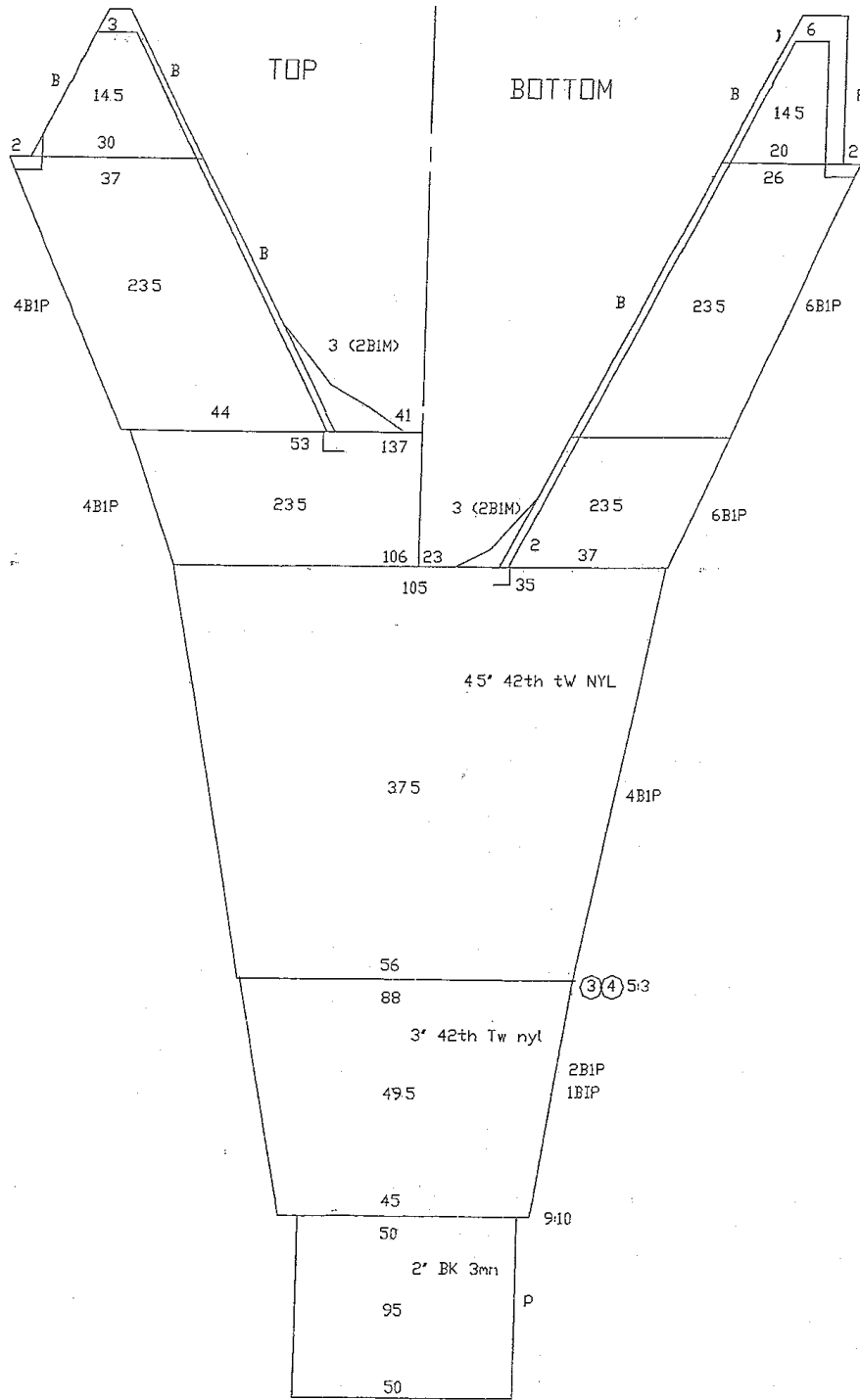
#### **Acknowledgements:**

Special thanks are again extended to Captain Patrick Brown and Assistant Captain Sean Fitzgerald, and the entire seasonal staff and volunteers. The support given over the years has been greatly appreciated.

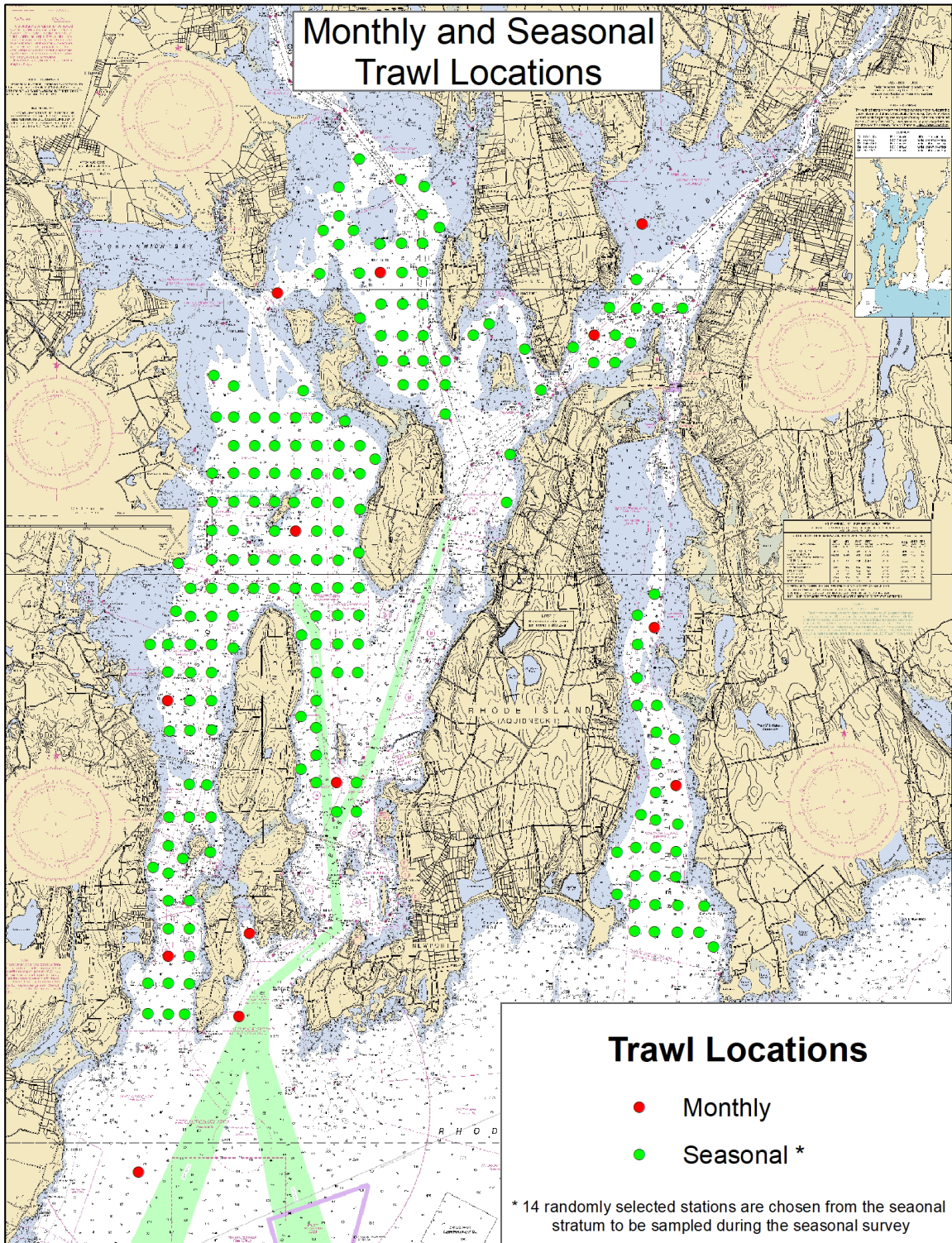


Figure 1

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

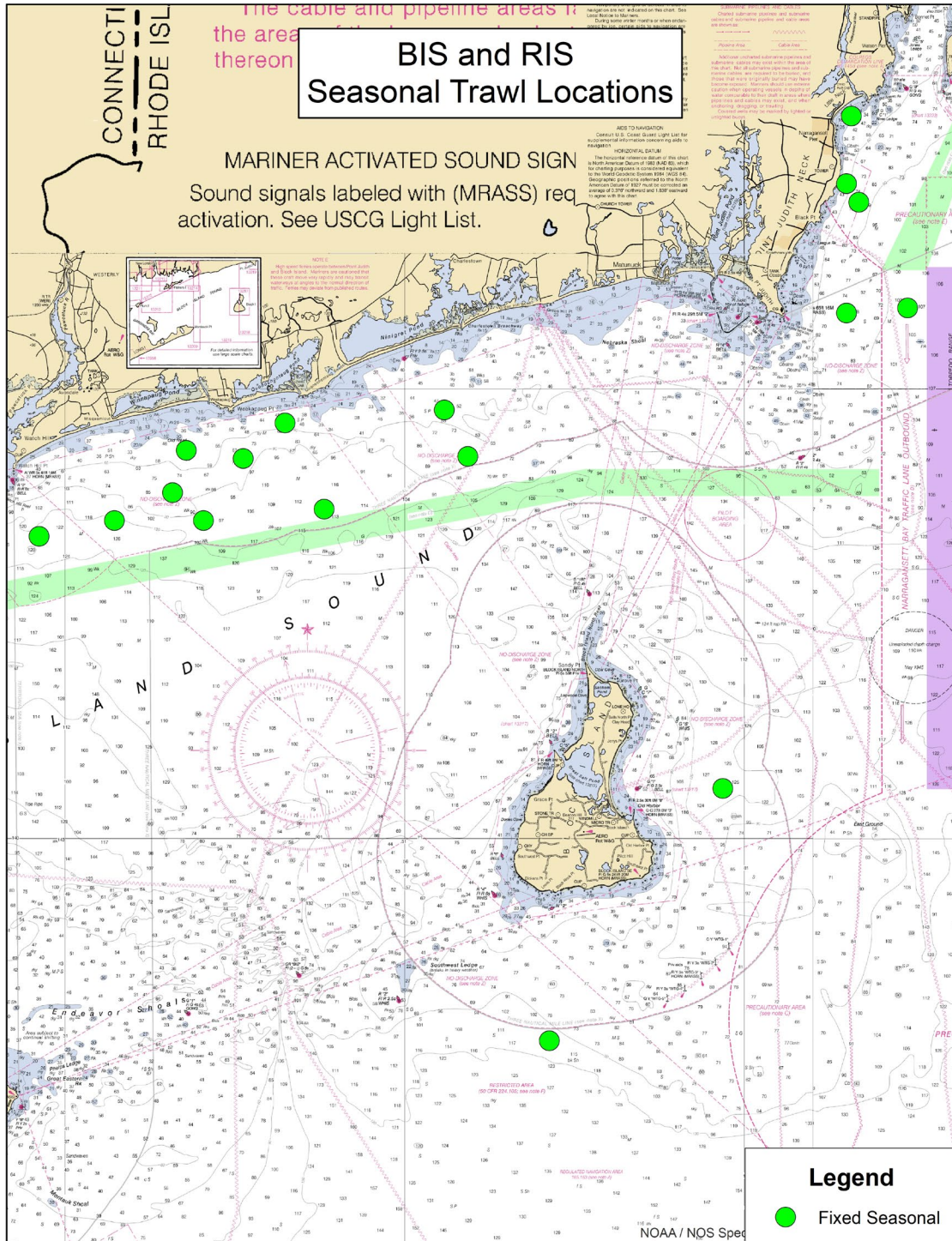


**Map 1: Monthly (fixed) and Seasonal (grid) Stations in Narragansett Bay**





Map 2: Seasonal Fixed Stations in Rhode Island Sound and Block Island Sound



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

A total of 66 species were observed and recorded during the 2022 Narragansett Bay Monthly Trawl Survey totaling 537,747 individuals or 3447.09 fish per tow. In weight, the catch accounted for 9065.12 kg. or 58.1 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 and shows a clear shift from demersal species to a more pelagic or multi-habitat species.

**Figure 2 (Total Catch in Number)**

Scientific Name	Common Name	Total #
ANCHOA MITCHILLI	Bay Anchovy	160779
STENOTOMUS CHRYSOPS	Scup	137155
BREVOORTIA TYRANNUS	Atlantic Menhaden	104340
PEPRILUS TRIACANTHUS	Butterfish	30883
DORYTEUTHIS PEALEII	Longfin Squid	24801
CLUPEA HARENGUS	Atlantic Herring	24537
CYNOSCION REGALIS	Weakfish	23347
MENIDIA MENIDIA	Atlantic Silverside	18238
ALOSA PSEUDOHARENGUS	Alewife	6810
SELENE SETAPINNIS	Atlantic Moonfish	2518
UROPHYCIS REGIA	Spotted Hake	908
CENTROPRISTIS STRIATA	Black Sea Bass	621
ALOSA AESTIVALIS	Blueback Herring	507
MERLUCCIIUS BILINEARIS	Silver Hake	432
MENTICIRRHUS SAXATILIS	Northern Kingfish	395
PLEURONECTES AMERICANUS	Winter Flounder	152
LEUCORAJA ERINACEA	Little Skate	127
SQUALUS ACANTHIAS	Spiny Dogfish	117
UROPHYCIS CHUSS	Red Hake	112
POMATOMUS SALTATRIX	Bluefish	96
CANCER IRRORATUS	Rock Crab	91
PRIONOTUS EVOLANS	Striped Sea Robin	87
TAUTOGA ONITIS	Tautog	85
MUSTELUS CANIS	Smooth Dogfish	74
HOMARUS AMERICANUS	American Lobster	71
TRACHURUS LATHAMI	Rough Scad	69
GADUS MORHUA	Atlantic Cod	56
PRIONOTUS CAROLINUS	Northern Sea Robin	50
PARALICHTHYS DENTATUS	Summer Flounder	48
ALOSA SAPIDISSIMA	American Shad	23
CITHARICHTHYS ARCTIFRONS	Gulfstream Flounder	22

BUSYCOTYPUS CANALICULATUS	Channeled Whelk	20
MORONE SAXATILIS	Striped Bass	17
SCOPHTHALMUS AQUOSUS	Windowpane Flounder	15
RAJA EGLANTERIA	Clearnose Skate	14
AMMODYTES AMERICANUS	Sand Lance	14
DOROSOMA CEPEDIANUM	Gizzard Shad	14
SCOMBER SCOMBRUS	Atlantic Mackerel	11
SQUILLA EMPUSA	Mantis Shrimp	9
CALLINECTES SAPIDUS	Blue Crab	7
CANCER BOREALIS	Jonah Crab	7
MYOXOCEPHALUS		
OCTODECEMSPINOS	Longhorn Sculpin	6
MULLUS AURATUS	Red Goatfish	6
BUSYCON CARICA	Knobbed Whelk	6
PARALICHTHYS OBLONGUS	Fourspot Flounder	5
SPHOEROIDES MACULATUS	Northern Puffer	5
LIMULUS POLYPHEMUS	Horseshoe Crab	5
LEUCORAJA OCELLATA	Winter Skate	4
TAUTOGOLABRUS ADSPERSUS	Cunner	4
PETROMYZON MARINUS	Sea Lamprey	3
CARANX CRYSOS	Blue Runner	3
SYNGNATHUS FUSCUS	Northern Pipefish	2
MORONE AMERICANA	White Perch	2
MACROZOARCES AMERICANUS	Ocean Pout	2
MICROGADUS TOMCOD	Atlantic Tomcod	2
ROSSIA MOELLERI	Bobtail Squid	2
GOBIIDAE	Gobies	2
SQUATINA DUMERIL	Atlantic Angel Shark	1
ANCHOA HEPSETUS	Striped Anchovy	1
ETROPUS MICROSTOMUS	Smallmouth Flounder	1
LEIOSTOMUS XANTHURUS	Spot	1
MYOXOCEPHALUS AENAEUS	Grubby Sculpin	1
RHINOPTERA BONASUS	Cownose Eagle Ray	1
APELTES QUADRACUS	Fourspine Stickleback	1
ALECTIS CILIARIS	African Pompano	1
ALUTERUS SCHOEPFI	Orange Filefish	1

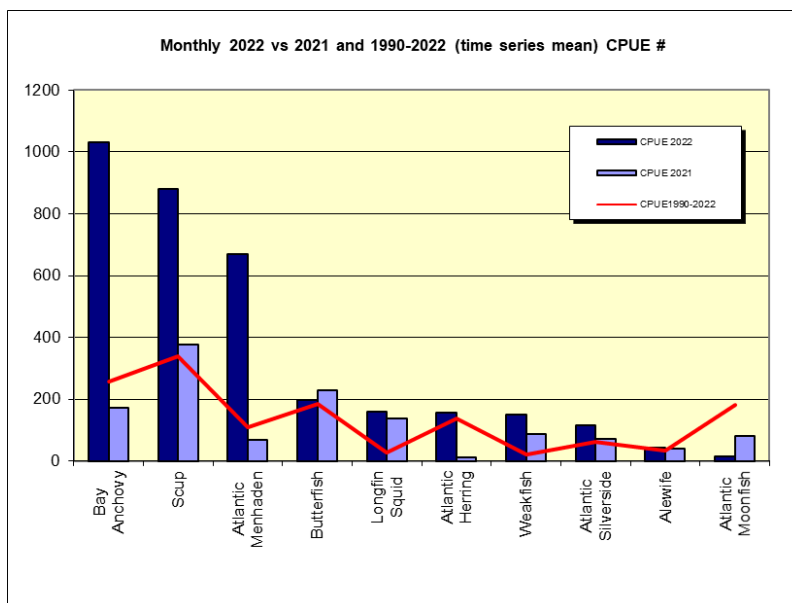
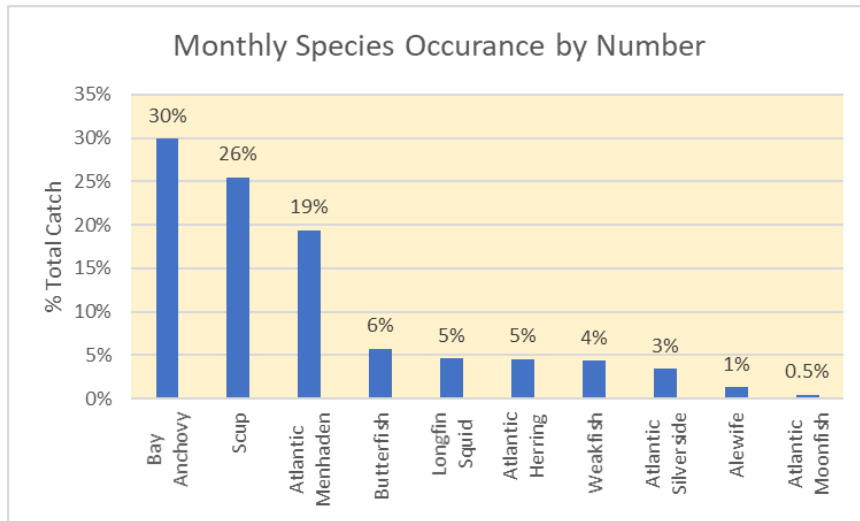
**Figure 3 (Total Catch in Kilograms)**

Scientific Name	Common Name	Total Weight (kg)
STENOTOMUS CHRYSOPS	Scup	5979.02
PEPRILUS TRIACANTHUS	Butterfish	750.08
DORYTEUTHIS PEALEII	Longfin Squid	485.35
BREVOORTIA TYRANNUS	Atlantic Menhaden	357.65
CYNOSCION REGALIS	Weakfish	246.67
CLUPEA HARENGUS	Atlantic Herring	202.49
ALOSA PSEUDOHARENGUS	Alewife	141.12
TAUTOGA ONITIS	Tautog	113.54
ANCHOA MITCHILLI	Bay Anchovy	113.17
CENTROPRISTIS STRIATA	Black Sea Bass	109.78
MUSTELUS CANIS	Smooth Dogfish	96.37
LEUCORAJA ERINACEA	Little Skate	67.32
MENIDIA MENIDIA	Atlantic Silverside	56.79
PARALICHTHYS DENTATUS	Summer Flounder	40.97
MORONE SAXATILIS	Striped Bass	37.87
PRIONOTUS EVOLANS	Striped Sea Robin	30.96
HOMARUS AMERICANUS	American Lobster	27.94
PLEURONECTES AMERICANUS	Winter Flounder	23.32
RAJA EGLANTERIA	Clearnose Skate	21.78
SQUALUS ACANTHIAS	Spiny Dogfish	20.12
SQUATINA DUMERIL	Atlantic Angel Shark	20.00
MERLUCCIIUS BILINEARIS	Silver Hake	16.43
MENTICIRRHUS SAXATILIS	Northern Kingfish	16.16
CANCER IRRORATUS	Rock Crab	15.65
LIMULUS POLYPHEMUS	Horseshoe Crab	10.73
PRIONOTUS CAROLINUS	Northern Sea Robin	10.02
SELENE SETAPINNIS	Atlantic Moonfish	8.53
POMATOMUS SALTATRIX	Bluefish	7.57
UROPHYCIS CHUSS	Red Hake	5.25
ALOSA AESTIVALIS	Blueback Herring	4.62
BUSYCOTYPUS CANALICULATUS	Channeled Whelk	3.96
UROPHYCIS REGIA	Spotted Hake	3.35
SCOPHTHALMUS AQUOSUS	Windowpane Flounder	2.79
MYOXOCEPHALUS		
OCTODECEMSPINOS	Longhorn Sculpin	2.22
MACROZOARCES AMERICANUS	Ocean Pout	1.48
CANCER BOREALIS	Jonah Crab	1.40
SCOMBER SCOMBRUS	Atlantic Mackerel	1.31
RHINOPTERA BONASUS	Cownose Eagle Ray	1.30

CALLINECTES SAPIDUS	Blue Crab	1.24
GADUS MORHUA	Atlantic Cod	1.22
TAUTOGOLABRUS ADSPERSUS	Cunner	1.20
LEUCORAJA OCELLATA	Winter Skate	1.09
PARALICHTHYS OBLONGUS	Fourspot Flounder	0.99
BUSYCON CARICA	Knobbed Whelk	0.86
TRACHURUS LATHAMI	Rough Scad	0.72
ALOSA SAPIDISSIMA	American Shad	0.53
DOROSOMA CEPEDIANUM	Gizzard Shad	0.46
MULLUS AURATUS	Red Goatfish	0.42
CITHARICHTHYS ARCTIFRONS	Gulfstream Flounder	0.30
SQUILLA EMPUSA	Mantis Shrimp	0.29
CARANX CRYSOS	Blue Runner	0.13
SPHOEROIDES MACULATUS	Northern Puffer	0.13
LEIOSTOMUS XANTHURUS	Spot	0.09
ALECTIS CILIARIS	African Pompano	0.09
ALUTERUS SCHOEPFI	Orange Filefish	0.09
AMMODYTES AMERICANUS	Sand Lance	0.09
MORONE AMERICANA	White Perch	0.03
PETROMYZON MARINUS	Sea Lamprey	0.02
MYOXOCEPHALUS AENAEUS	Grubby Sculpin	0.02
ETROPUS MICROSTOMUS	Smallmouth Flounder	0.02
ANCHOA HEPSETUS	Striped Anchovy	0.01
ROSSIA MOELLERI	Bobtail Squid	0.01
SYNGNATHUS FUSCUS	Northern Pipefish	0.01
MICROGADUS TOMCOD	Atlantic Tomcod	0.004
GOBIIDAE	Gobies	0.002
APELTES QUADRACUS	Fourspine Stickleback	0.001

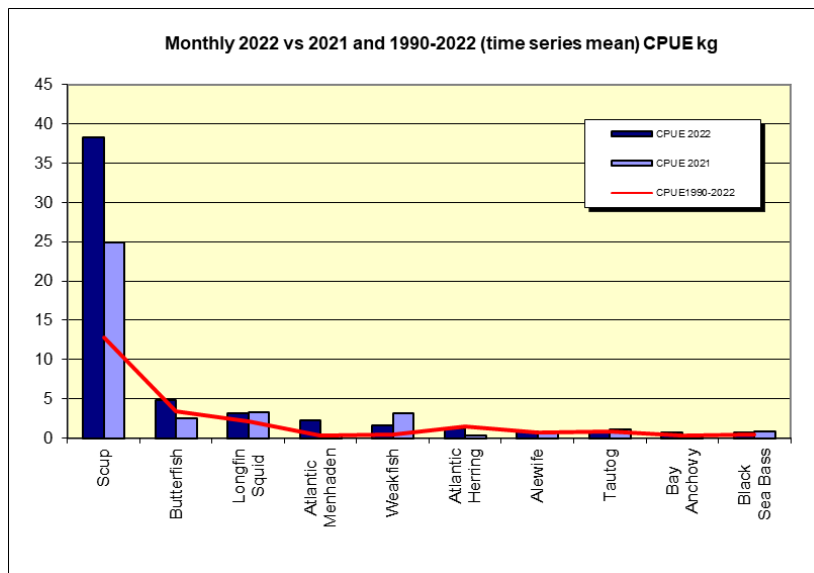
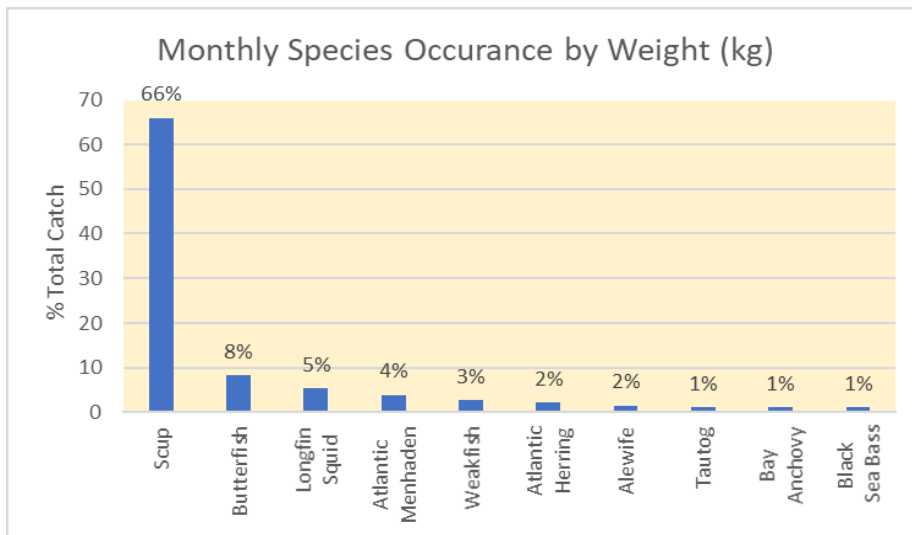
**Figure 4 Monthly Survey Top Ten Species Catch in Number**

Scientific Name	Common Name	%
ANCHOA MITCHILLI	Bay Anchovy	29.90%
STENOTOMUS CHRYSOPS	Scup	25.51%
BREVOORTIA TYRANNUS	Atlantic Menhaden	19.40%
PEPRILUS TRIACANTHUS	Butterfish	5.74%
DORYTEUTHIS PEALEII	Longfin Squid	4.61%
CLUPEA HARENGUS	Atlantic Herring	4.56%
CYNOSCION REGALIS	Weakfish	4.34%
MENIDIA MENIDIA	Atlantic Silverside	3.39%
ALOSA PSEUDOHARENGUS	Alewife	1.27%
SELENE SETAPINNIS	Atlantic Moonfish	0.47%



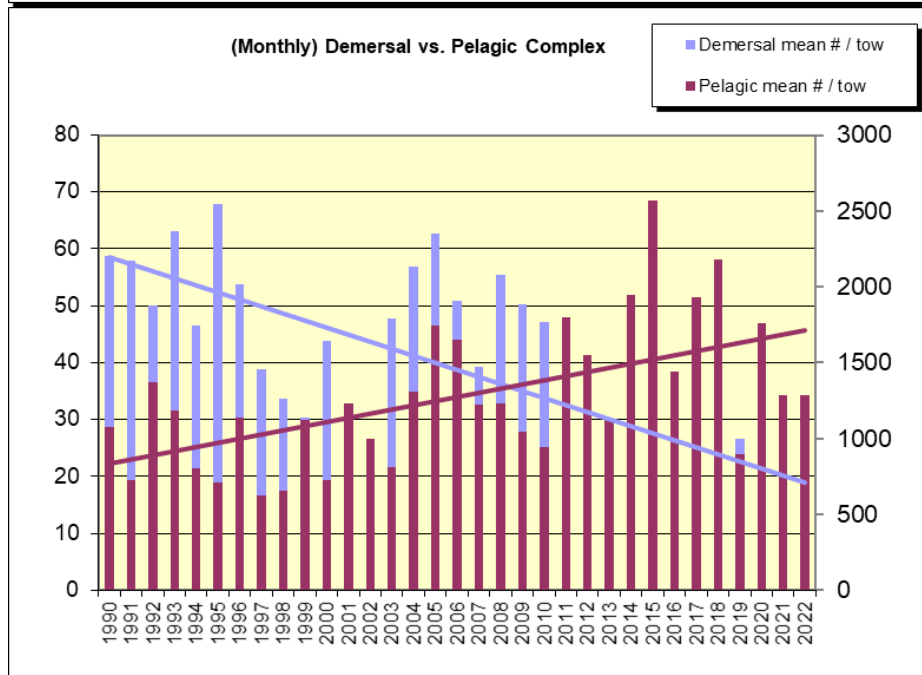
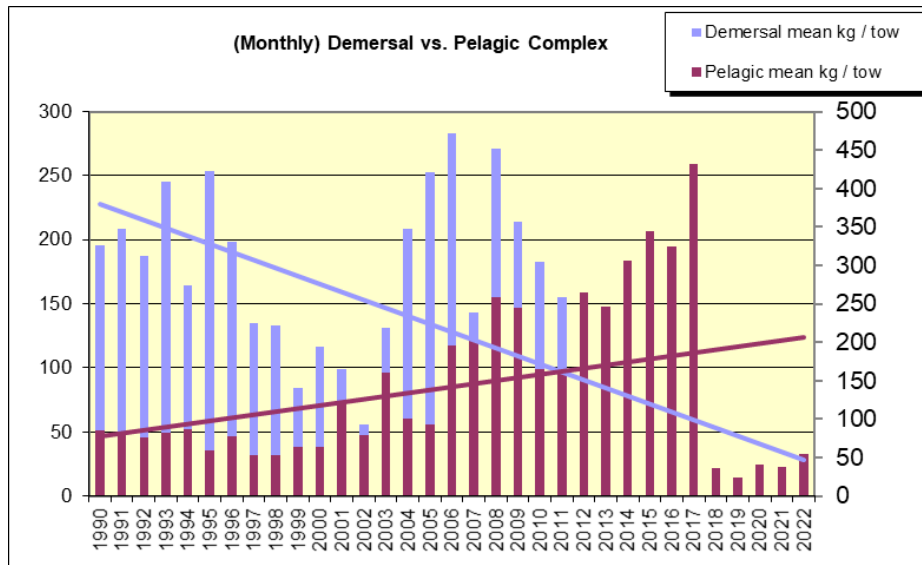
**Figure 5 Top Ten Species Catch in Kilograms**

Scientific Name	Common Name	%
STENOTOMUS CHRYSOPS	Scup	65.96%
PEPRILUS TRIACANTHUS	Butterfish	8.27%
DORYTEUTHIS PEALEII	Longfin Squid	5.35%
BREVOORTIA TYRANNUS	Atlantic Menhaden	3.95%
CYNOSCION REGALIS	Weakfish	2.72%
CLUPEA HARENGUS	Atlantic Herring	2.23%
ALOSA PSEUDOHARENGUS	Alewife	1.56%
TAUTOGA ONITIS	Tautog	1.25%
ANCHOA MITCHILLI	Bay Anchovy	1.25%
CENTROPRESTIS STRIATA	Black Sea Bass	1.21%



**Figure 6 and 7: Demersal vs. Pelagic Species Complex**

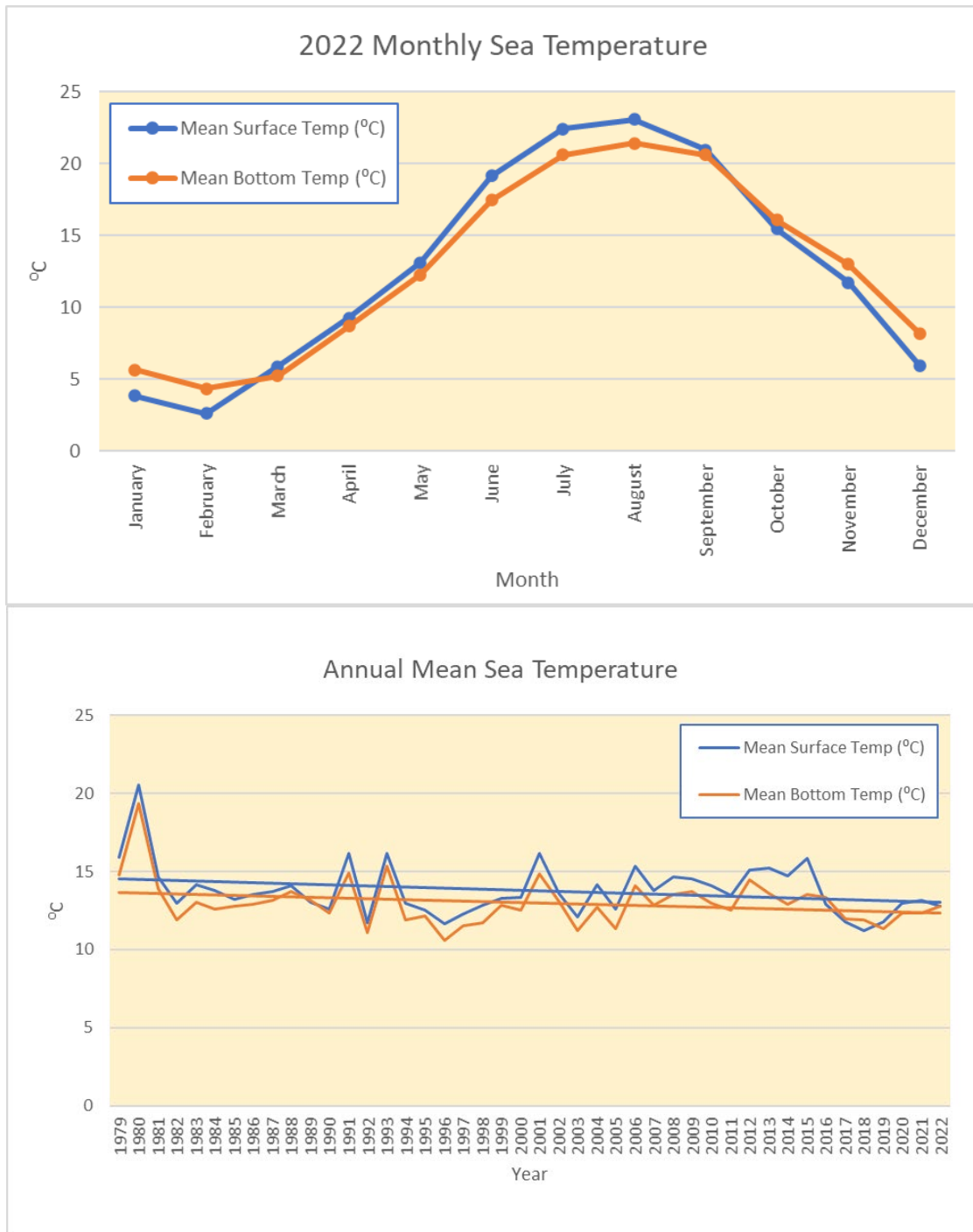
Demersal Species		Pelagic/Multi-Habitat Species	
Smooth Dogfish	Hogchoker	Atlantic Herring	Bluefish
Spiny Dogfish	Longhorn Sculpin	Alewife	Striped Bass
Skates	Sea Raven	Blueback Herring	Black Sea Bass
Silver Hake	Northern Searobin	Shad	Scup
Red Hake	Striped Searobin	Menhaden	Weakfish
Spotted Hake	Cunner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





## Monthly Survey Temperature Profile (Annual mean surface and bottom temperature)

Surface and bottom temperatures are collected at every station. The bottom temperature was collected by Niskin bottle until June 2019 at the average or maximum depth for each station. From June 2019 onward bottom temperature is the average over an entire tow as record by a Starmon TD® temperature and depth sensor attached to the footrope of the net.



**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. 62 species were observed and recorded during the 2022 Rhode Island Seasonal Trawl Survey, totaling 458,031 individuals or 5204.89 fish per tow. In weight, the catch accounted for 6035.38 kg. or 68.58 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 and shows a clear shift from demersal species to a more pelagic or multi-habitat species.

**Figure 8 (Total Catch in Number)**

Scientific Name	Common Name	Total #
STENOTOMUS CHRYSOPS	Scup	183519
BREVOORTIA TYRANNUS	Atlantic Menhaden	98428
ANCHOA MITCHILLI	Bay Anchovy	92234
PEPRILUS TRIACANTHUS	Butterfish	35185
CLUPEA HARENGUS	Atlantic Herring	16303
DORYTEUTHIS PEALEII	Longfin Squid	14085
CYNOSCION REGALIS	Weakfish	8940
SELENE SETAPINNIS	Atlantic Moonfish	3833
ALOSA PSEUDOHARENGUS	Alewife	1777
POMATOMUS SALTATRIX	Bluefish	1543
PRIONOTUS CAROLINUS	Northern Sea Robin	365
CENTROPRISTIS STRIATA	Black Sea Bass	301
LEUCORAJA ERINACEA	Little Skate	162
MENTICIRRHUS SAXATILIS	Northern Kingfish	162
MERLUCCIOUS BILINEARIS	Silver Hake	145
GADUS MORHUA	Atlantic Cod	119
PLEURONECTES AMERICANUS	Winter Flounder	119
ALOSA AESTIVALIS	Blueback Herring	75
UROPHYCIS CHUSS	Red Hake	63
PARALICHTHYS DENTATUS	Summer Flounder	63
UROPHYCIS REGIA	Spotted Hake	55
MUSTELUS CANIS	Smooth Dogfish	54
LEUCORAJA OCELLATA	Winter Skate	53
MENIDIA MENIDIA	Atlantic Silverside	53
TAUTOGA ONITIS	Tautog	47
CITHARICHTHYS ARCTIFRONS	Gulfstream Flounder	43
SPHOEROIDES MACULATUS	Northern Puffer	36
PRIONOTUS EVOLANS	Striped Sea Robin	32
CANCER IRRORATUS	Rock Crab	31
HOMARUS AMERICANUS	American Lobster	28

TRACHURUS LATHAMI	Rough Scad	16
AMMODYTES AMERICANUS	Sand Lance	14
ANCHOA HEPSETUS	Striped Anchovy	13
SQUALUS ACANTHIAS	Spiny Dogfish	11
DOROSOMA CEPEDIANUM	Gizzard Shad	11
SCOPHTHALMUS AQUOSUS	Windowpane Flounder	10
CARANX CRYSOS	Blue Runner	10
SELAR CRUMENOPHTHALMUS	Bigeye Scad	10
ALOSA SAPIDISSIMA	American Shad	9
MACROZOARCES AMERICANUS	Ocean Pout	8
SPHYRAENA BOREALIS	Northern Sennet	8
RAJA EGLANTERIA	Clearnose Skate	7
SCOMBER SCOMBRUS	Atlantic Mackerel	7
MORONE SAXATILIS	Striped Bass	6
SQUILLA EMPUSA	Mantis Shrimp	5
BUSYCOTYPUS CANALICULATUS	Channeled Whelk	4
CANCER BOREALIS	Jonah Crab	4
DIPTURUS LAEVIS	Barndoor Skate	3
ALOSA MEDIOCRIS	Hickory Shad	3
LIMULUS POLYPHEMUS	Horseshoe Crab	3
PARALICHTHYS OBLONGUS	Fourspot Flounder	2
ETROPUS MICROSTOMUS	Smallmouth Flounder	2
FISTULARIA TABACARIA	Cornetfish	2
ALECTIS CILIARIS	African Pompano	2
PETROMYZON MARINUS	Sea Lamprey	1
SYNGNATHUS FUSCUS	Northern Pipefish	1
PRIACANTHUS ARENATUS	Bigeye	1
MYOXOCEPHALUS		
OCTODECEMSPINOS	Longhorn Sculpin	1
TAUTOGOLABRUS ADSPERSUS	Cunner	1
PLACOPECTEN MAGELLANICUS	Atlantic Sea Scallop	1
LAGODON RHOMBOIDES	Pinfish	1
BUSYCON CARICA	Knobbed Whelk	1

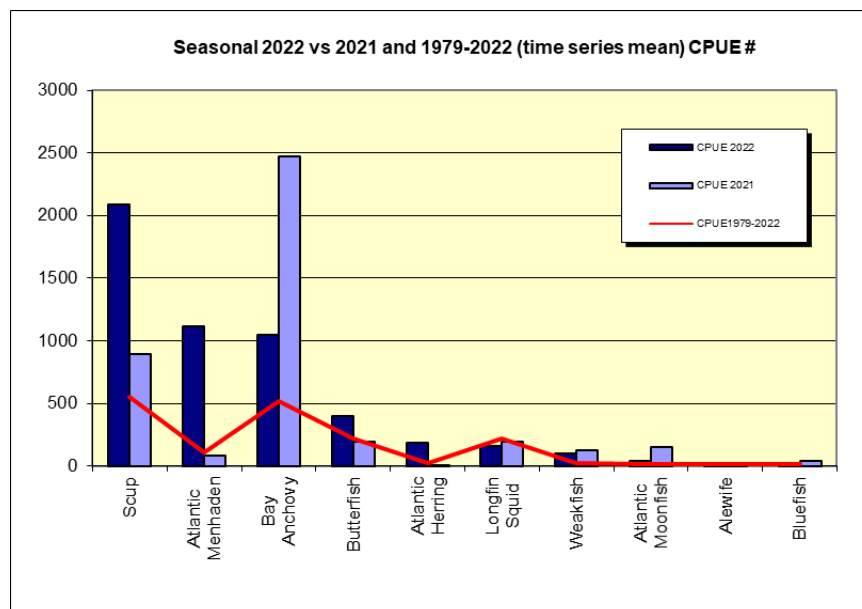
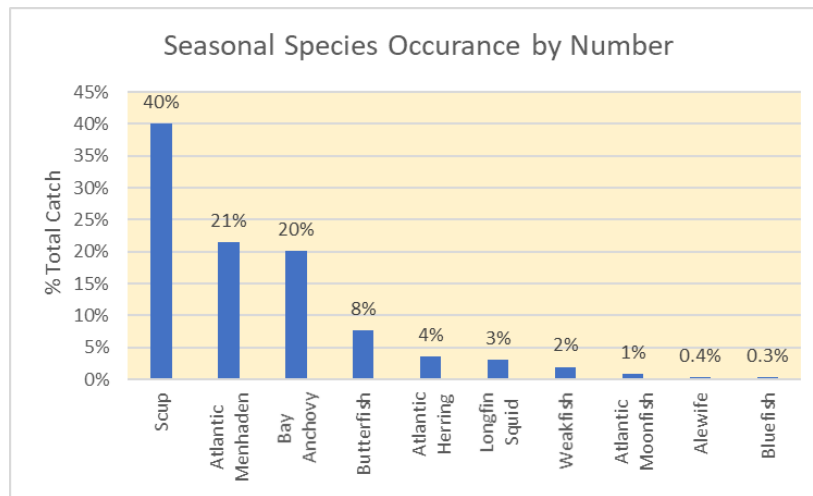
**Figure 9 (Total Catch in Kilograms)**

Scientific Name	Common Name	Total Weight (kg)
STENOTOMUS CHRYSOPS	Scup	3564.77
PEPRILUS TRIACANTHUS	Butterfish	625.64
DORYTEUTHIS PEALEII	Longfin Squid	492.15
BREVOORTIA TYRANNUS	Atlantic Menhaden	428.06
CYNOSCIION REGALIS	Weakfish	192.43
ANCHOA MITCHILLI	Bay Anchovy	86.35
LEUCORAJA ERINACEA	Little Skate	79.18
MUSTELUS CANIS	Smooth Dogfish	74.50
PRIONOTUS CAROLINUS	Northern Sea Robin	56.86
TAUTOGA ONITIS	Tautog	56.75
CENTROPRISTIS STRIATA	Black Sea Bass	51.51
PARALICHTHYS DENTATUS	Summer Flounder	50.99
ALOSA PSEUDOHARENGUS	Alewife	43.13
CLUPEA HARENGUS	Atlantic Herring	31.11
LEUCORAJA OCELLATA	Winter Skate	28.48
PLEURONECTES AMERICANUS	Winter Flounder	25.96
POMATOMUS SALTATRIX	Bluefish	23.74
SELENE SETAPINNIS	Atlantic Moonfish	15.05
PRIONOTUS EVOLANS	Striped Sea Robin	12.30
HOMARUS AMERICANUS	American Lobster	10.68
RAJA EGLANTERIA	Clearnose Skate	10.12
MORONE SAXATILIS	Striped Bass	9.33
LIMULUS POLYPHEMUS	Horseshoe Crab	8.47
MERLUCCIIUS BILINEARIS	Silver Hake	8.43
SQUALUS ACANTHIAS	Spiny Dogfish	8.28
MENTICIRRHUS SAXATILIS	Northern Kingfish	7.68
MACROZOARCES AMERICANUS	Ocean Pout	6.33
CANCER IRRORATUS	Rock Crab	4.64
UROPHYCIS CHUSS	Red Hake	3.79
ALOSA AESTIVALIS	Blueback Herring	2.30
ALOSA MEDIOCRIS	Hickory Shad	2.00
SCOPHTHALMUS AQUOSUS	Windowpane Flounder	1.97
DIPTURUS LAEVIS	Barndoor Skate	1.45
SPHOEROIDES MACULATUS	Northern Puffer	1.24
GADUS MORHUA	Atlantic Cod	1.16
SCOMBER SCOMBRUS	Atlantic Mackerel	0.89
CANCER BOREALIS	Jonah Crab	0.81
BUSYCOTYPUS CANALICULATUS	Channeled Whelk	0.80
UROPHYCIS REGIA	Spotted Hake	0.73

CITHARICHTHYS ARCTIFRONS	Gulfstream Flounder	0.71
CARANX CRYSOS	Blue Runner	0.62
SPHYRAENA BOREALIS	Northern Sennet	0.54
SELAR CRUMENOPHTHALMUS	Bigeye Scad	0.50
DOROSOMA CEPEDIANUM	Gizzard Shad	0.46
PARALICHTHYS OBLONGUS	Fourspot Flounder	0.35
MYOXOCEPHALUS		
OCTODECEMSPINOS	Longhorn Sculpin	0.32
ALOSA SAPIDISSIMA	American Shad	0.30
MENIDIA MENIDIA	Atlantic Silverside	0.29
TRACHURUS LATHAMI	Rough Scad	0.28
ALECTIS CILIARIS	African Pompano	0.24
SQUILLA EMPUSA	Mantis Shrimp	0.20
ANCHOA HEPSETUS	Striped Anchovy	0.16
AMMODYTES AMERICANUS	Sand Lance	0.10
LAGODON RHOMBOIDES	Pinfish	0.09
FISTULARIA TABACARIA	Cornetfish	0.06
BUSYCON CARICA	Knobbed Whelk	0.05
ETROPUS MICROSTOMUS	Smallmouth Flounder	0.03
PETROMYZON MARINUS	Sea Lamprey	0.02
PLACOPECTEN MAGELLANICUS	Atlantic Sea Scallop	0.01
PRIACANTHUS ARENATUS	Bigeye	0.01
SYNGNATHUS FUSCUS	Northern Pipefish	0.003
TAUTOGOLABRUS ADSPERSUS	Cunner	0.003

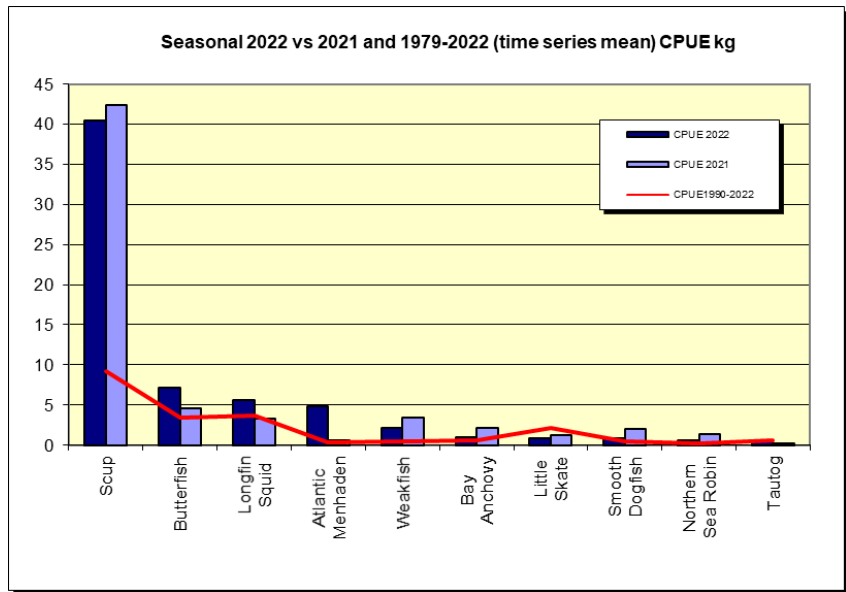
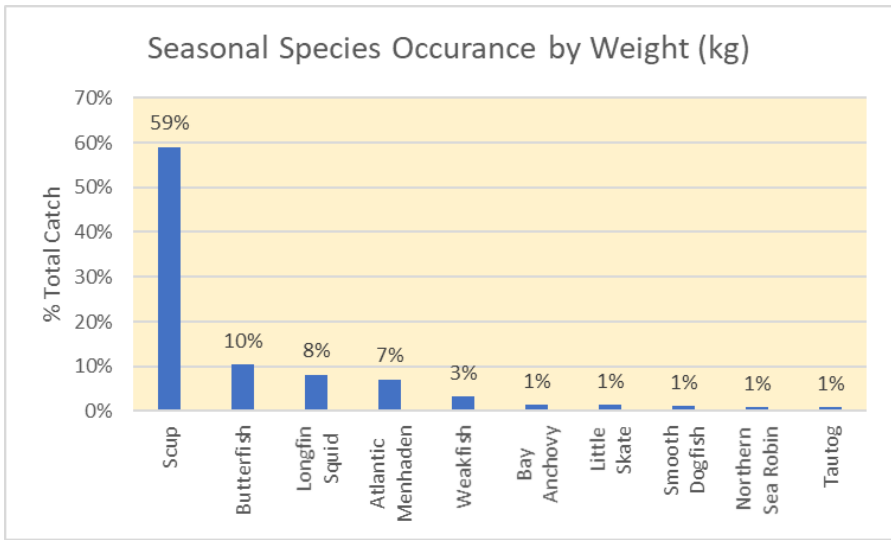
**Figure 10 Top Ten Species Catch in Number**

Scientific Name	Common Name	%
STENOTOMUS CHRYSOPS	Scup	40.07%
BREVOORTIA TYRANNUS	Atlantic Menhaden	21.49%
ANCHOA MITCHILLI	Bay Anchovy	20.14%
PEPRILUS TRIACANTHUS	Butterfish	7.68%
CLUPEA HARENGUS	Atlantic Herring	3.56%
DORYTEUTHIS PEALEII	Longfin Squid	3.08%
CYNOSCION REGALIS	Weakfish	1.95%
SELENE SETAPINNIS	Atlantic Moonfish	0.84%
ALOSA PSEUDOHARENGUS	Alewife	0.39%
POMATOMUS SALTATRIX	Bluefish	0.34%



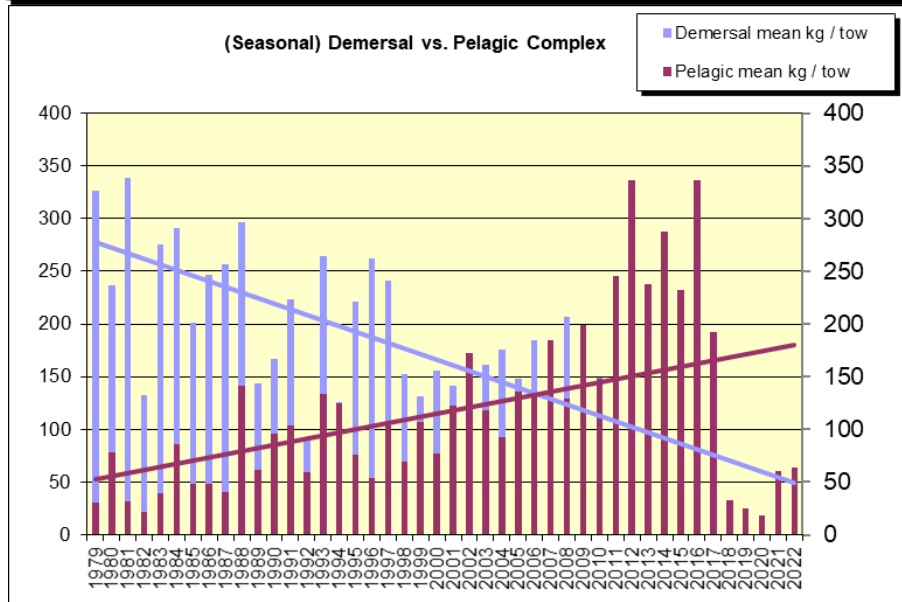
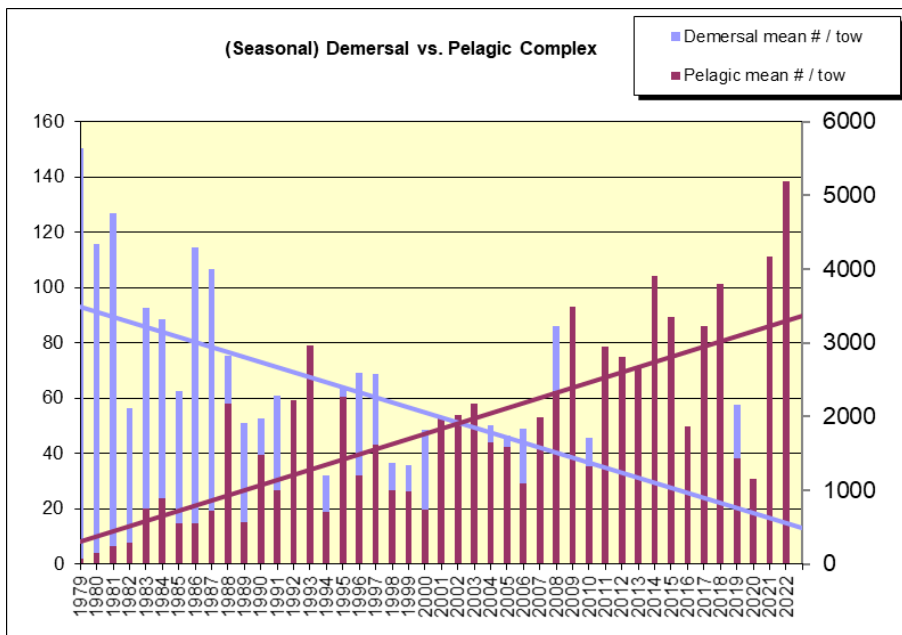
**Figure 11 Top Ten Species Catch in Kilograms**

Scientific Name	Common Name	%
STENOTOMUS CHRYSOPS	Scup	59.06%
PEPRILUS TRIACANTHUS	Butterfish	10.37%
DORYTEUTHIS PEALEII	Longfin Squid	8.15%
BREVOORTIA TYRANNUS	Atlantic Menhaden	7.09%
CYNOSCION REGALIS	Weakfish	3.19%
ANCHOA MITCHILLI	Bay Anchovy	1.43%
LEUCORAJA ERINACEA	Little Skate	1.31%
MUSTELUS CANIS	Smooth Dogfish	1.23%
PRIONOTUS CAROLINUS	Northern Sea Robin	0.94%
TAUTOGA ONITIS	Tautog	0.94%



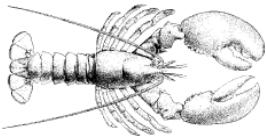
**Figure 12 and 13: Demersal vs. Pelagic Species Complex**

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



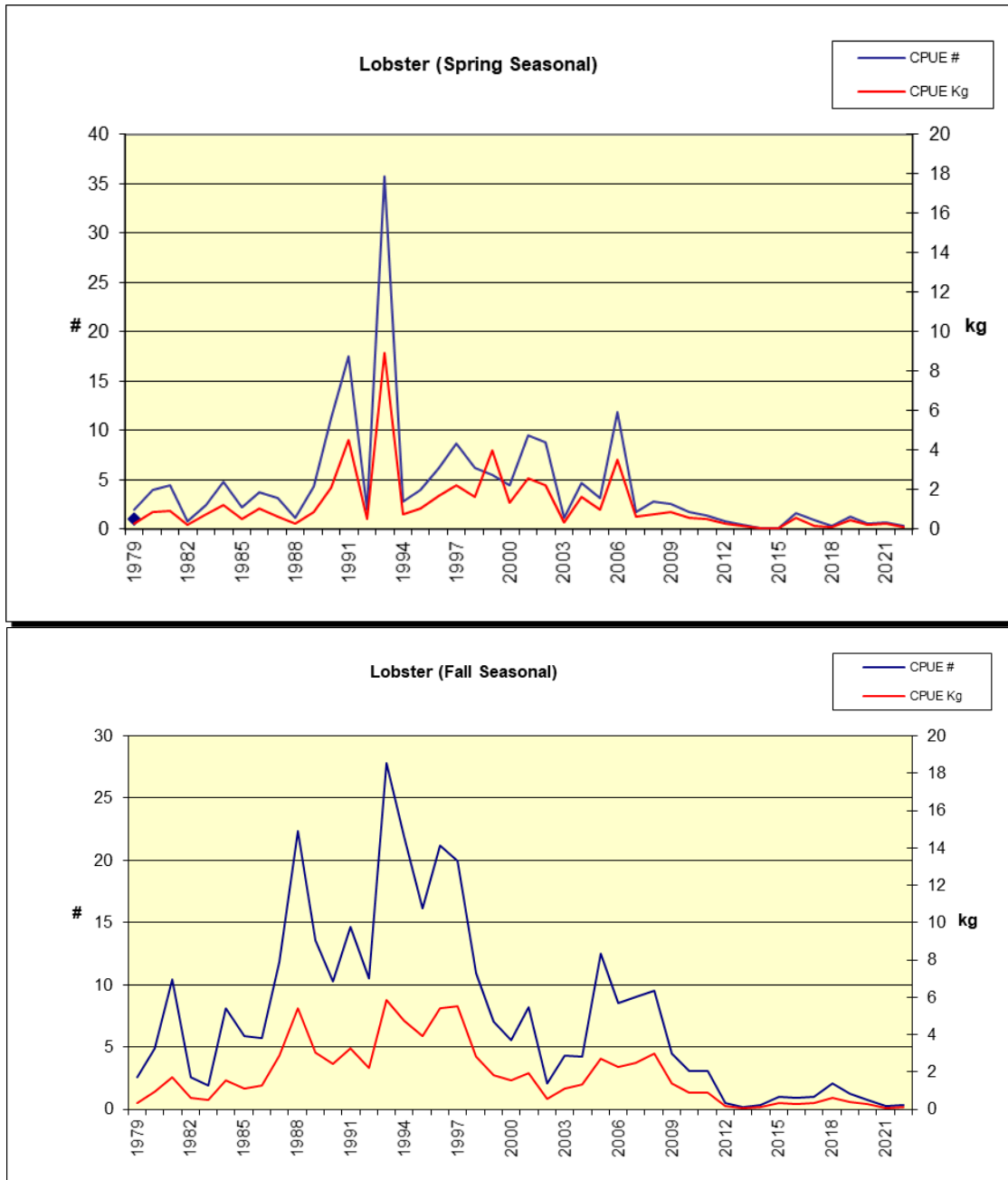


The following species represented are of high importance and are currently managed under fishery management plans through the Atlantic States Marine Fisheries Commission, New England Fishery Management Council, or the National Marine Fisheries Service. The seasonal portion of the Rhode Island Coastal 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*

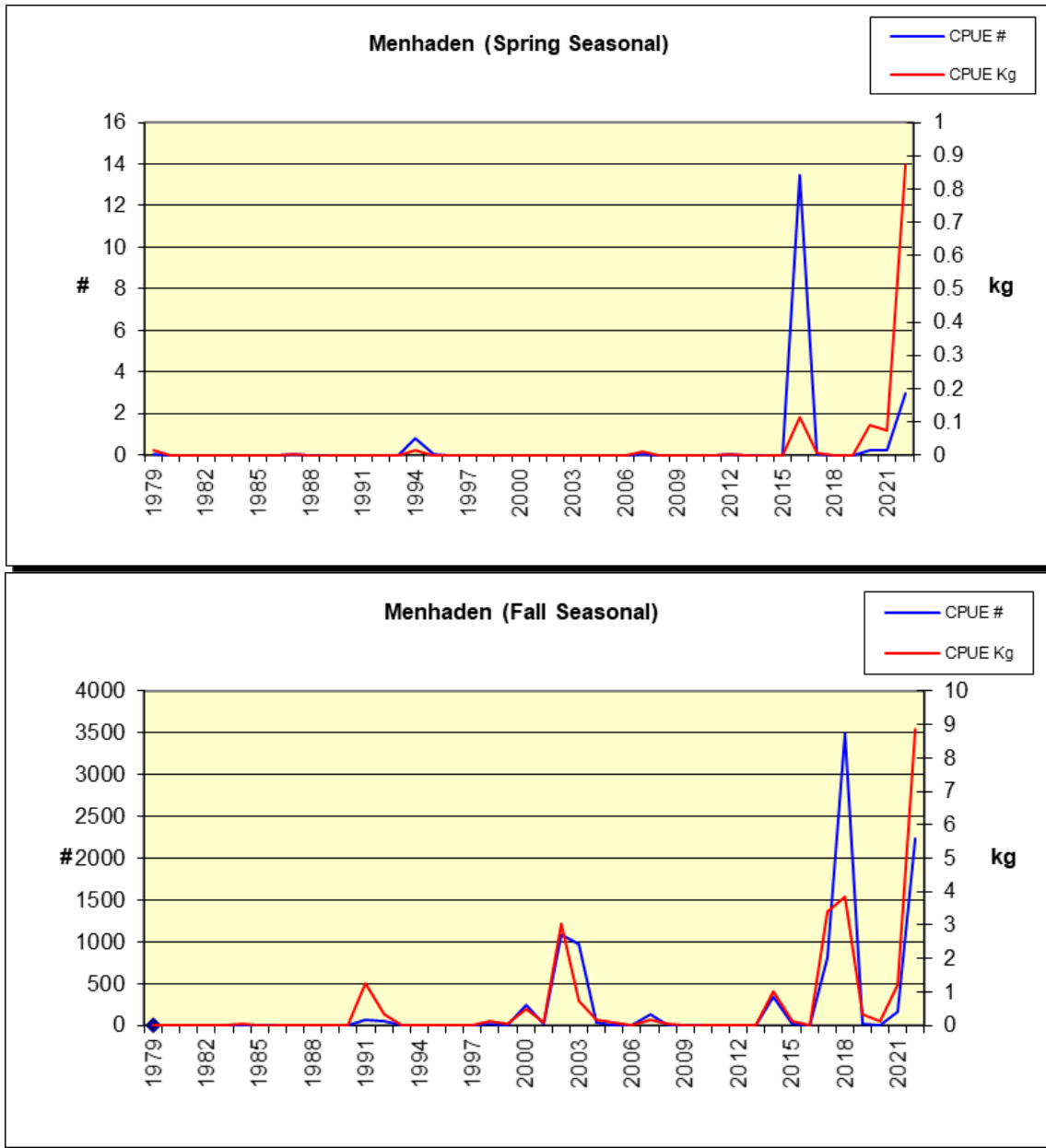
Stock Status: Southern New England Stock: overfished. Depleted Poor condition.  
Management: ASMFC Amendment III, Addendum XXVI





Atlantic Menhaden *Brevoortia tyrannus*

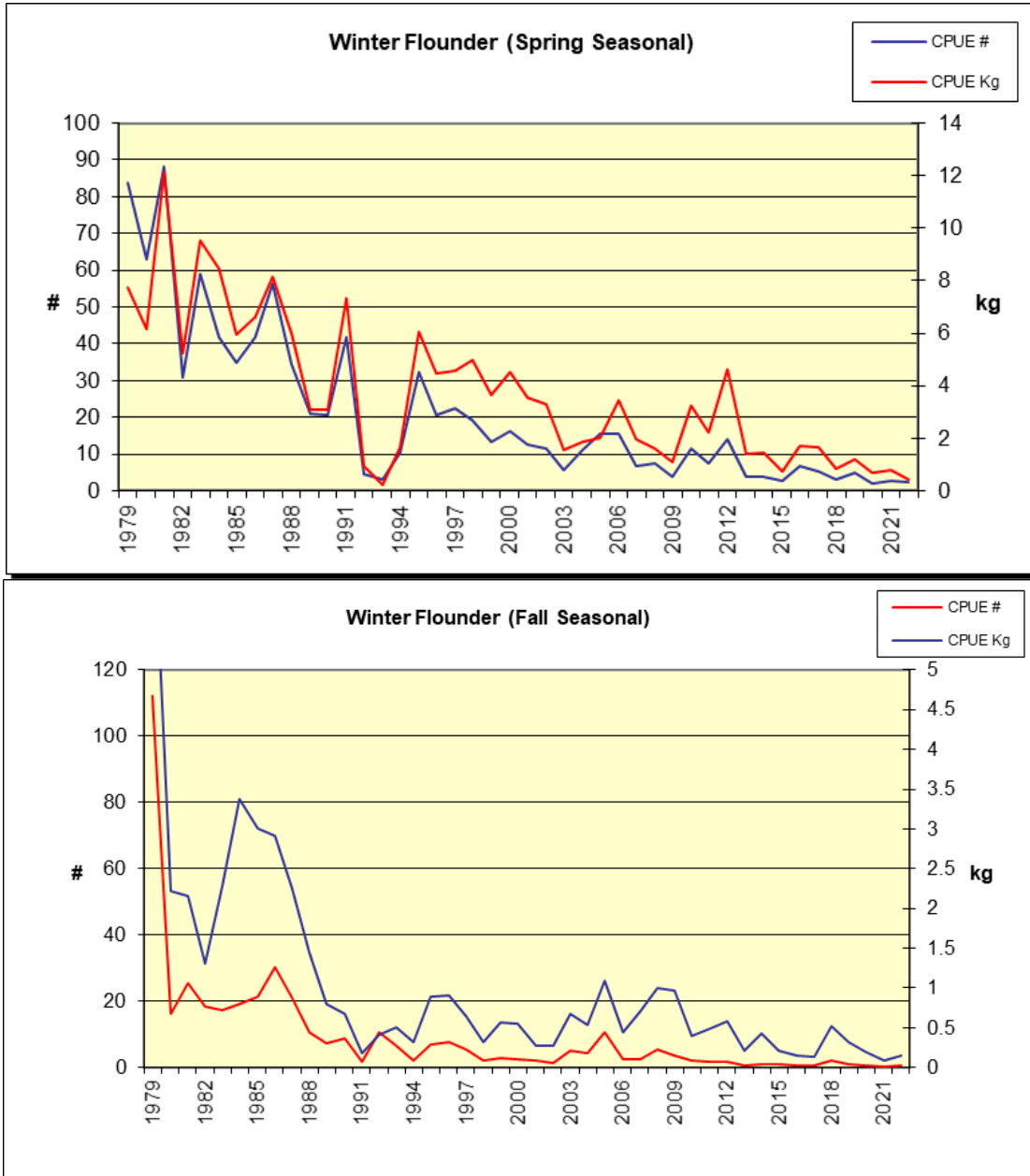
Stock Status: Not Overfished and overfishing is not occurring.  
Management: ASMFC Amendment III, Addendum I





Winter Flounder *Pleuronectes americanus*

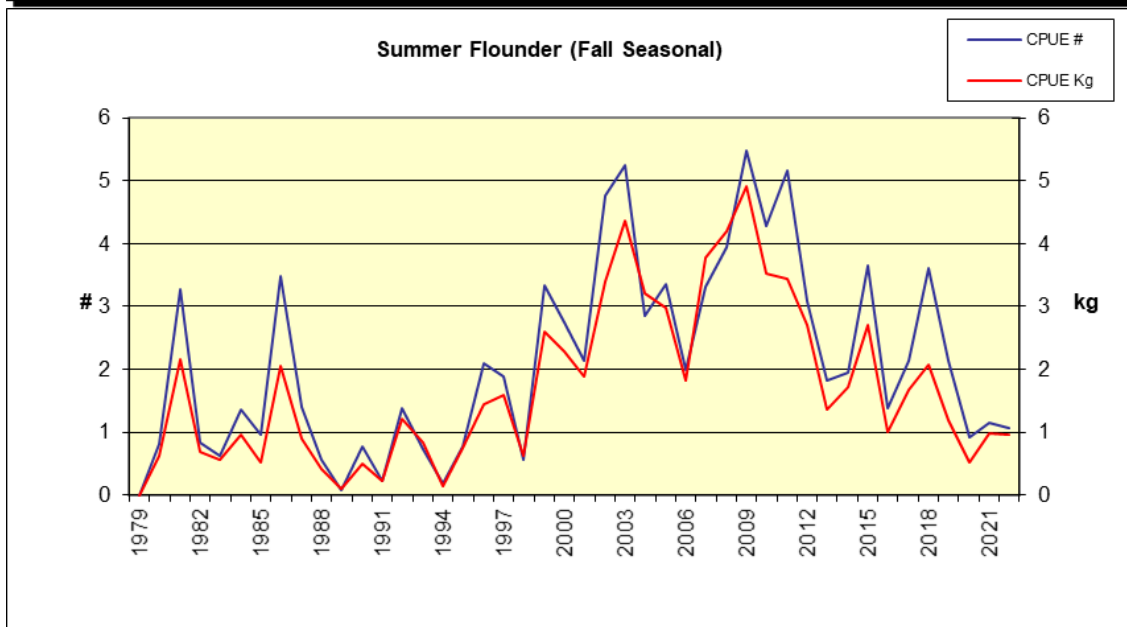
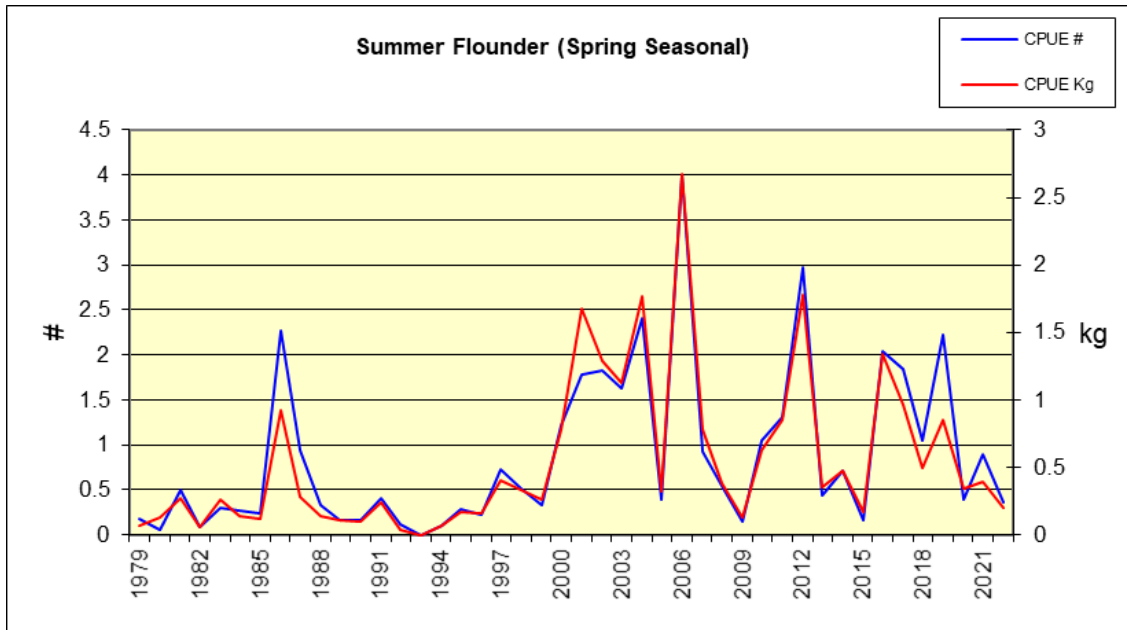
Stock Status: Overfished but overfishing is not occurring.  
Management: ASMFC Amendment I, Addendum III





Sumer Flounder *Paralichthys dentatus*

Stock Status: Not overfished and overfishing is occurring.  
Management: ASMFC Amendment XIII Addendum XXXII

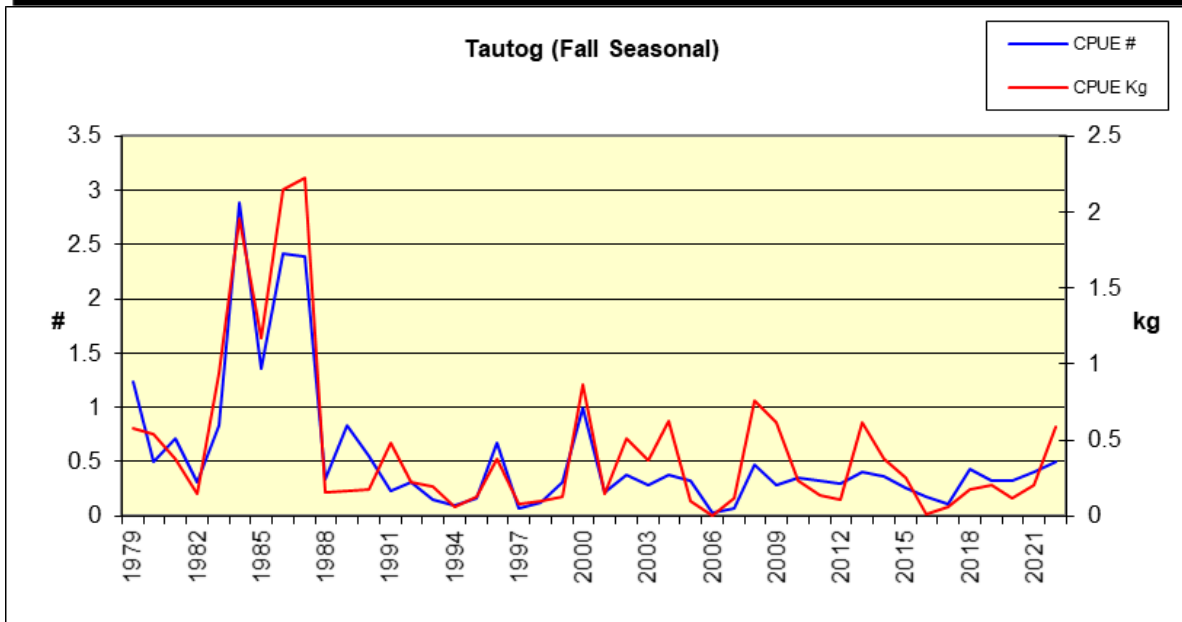
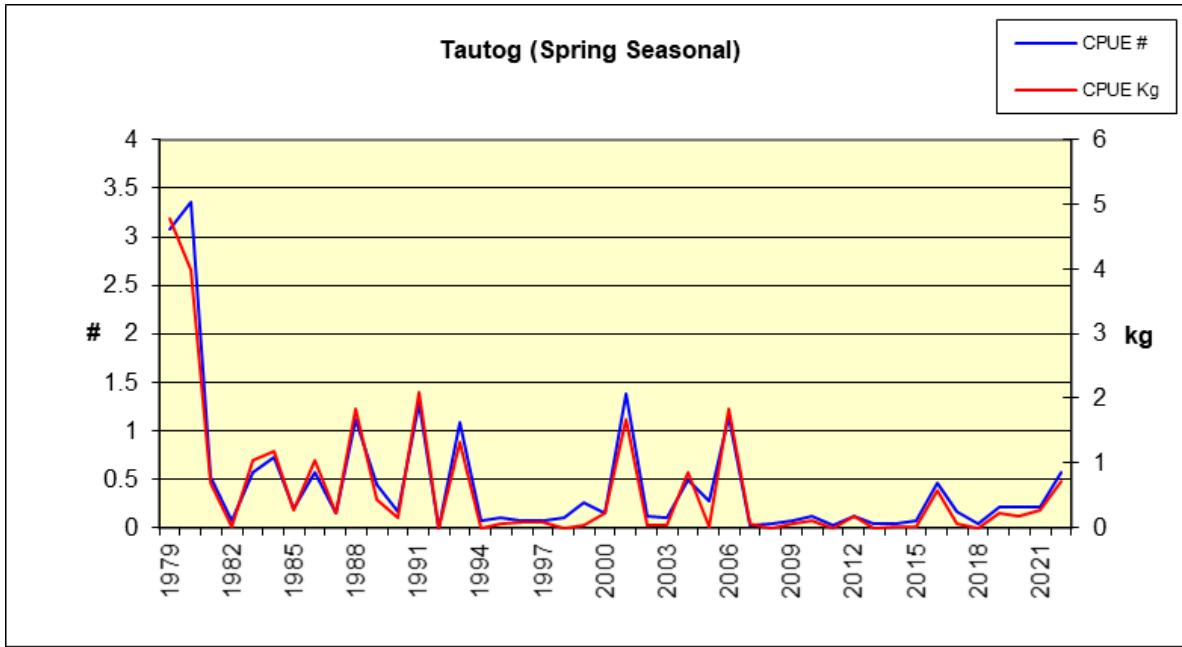


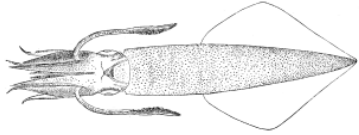


Tautog *Tautoga onitis*

Stock Status: Not Overfished and Overfishing is not occurring based on Regional (Rhode Island and Massachusetts) Stock Assessment

Management: ASMFC Amendment I, Addendum VI

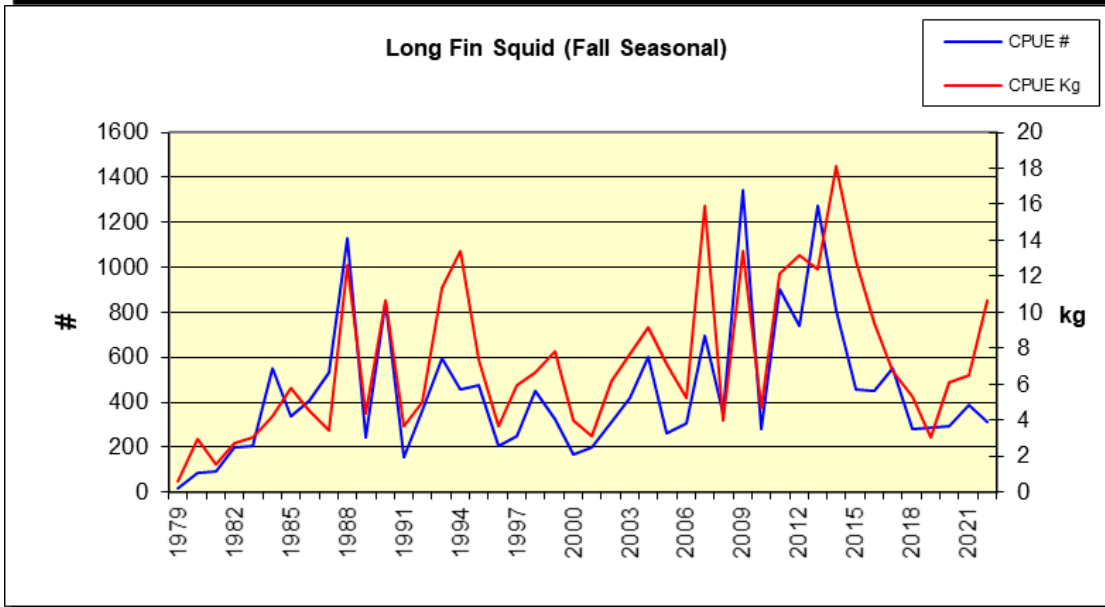
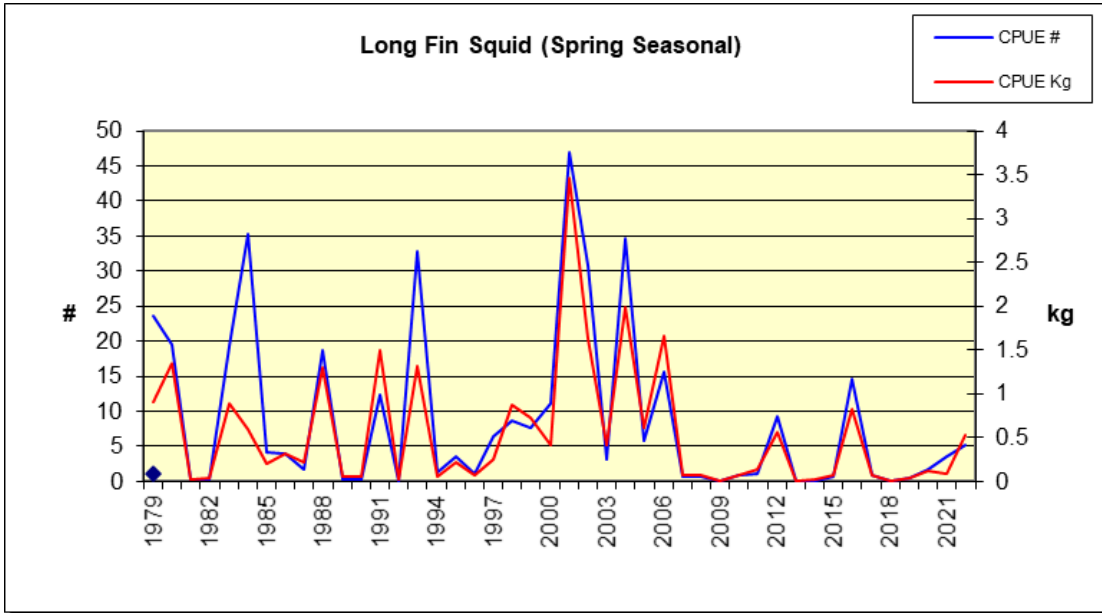




Longfin Squid *Doryteuthis pealeii*

Stock Status: Overfishing undetermined not overfished

Management: NMFS, MAFMC, Atlantic Mackerel, Squid Butterfish FMP

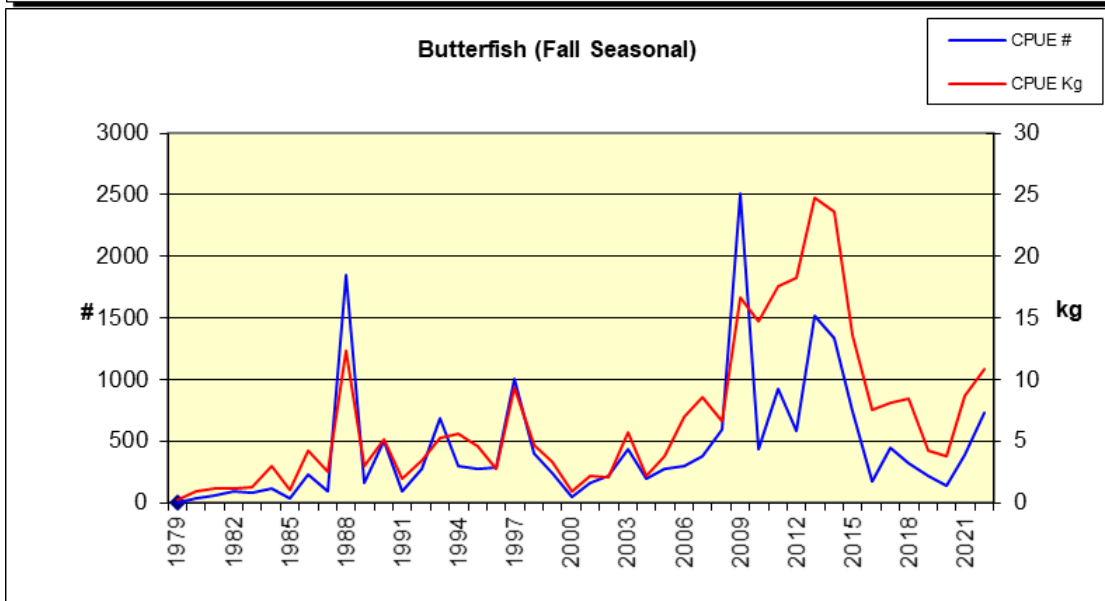
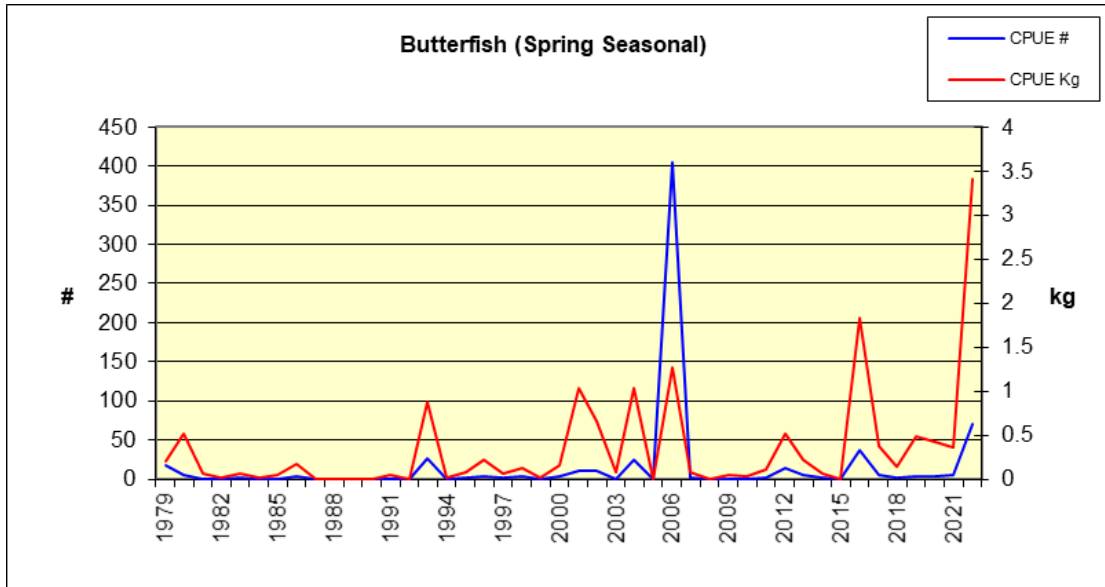




Butterfish *Peprilus triacanthus*

Stock Status: Variable / Uncertain

Management: Mid Atlantic Fishery Management Council, Atlantic Mackerel, Squid Butterfish FMP, ACL



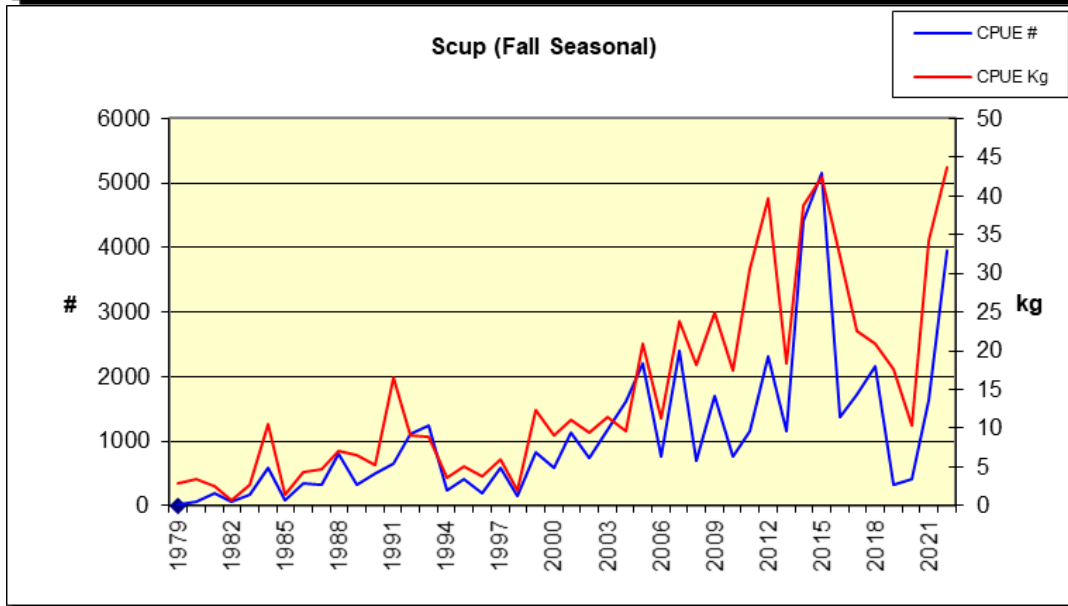
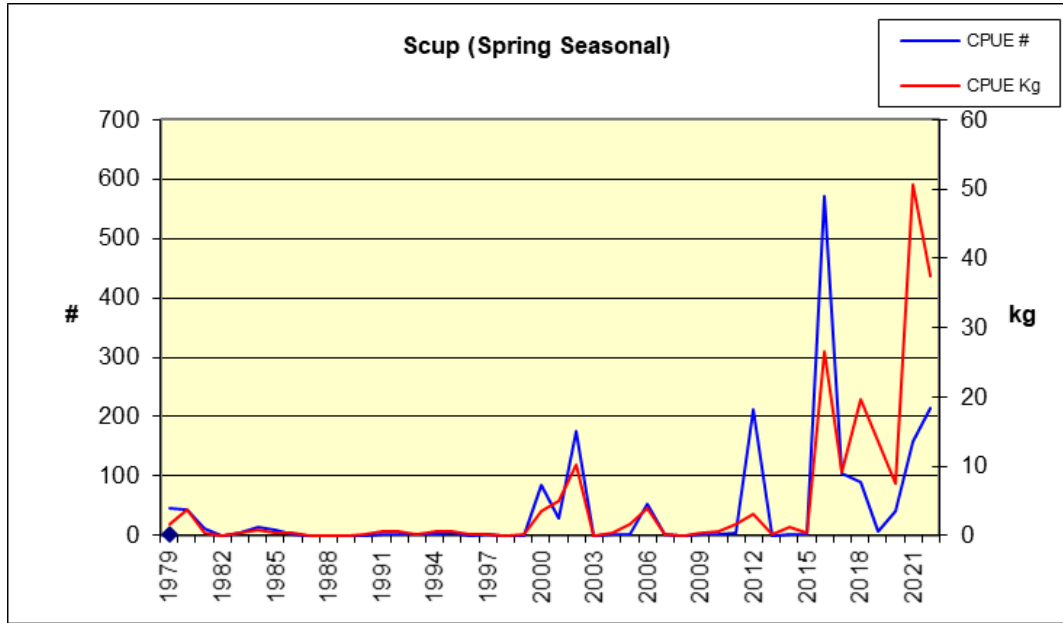




Scup *Stenotomus chrysops*

Stock Status: Rebuilt, not overfished and overfishing is not occurring

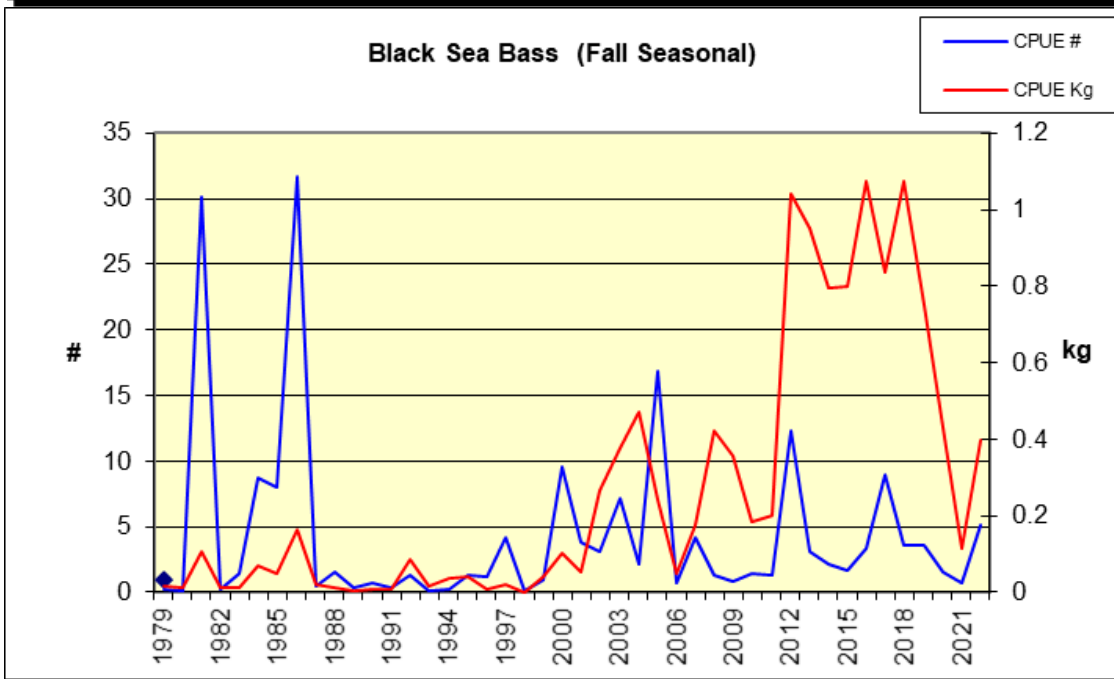
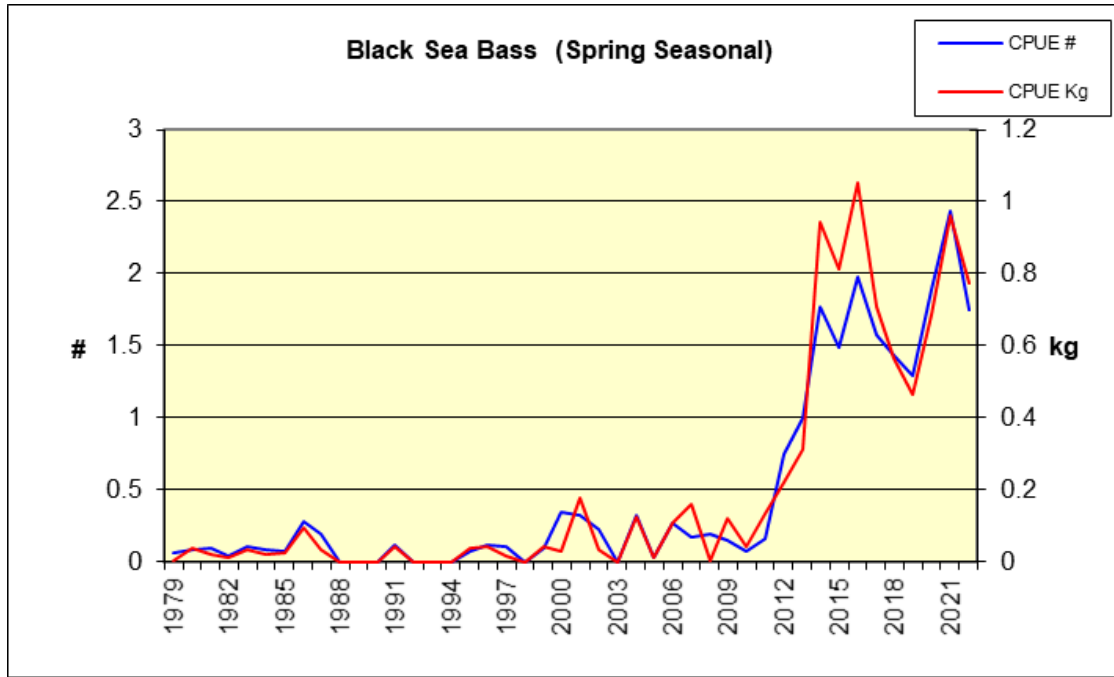
Management: ASMFC Amendment XIII, Addendum XXXI, Summer Flounder, Scup Black Sea Bass FMP





Black Sea Bass *Centropristis striata*

Stock Status: Rebuilt, not overfished overfishing is not occurring  
Management: ASMFC Amendment XIII, Addendum XXXI



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



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Federal Aid in Sportfish Restoration  
F-61-R

Performance Report – Job 3

March 2023

## Performance Report

**State:** Rhode Island

**Project Number:** F-61-R

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

**Period Covered:** January 1, 2022 – December 31, 2022

**Job Number & Title:** Job 3 – Young of the Year Survey of Selected Rhode Island Coastal Ponds and Embayments

**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 2022, investigators caught 58 species of finfish representing 36 families within the Washington County coastal ponds. This number is comparable but slightly down from 2021, where 58 species from 36 families were collected. However, the number of individuals caught in 2022 greatly increased from the 2021 survey, with 91,611 collected in 2022 and 38,576 collected in 2021. However, this number is greatly inflated by an unusually high abundance of Atlantic menhaden caught at a single station in August (40,285 fish). All 144 seine samples were completed in 2022. The Block Island juvenile finfish seine survey was completed by Diandra Verbeyst, Great Salt Pond Scientist, The Nature Conservancy. Appendix 1 displays the frequency of all species caught by station during the 2022 Coastal Pond Survey. Additional data is available by request.

**Target Date:** December 2022

**Status of Project:** On Schedule

**Significant Deviations:** There were no significant deviations in 2022.

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

### **Remarks:**

During 2022, investigators successfully sampled all twenty-four traditional stations in eight coastal ponds from May through October: Winnapaug Pond, Quonochontaug Pond, Charlestown Pond, Point Judith Pond, Green Hill Pond, Potter Pond, Little Narragansett Bay and Narrow River (Figures 1-3). Since 2018, the time series species indices for young of the year (YOY) winter flounder includes the data taken from the new stations added in 2011 (PP 1 and 2, GH 1 and 2, PR 1 through 3, PJ4). These stations were previously excluded due to potential unknown bias the new stations could introduce to the time series.

The abundance indices for winter flounder targets only YOY individuals. For

consistency, only individuals with a total length (TL) less than 12 cm are included in these analyses.

## **Materials and Methods:**

As in previous years, investigators attempted to perform all seining on an outgoing tide. To collect animals, investigators used a seine 130 ft. long (39.62m), 6 ft deep (1.67m) with ¼" mesh (6.4mm). The seine has a bag at its midpoint, a weighted foot rope and floats on the head rope. Figure 4 describes the area covered by the seine net. The beach seine is set in a semi-circle away from the shoreline and back again using an outboard powered 16' Polarkraft aluminum boat. The net is then hauled toward the beach by hand and the bag is emptied into a large water-filled tote. All animals collected are identified to species, measured, enumerated, and sub-samples taken when appropriate. Water quality parameters including temperature, salinity and dissolved oxygen are measured at each station. Figure 1 shows the location of the subject coastal ponds and embayments, while figures 2-3 indicate the location of the sampling stations within each waterbody.

## **Results and Discussion:**

### **Winter Flounder (*Pseudopleuronectes americanus*)**

Juvenile winter flounder were collected at all 24 stations over the course of the season. Winter flounder ranked fifth in overall species abundance (n=2,007) in 2022, with the highest mean abundance (fish/seine haul) occurring in June and May (Table 1). This is somewhat earlier than the usual peak seen in June/July. This early season peak abundance was consistent across all ponds. As with previous years, a sharp decline in catch occurred as the survey season progressed.

Winter flounder abundance increased slightly from 2021 (2,007 individuals caught vs. 1,579 in 2021), and is a sharp increase from the series low of 811 individuals in 2019. The juvenile winter flounder abundance index (YOY WFL index) for the survey measured using the mean fish/seine haul increased from 10.96 fish/seine haul in 2021 to 13.9 fish/seine haul in 2022. Figure 5 displays the abundance indices by pond over the duration of the coastal pond survey. Table 1 and Figure 6 display the mean catch per seine haul (CPUE) of winter flounder for each month by pond during the 2022 survey. Figure 8 displays winter flounder abundance against mean recorded water temperature.

With increasing seasonal temperatures, Rhode Island waters have seen an ecological shift from resident demersal species (including winter flounder) to a pelagic community dominated by more southern species (Collie et al. 2008, Oviatt 2004). Over the course of this survey, average water temperature of the coastal ponds has steadily increased, while winter flounder YOY CPUE has decreased. Average water temperature measured during the survey has not been below 20°C since 2006 (19.3°C). The highest average temperature was observed in 2016 at 22.5°C. Average temperature in 2022 was 21.47°C. These findings are consistent with the overall trend occurring in northeast region and the observed declines in winter flounder population. A clear negative trend is seen between mean coastal pond water temperature and winter flounder catch (Figure 8).

In 2022, juvenile winter flounder ranged in size from 1.7 to 19.0 cm, representing age groups 0-1+ (Figure 7). The size range of animals collected is similar to those caught in previous years. Length-frequency distributions indicate that 99.9% of individuals collected

during sampling season were group 0 fish (less than 12 cm total length, 2,004/2,007). 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).

Two other RIDFW surveys target juvenile and adult winter flounder: the Narragansett Bay Spring Seasonal Trawl Survey (Spring Trawl) and the Narragansett Bay Juvenile Finfish Survey (NBS). A comparison of the Coastal Pond Survey (CPS) to these other projects reveals that despite some slight differences, they display similar trends (Figure 9). Like the CPS, The NBS again saw a fairly high CPUE of YOY compared to the past few years (8.17 fish/haul in 2022 and 8.87 fish/haul in 2021). However, this index is still trending downwards over the time series. The Spring Trawl Survey WFL index was consistent with 2021, at 2.25 fish/tow compared to 2.66 fish/tow. Winter flounder catch in the trawl continues to be near time-series lows. Regulations 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 5,000 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. NOAA Fisheries has changed their procedures for administration of common pool possession limit, restricting it to lower values during the year than allowed (typically 2,000 lbs per day) in 2013. Possession limits remain 50 pounds in State waters. Despite these low catch limits, abundance of adult winter flounder remains low.

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 fish which occur in May in the shallow coves. 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 0.73 fish/seine haul in 2008. Between 2009 and 2019, the overall YOY WFL index in Point Judith pond increased slightly from the low 2008 value and since then (with the exception of the low abundances of 1.29 fish/haul in 2010 and 2.9 fish/haul in 2018) has remained relatively level with index values averaging approximately 5 fish/haul. From 2020-2022, higher numbers of winter flounder were caught, with CPUEs ranging from 14.9 in 2020 to 7.0 in 2022. This trend in abundance might reflect the no possession rule in the pond as well as the former coast wide closure. Despite this, the pond's winter flounder population has not rebounded to historic levels. A winter fyke net survey (Adult Winter Flounder Tagging Survey) is also conducted targeting adult winter flounder that use the ponds to spawn. Currently, Point Judith, Potter Pond, and Charlestown Ponds are the only coastal ponds where both a juvenile survey and an adult winter flounder survey occur annually (winter fyke net stations in Charlestown Pond were sampled from 2012-2015 and continued in 2019). 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 in Point Judith Pond, an overall declining trend in relative abundance of winter flounder is observed in both surveys (Figure 10). The index value observed in the adult spawner survey was the lowest ever recorded at 0.8 WFL per net haul in 2014, recovering slightly in 2016-2018 (1.1 fish/haul-6 fish/haul). In 2019, the number of captured fish declined again, with an index value of 0.67 fish/haul, but increased slightly in 2020 to 1.6 fish/haul. This number was again down in 2021 and 2022, with only 0.5 and 0.33 fish/haul respectively. Most fish caught were mature females. A total of

2 mature fish were tagged and released in Point Judith Pond, and 101 total in all three ponds. 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 on April 8, 2011 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.

### **Bluefish (*Pomatomus saltatrix*)**

A total of 100 bluefish were collected in 2022 (CPUE=0.69 fish/haul). The majority were caught in September and October in Quonochontaug, Point Judith Pond, Winnapaug Pond, and Pawcatuck River. This is an increase from 2021 (CPUE=0.3 fish/haul). Table 2 contains the abundance indices for the 2022 survey by month and pond. Bluefish ranged in size from 4 cm to 18 cm. Figure 11 displays the annual abundance index of bluefish for all stations combined.

### **Tautog (*Tautoga onitis*)**

From May to October of 2021, 346 2022 227 (CPUE= 2.4 fish/haul) tautog were collected in all ponds except Green Hill. This is an increase from the 227 tautog caught in 2021 (CPUE=1.57 fish/haul) consistent or increasing with the last few years (CPUE= ~2 for 2015-2018). An increasing trend in tautog has been observed over the time series. Table 3 contains the abundance indices for the 2022 survey by month and pond. The highest abundances in 2022 occurred in Quonochontaug Pond in July. Tautog caught in 2022 ranged in size from 2.0 cm to 19.5 cm. Figure 12 displays the annual abundance index of tautog for all stations combined.

### **Black Sea Bass (*Centropristis striata*)**

A total of 30 juvenile black sea bass were collected from May to October of 2022 from Charlestown Pond, Narrow River, Quonochontaug Pond, and Winnapaug Pond (CPUE=0.21 fish/haul). This is down from last year (CPUE=0.64 fish/haul). Despite this interannual variability, there is an increasing trend over the time series. In 2018 the highest abundance of black sea bass in the history of the survey was recorded (CPUE=4.2). The highest abundance in 2022 was seen in Charlestown Pond in August (CPUE=3.25). Table 4 contains the abundance indices for the survey by month and pond. Black sea bass caught in 2022 ranged in size from 3 cm to 7 cm.

### **Scup (*Stenotomus chrysops*)**

In 2022, 217 scup were collected from July to September in all ponds except Green Hill Pond, Winnapaug Pond, and Point Judith Pond CPUE=1.5 (CPUE=0.44 fish/haul). This is up from 2021 (CPUE=0.44 fish/haul) but down from 2017-2019 (all time high of 3.9 fish/haul in 2017 and 2.7 and 1.8 fish/haul in 2018-2019). Despite this, an increasing trend in scup has been seen over the time series. Table 5 contains the abundance indices for the 2022 survey by month and pond. Figure 14 displays the annual abundance index of scup for all stations combined. Scup caught in 2022 ranged in size from 3 cm to 13 cm.



## **Clupeids:**

In 2022, three species of clupeids were caught in the coastal pond survey: Atlantic menhaden (*Brevoortia tyrannus*), Alewife (*Alosa pseudoharengus*), and Bay Anchovy (*Anchoa mitchilli*). The most prevalent clupeid caught in 2022 was by far Atlantic Menhaden, with 62,902 individuals captured from July to October (CPUE=436.8 fish/haul). This is a large increase from 2021, but menhaden catches are highly variable. In many instances, high numbers of YOY menhaden are caught in a single seine haul due to their dense schooling nature and because such a school was present at a given station upon sampling. The second most abundant clupeid observed in 2022 was Bay Anchovy. A total of 81 were captured in across all months (CPUE=0.56). Sixty-three Alewife were caught in 2022 (CPUE=0.43), up from the 29 caught in 2021. No blueback herring or Atlantic herring were caught in 2022. Table 6 contains the abundance indices for clupeids by month pooled across all 8 ponds. Figure 15 displays the annual abundance indices of clupeids for all stations combined. Due to the highly variable magnitude of catches, abundance is in log-scale.

## **Baitfish Species:**

### **Silversides (*Menidia sp.*)**

Silversides had the highest abundance of all species, with 13,798 caught during the 2022 survey (CPUE=95.82 fish/haul). This is consistent with observed abundances in the last few years. Silversides were collected in each of the ponds throughout the survey, with the exception of Potter Pond in May. The highest abundance index was observed in Quonochontaug Pond, and from August-October across most ponds. Table 7 contains the abundance indices for the survey by month and pond. Atlantic silversides caught in 2022 ranged in size from 2 cm to 13 cm.

### **Striped Killifish (*Fundulus majalis*)**

Striped killifish ranked fourth in species abundance with 2,103 fish caught during 2022 (CPUE=14.6). This is down from 2021, but consistent with the last few years. They occurred in each of the ponds at least once and were caught each month during the survey. They were most prevalent in August and September. Table 8 contains the abundance indices for the survey by month and pond. Striped killifish caught in 2020 ranged in size from 2 cm to 12 cm.

### **Common Mummichog (*Fundulus heteroclitus*)**

The mummichog ranked third in overall abundance in 2022 with 5,260 individuals (CPUE=36.5), up from the last few years where catches averaged ~2,000 fish per year. They occurred in each of the ponds at least once and were caught each month during the survey. Potter Pond had the highest abundances of Mummichogs. This year continues the rebound from the lowest mummichog abundance on record of 2.09 fish/seine haul in 2013. Table 9 contains the abundance indices for the survey by month and pond. Mummichogs caught in 2022 ranged in size from 2 cm to 10 cm.

### **Sheepshead Minnow (*Cyprinodon variegatus*)**

The Sheepshead minnow ranked sixth in overall abundance with 1,170 individuals collected (CPUE=8.1). This is consistent with 2021 (CPUE=9.63). Sheepshead minnow occurred in each of the ponds and were caught from May through October. Overall, the

highest abundances were seen in August, slightly earlier than the typical fall peak. Table 10 contains the abundance indices for the survey by month and pond. Sheepshead minnow caught in 2022 ranged in size from 2 cm to 6 cm.

Figure 16 displays the annual abundance index (log-transformed) of the baitfish species for all stations combined.

### **Physical and Chemical Data:**

Physical and Chemical data for the 2022 Coastal Pond Survey is summarized in tables 11-13 and Figure 17. Water temperature in 2021 averaged 21.45 °C, with the lowest observed value of 13.2 °C in October in Pawcatuck River and the highest at 29.2 °C in Charlestown Pond in July. Temperature continues on an annual upward trend. Salinity ranged from 15.26 ppt to 37.03 ppt, and averaged 28.96 ppt. Dissolved oxygen ranged from 3.82 mg/l to 14.60 mg/l with an average of 8.32 mg/l.

### **New Station Preliminary Data**

This year was the twelfth year of sampling stations in the three additional ponds. On a whole, the samples were consistent with 2011-2021q. Since 2018, data from these additional stations has been included in the abundance indices for all species, including YOY winter flounder. This data will continue to be included in future analyses. A brief description of each pond follows.

**Green Hill Pond:** Green Hill Pond is a small coastal pond located east of Charlestown Pond. It does not open directly to the ocean, but 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 fine, muddy sand. WFL YOY have been caught in relatively high abundance in May, suggesting spawning activity within the pond. The WFL YOY decrease in abundance at the stations in July and August when the water is warm and are not caught frequently after it cools in the fall. Other species frequently present in the pond are the baitfish species, naked goby, and blue crabs.

**Potter Pond:** 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. However, the local geography is such that more tidal flushing occurs than in Green Hill Pond. 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. Also similar to Green Hill Pond, WFL YOY are highest in abundance in May and decrease in abundance as the season progresses. The water temperature in Potter 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 eight years had small catches of 1-year old flounder at station PP-1 during

the late summer and early fall. Water temperatures are generally higher than the pond proper, while dissolved oxygen near this station is lower. 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.

Lower Pawcatuck River: The lower Pawcatuck River (also known as Little Narragansett Bay) is the mouth of a coastal estuary formed by the Pawcatuck River. It is different from 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 typically has the most consistent catch of WFL YOY which are present during all months of the survey. However, in 2018, WFL were only captured June-August. PR-2 is located on a sand bar island in the middle of Little Narragansett Bay on the protected (inland) 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 catches WFL YOY, but usually at lower frequencies than PR-1. 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 now 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 juvenile tautog, the baitfish species, alewife, tomcod, menhaden, and bluefish.

Point Judith Pond: 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 has higher catch frequencies of WFL YOY than the other stations in the pond, but still is low in comparison to the other ponds.

The first six 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. Moving forward, this data will be included in the time series abundance indices.

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Table 1: 2022 Coastal Pond Survey winter flounder abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	Aug	Sept	Oct
Charlestown Pond	76.50	16.33	12.25	2.00	0.00	0.00
Green Hill Pond	25.00	5.00	5.00	0.00	0.00	0.00
Narrow River	17.33	9.00	9.00	4.00	0.67	0.33
Pawcatuck River	20.67	54.00	29.67	9.00	0.00	0.67
Point Judith Pond	1.75	32.25	5.00	2.00	0.25	0.50
Potter's Pond	0.00	1.00	1.00	0.50	0.00	0.00
Quonochontaug Pond	21.33	66.67	7.33	3.67	1.67	1.67
Winnapaug Pond	29.33	87.00	39.67	14.00	11.33	6.00
<b>Total Pond Index</b>	<b>26.21</b>	<b>35.68</b>	<b>14.08</b>	<b>4.54</b>	<b>1.75</b>	<b>1.16</b>

Table 2: 2022 Coastal Pond Survey bluefish abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	0.00	0.00	0.00	1.75	0.75	0.00
Green Hill Pond	0.00	0.00	0.00	0.00	0.00	0.00
Narrow River	0.00	0.00	0.00	0.67	0.00	0.00
Pawcatuck River	0.00	0.00	0.67	2.00	0.00	0.00
Point Judith Pond	0.00	2.25	0.25	0.25	3.25	0.00
Potter Pond	0.00	0.00	0.00	0.00	1.50	0.00
Quonochontaug Pond	0.00	0.67	0.00	8.67	5.00	0.00
Winnapaug Pond	0.00	0.00	0.00	0.00	3.33	0.00
<b>Total Pond Index</b>	<b>0.00</b>	<b>0.46</b>	<b>0.13</b>	<b>1.75</b>	<b>1.83</b>	<b>0.00</b>

Table 3: 2022 Coastal Pond Survey tautog abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	0.50	0.00	5.25	1.25	1.50	0.75
Green Hill Pond	0.00	0.00	0.00	0.00	0.00	0.00
Narrow River	0.00	0.00	1.67	3.33	2.33	1.00
Pawcatuck River	0.33	0.00	5.00	9.33	0.33	0.00
Point Judith Pond	0.50	0.25	8.00	7.25	5.50	0.25
Potter Pond	0.00	0.00	5.50	6.50	0.00	1.50
Quonochontaug Pond	0.00	0.33	18.33	0.67	3.33	0.33
Winnapaug Pond	0.00	0.00	7.33	9.33	2.00	0.00
<b>Total Pond Index</b>	<b>0.21</b>	<b>0.08</b>	<b>6.71</b>	<b>4.79</b>	<b>2.17</b>	<b>0.46</b>

Table 4: 2022 Coastal Pond Survey black sea bass abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	0.25	0.25	0.00	3.25	0.00	0.00
Green Hill Pond	0.00	0.00	0.00	0.00	0.00	0.00
Narrow River	0.00	0.00	0.00	0.00	3.00	0.33
Pawcatuck River	0.00	0.00	0.00	0.00	0.00	0.00
Point Judith Pond	0.00	0.00	0.00	0.00	0.00	0.00
Potter Pond	0.00	0.00	0.00	0.00	0.00	0.00
Quonochontaug Pond	0.00	0.33	0.00	0.00	0.00	0.00
Winnapaug Pond	0.00	0.00	0.00	1.33	0.00	0.00
<b>Total Pond Index</b>	<b>0.04</b>	<b>0.08</b>	<b>0.00</b>	<b>0.71</b>	<b>0.38</b>	<b>0.04</b>

Table 5: 2022 Coastal Pond Survey Scup abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	0.00	0.00	0.00	22.00	0.00	0.00
Green Hill Pond	0.00	0.00	0.00	0.00	0.00	0.00
Narrow River	0.00	0.00	0.00	0.00	1.67	0.00
Pawcatuck River	0.00	0.00	3.67	9.00	4.33	0.00
Point Judith Pond	0.00	0.00	0.00	0.00	0.00	0.00
Potter Pond	0.00	0.00	0.00	1.00	0.50	0.00
Quonochontaug Pond	0.00	0.00	2.33	13.67	7.33	0.00
Winnapaug Pond	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total Pond Index</b>	<b>0.00</b>	<b>0.00</b>	<b>0.75</b>	<b>6.58</b>	<b>1.7</b>	<b>0.00</b>

Table 6: 2022 Coastal Pond Survey Clupeid abundance indices (fish/seine haul) by month

Species	May	June	July	August	September	October
Alewife	0.00	0.82	1.42	0.00	0.10	0.00
Bay Anchovy	0.00	0.00	0.00	0.00	0.00	0.00
Atlantic Herring	0.00	0.00	139.38	2174.40	221.83	42.31
Blueback herring	0.06	0.07	4.19	0.27	0.25	0.04
Atlantic Menhaden	0.00	0.00	0.00	0.00	0.00	0.00

Table 7: 2022 Coastal Pond Survey Silverside abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	6.75	17.00	243.50	281.00	203.25	317.25
Green Hill Pond	16.50	2.00	64.50	125.50	56.50	333.00
Narrow River	6.67	1.00	87.33	221.00	136.33	52.67
Pawcatuck River	12.67	7.00	43.33	62.33	133.00	7.00
Point Judith Pond	96.25	4.00	30.25	141.00	113.25	159.75
Potter Pond	0.00	3.00	15.00	24.00	53.50	103.50
Quonochontaug Pond	9.67	5.00	390.33	50.33	69.67	22.00
Winnapaug Pond	8.00	10.67	140.67	242.00	34.67	163.67
<b>Total Pond Index</b>	<b>23.17</b>	<b>6.88</b>	<b>134.96</b>	<b>154.75</b>	<b>108.63</b>	<b>146.54</b>

Table 8: 2022 Coastal Pond Survey Striped Killifish abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	0.00	0.00	12.75	27.50	26.75	11.25
Green Hill Pond	0.00	0.00	0.00	0.00	0.50	0.00
Narrow River	0.00	0.00	0.00	18.67	3.67	33.00
Pawcatuck River	0.00	0.00	2.33	62.67	64.67	5.33
Point Judith Pond	0.50	28.50	18.75	11.00	47.25	32.25
Potter Pond	0.00	0.00	0.00	0.00	0.00	15.50
Quonochontaug Pond	0.00	0.00	14.67	5.67	57.67	26.67
Winnapaug Pond	0.00	0.00	20.00	75.67	9.33	1.67
<b>Total Pond Index</b>	<b>0.08</b>	<b>4.75</b>	<b>9.88</b>	<b>26.75</b>	<b>29.29</b>	<b>16.88</b>

Table 9: 2022 Coastal Pond Survey Mummichog abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	6.50	2.75	252.50	137.25	41.25	6.25
Green Hill Pond	2.50	5.50	1.50	19.50	118.00	0.00
Narrow River	120.33	80.33	21.00	12.33	13.67	38.00
Pawcatuck River	0.67	0.00	3.00	0.00	3.33	0.33
Point Judith Pond	5.25	4.00	16.75	7.50	171.75	19.75
Potter Pond	4.50	15.00	23.50	21.50	20.50	8.00
Quonochontaug Pond	0.00	0.00	6.00	1.00	4.00	0.33
Winnapaug Pond	0.00	3.33	176.67	195.33	9.67	8.67
<b>Total Pond Index</b>	<b>17.67</b>	<b>13.29</b>	<b>72.79</b>	<b>53.63</b>	<b>50.88</b>	<b>10.92</b>

Table 10: 2022 Coastal Pond Survey Sheepshead Minnow abundance indices (fish/seine haul) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	0.50	0.00	1.00	47.50	5.75	5.75
Green Hill Pond	7.50	0.00	0.50	0.00	46.50	8.50
Narrow River	0.00	0.00	0.00	45.67	22.67	95.00
Pawcatuck River	0.00	0.00	0.00	0.00	0.67	1.67
Point Judith Pond	0.00	0.00	0.00	0.50	7.75	0.75
Potter Pond	0.00	0.00	2.00	0.00	0.00	2.50
Quonochontaug Pond	0.00	0.33	0.00	0.00	0.00	1.33
Winnapaug Pond	0.00	0.33	8.33	68.33	0.00	8.00
<b>Total Pond Index</b>	<b>0.71</b>	<b>0.08</b>	<b>1.42</b>	<b>22.25</b>	<b>9.04</b>	<b>15.25</b>

Table 11: 2022 Coastal Pond Survey average water temperature (°C) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	22.48	22.33	27.63	24.90	20.30	15.53
Green Hill Pond	21.85	22.25	27.10	26.15	19.45	15.75
Narrow River	20.77	22.67	26.87	25.53	22.43	16.37
Pawcatuck River	17.07	20.53	25.47	23.83	18.90	13.97
Point Judith Pond	18.53	20.58	25.80	24.70	22.43	17.40
Potter's Pond	19.35	22.00	23.55	25.50	24.00	18.00
Quonochontaug Pond	21.40	19.53	25.13	24.20	21.67	14.60
Winnapaug Pond	16.90	21.23	24.50	23.17	21.33	14.97
<b>Average</b>	<b>19.79</b>	<b>21.39</b>	<b>25.76</b>	<b>24.75</b>	<b>21.31</b>	<b>15.82</b>

Table 12: 2022 Coastal Pond Survey average salinity (ppt) by pond and month

Waterbody	May	June	July	August	September	October
Charlestown Pond	29.95	30.35	31.10	31.22	30.07	30.04
Green Hill Pond	22.00	25.90	21.92	28.67	25.66	26.15
Narrow River	20.46	24.07	25.01	27.35	26.77	26.11
Pawcatuck River	28.05	26.65	25.94	30.16	28.20	27.29
Point Judith Pond	28.20	30.05	31.34	31.94	30.42	30.40
Potter's Pond	28.31	28.81	30.05	30.65	29.82	30.17
Quonochontaug Pond	31.48	31.95	31.86	32.04	31.91	33.55
Winnapaug Pond	30.85	30.95	31.22	31.73	31.37	31.75
<b>Average</b>	<b>27.41</b>	<b>28.59</b>	<b>27.69</b>	<b>30.47</b>	<b>29.43</b>	<b>29.43</b>



Table 13: 2022 Coastal Pond Survey average dissolved oxygen (mg/L) by pond and month

<b>Waterbody</b>	<b>May</b>	<b>June</b>	<b>July</b>	<b>August</b>	<b>September</b>	<b>October</b>
Charlestown Pond	9.81	10.92	7.96	6.65	9.60	8.89
Green Hill Pond	8.64	7.83	9.10	5.40	7.66	8.88
Narrow River	8.71	8.40	7.35	7.80	6.39	10.84
Pawcatuck River	11.60	9.82	8.30	8.61	6.94	8.64
Point Judith Pond	9.14	9.44	7.77	8.24	7.95	7.81
Potter's Pond	9.17	8.07	8.52	7.81	8.77	8.49
Quonochontaug Pond	8.74	9.04	8.60	8.67	6.91	8.12
Winnapaug Pond	8.63	6.43	7.07	7.44	6.21	7.84
<b>Average</b>	<b>9.30</b>	<b>8.74</b>	<b>8.10</b>	<b>7.58</b>	<b>7.55</b>	<b>8.69</b>

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

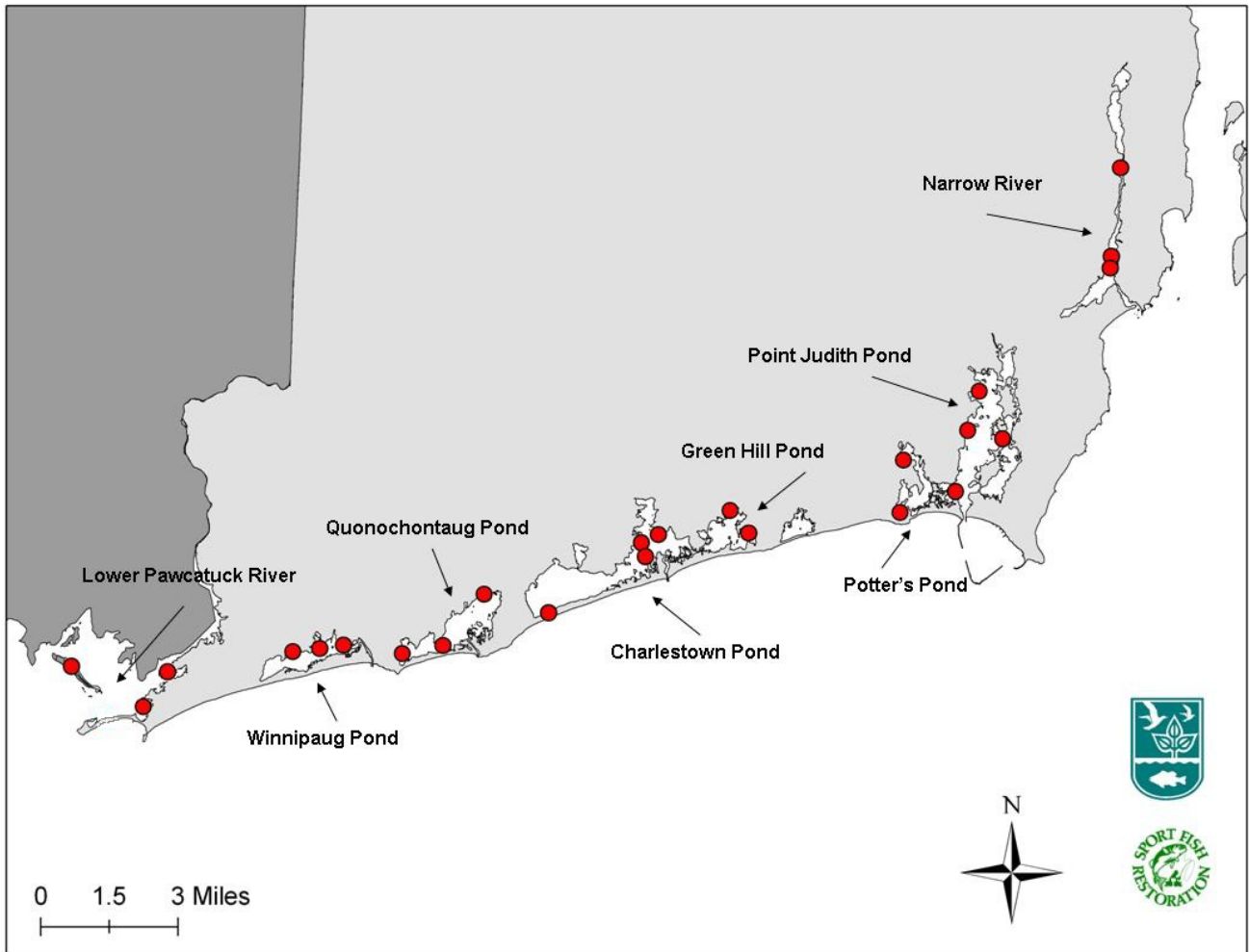


Figure 2: Coastal Pond Juvenile Finfish Survey station locations (western ponds).

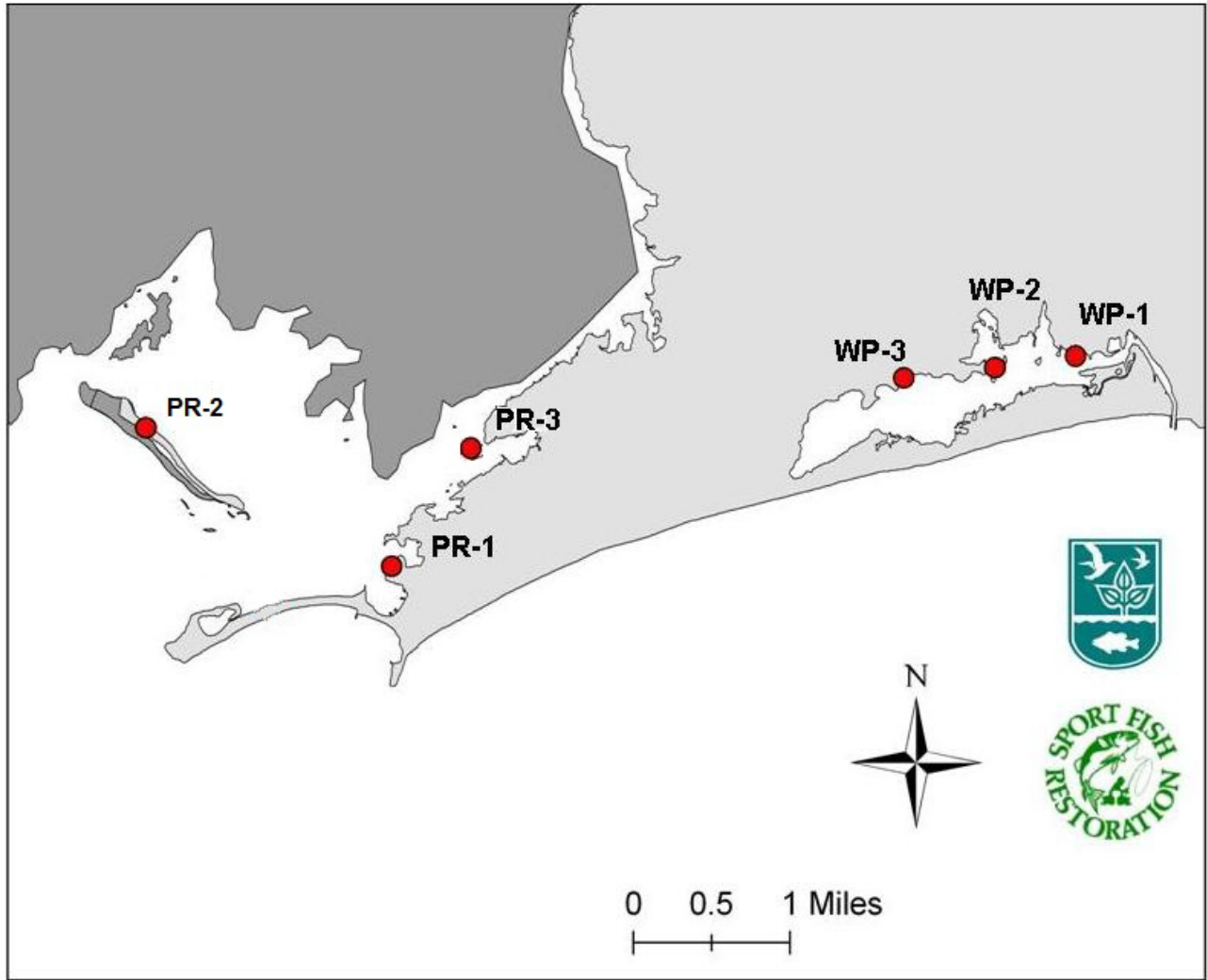


Figure 2 (cont): Coastal Pond Juvenile Finfish Survey station locations (western ponds).

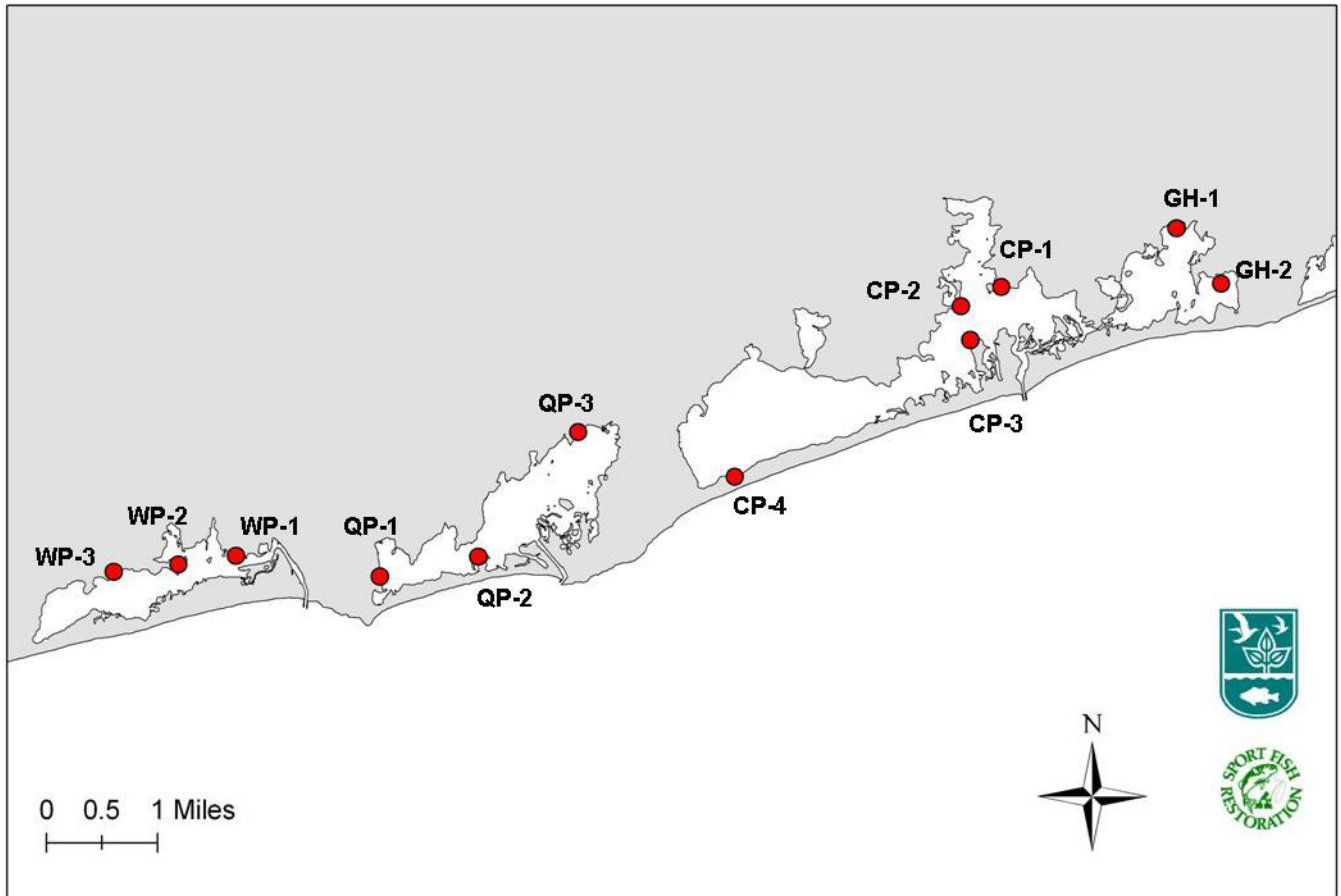


Figure 3: Coastal Pond Juvenile Finfish Survey station locations (eastern ponds).

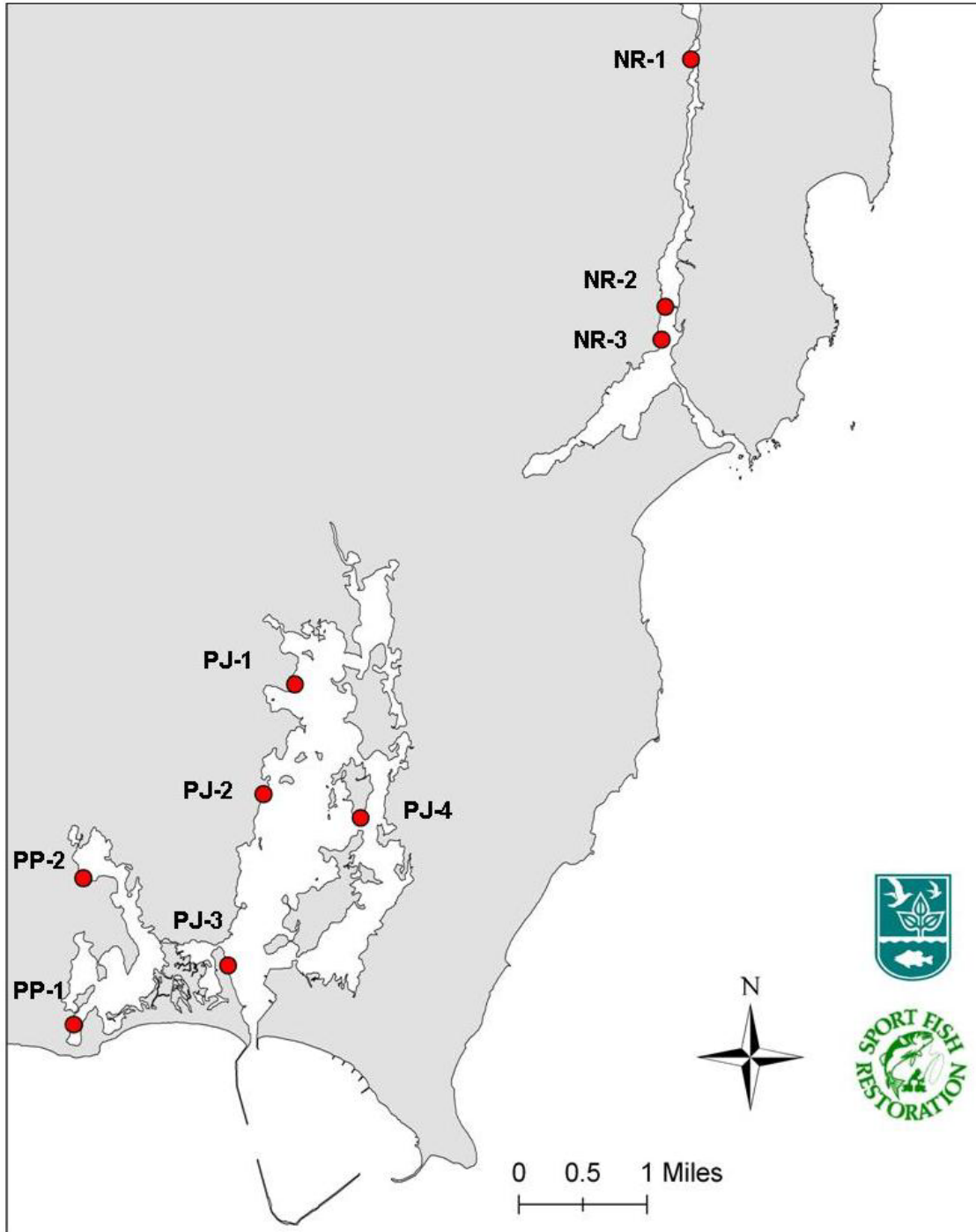


Figure 4  
Coastal Pond Juvenile Finfish Survey

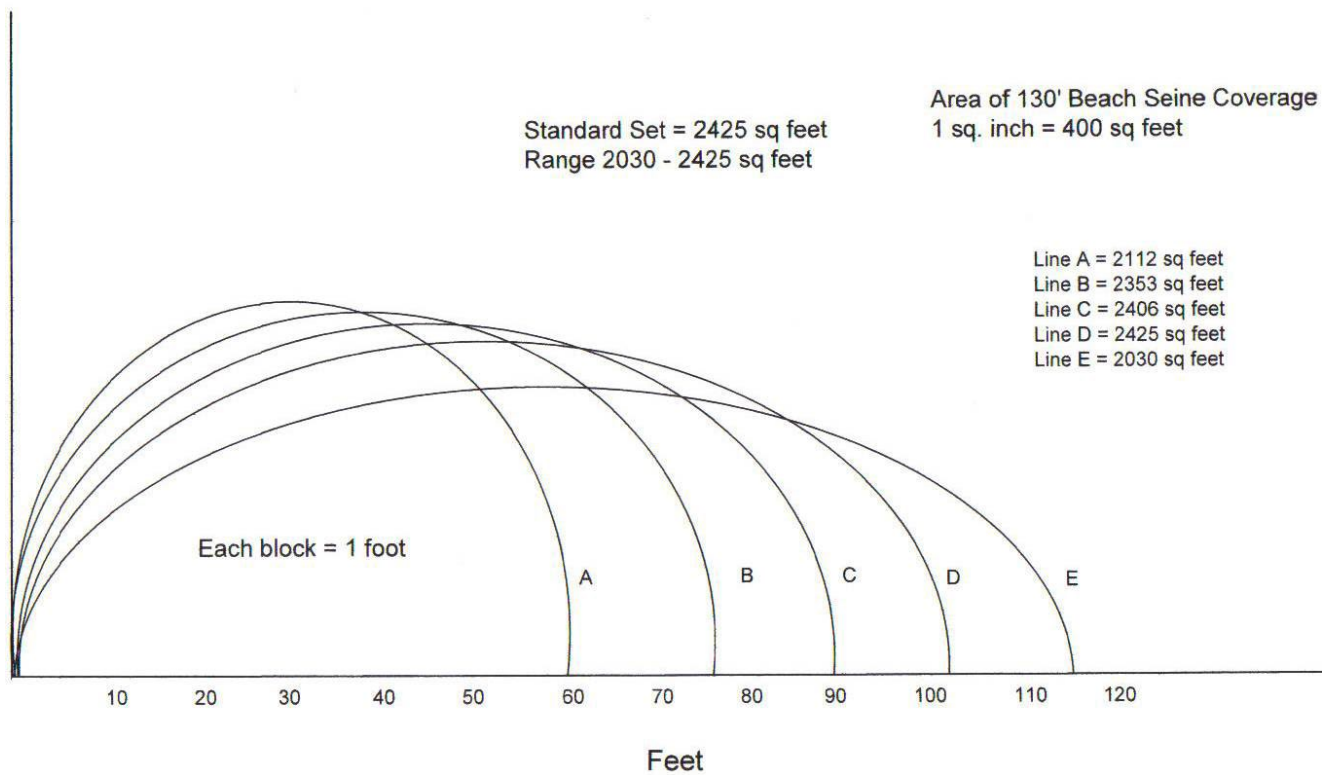


Figure 5: Time series of mean log-transformed abundance indices (fish/seine haul) for winter flounder young-of-year. Solid line is a linear regression. Grey dashed line is time series median.

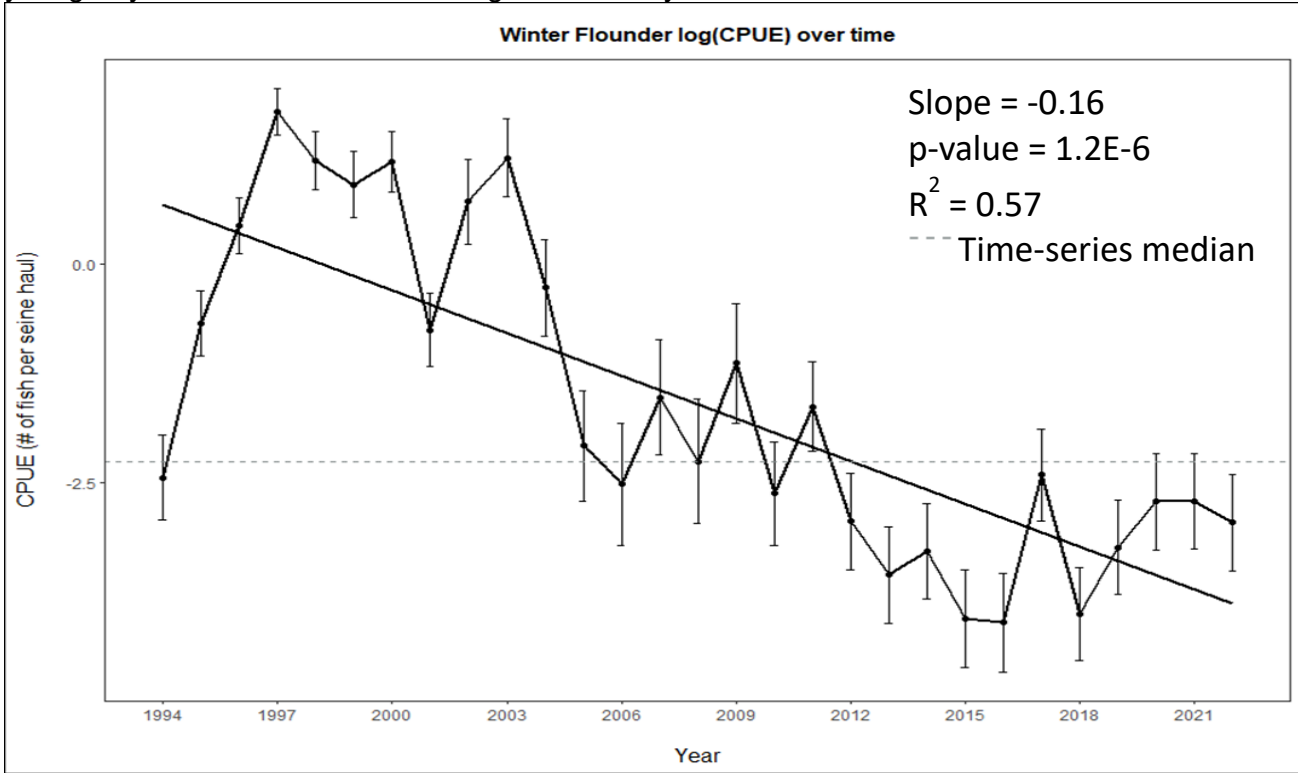


Figure 6: 2022 abundance indices (fish/seine haul) for YOY winter flounder for each pond by month.

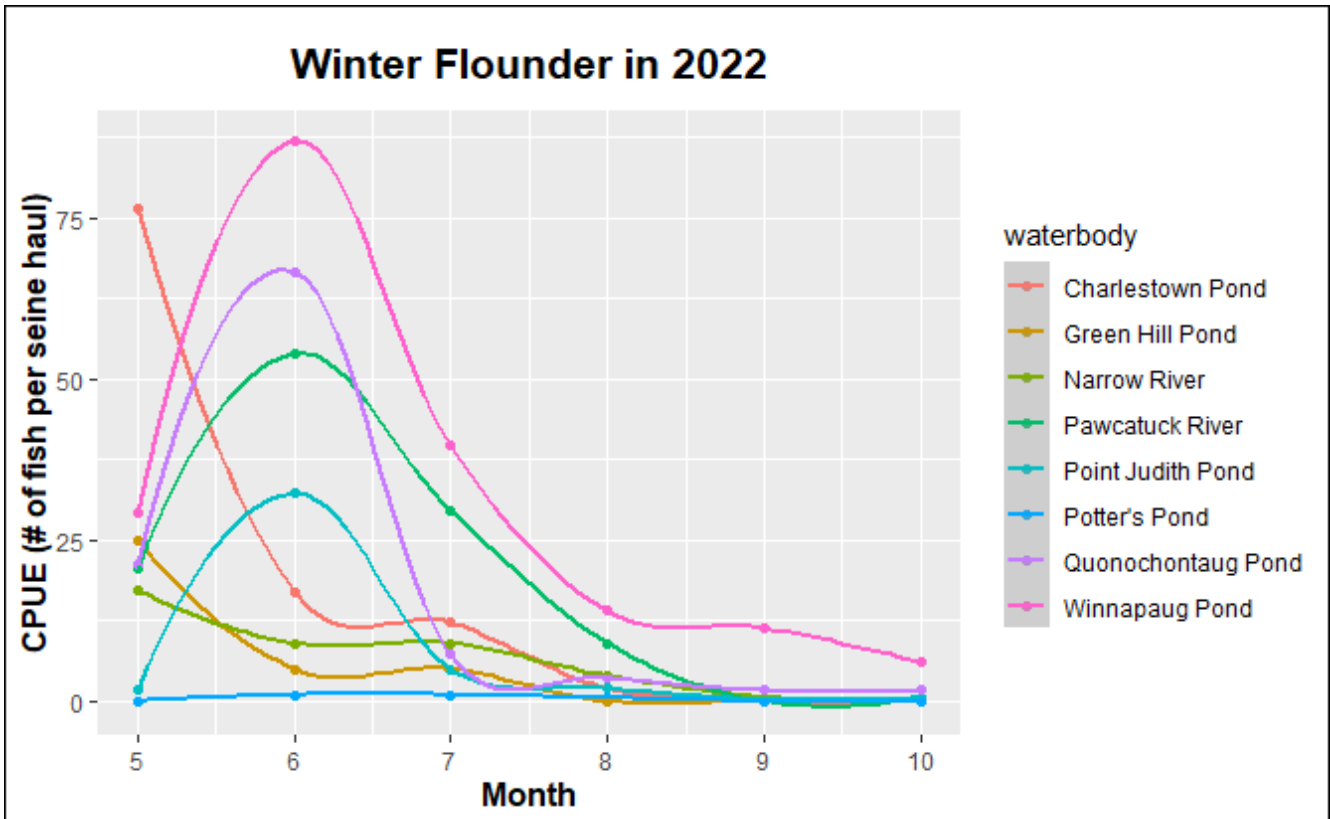


Figure 7: Length frequency of all winter flounder caught in Coastal Pond Survey during 2022. Note: YOY are to the left of the dashed line (<12cm TL)

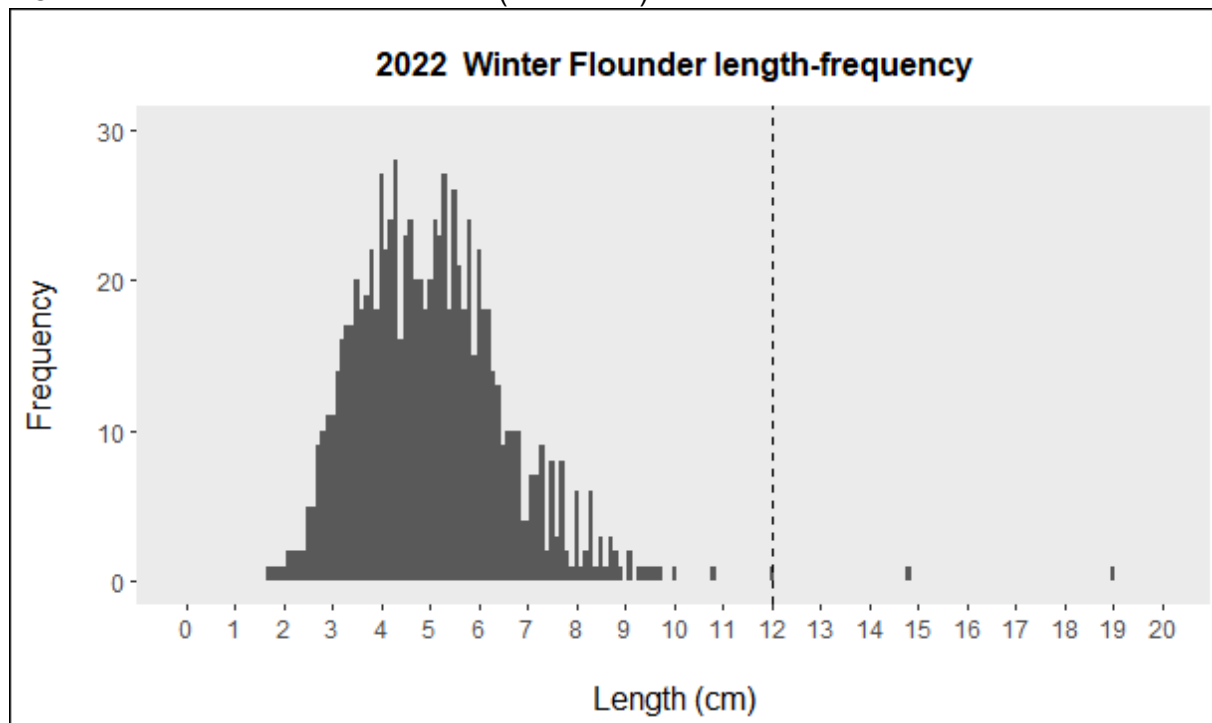


Figure 8: Winter flounder CPUE against mean measured water temperature. With increasing water temperature, we see a decrease in winter flounder catch. Solid line is a linear regression and dashed line is the time-series median.

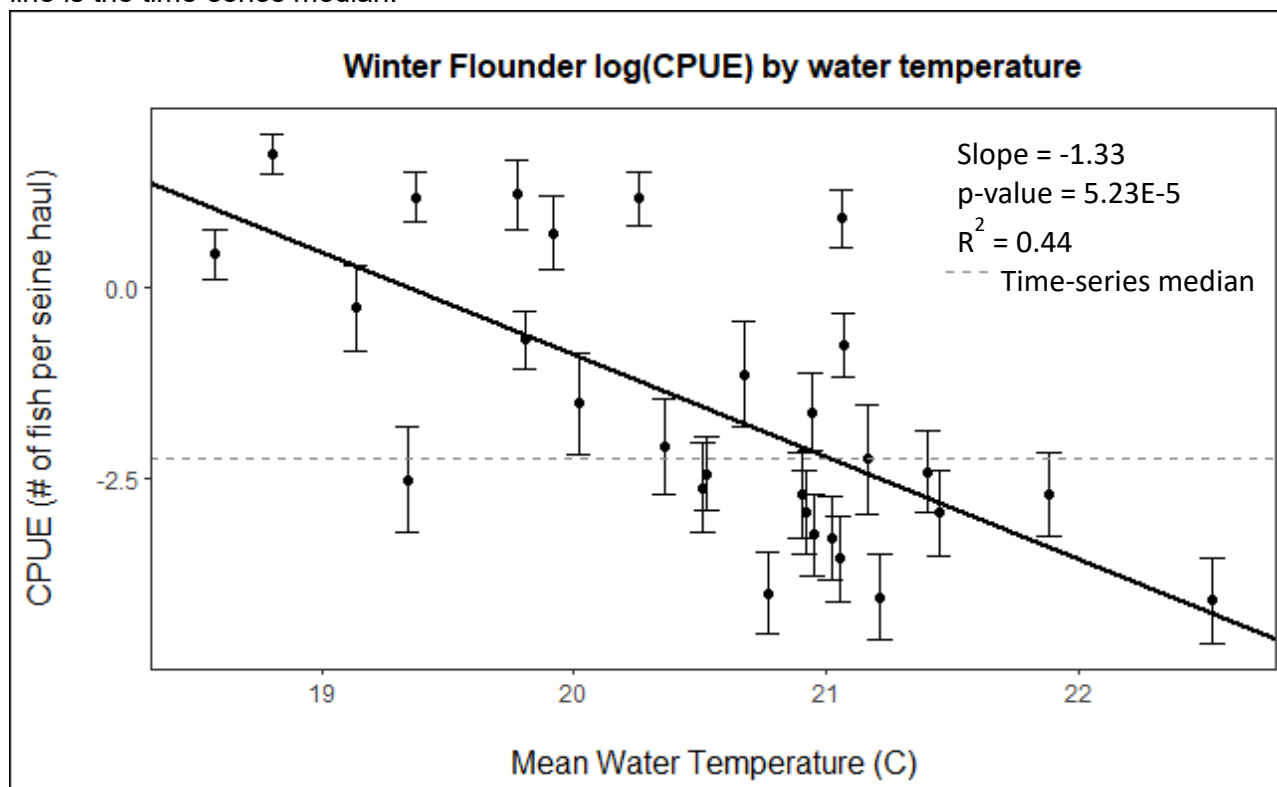




Figure 9: Abundance indices (fish/haul) from the RIDMF Coastal Pond Survey, Narragansett Bay Seine Survey, and Spring Trawl Survey for winter flounder.

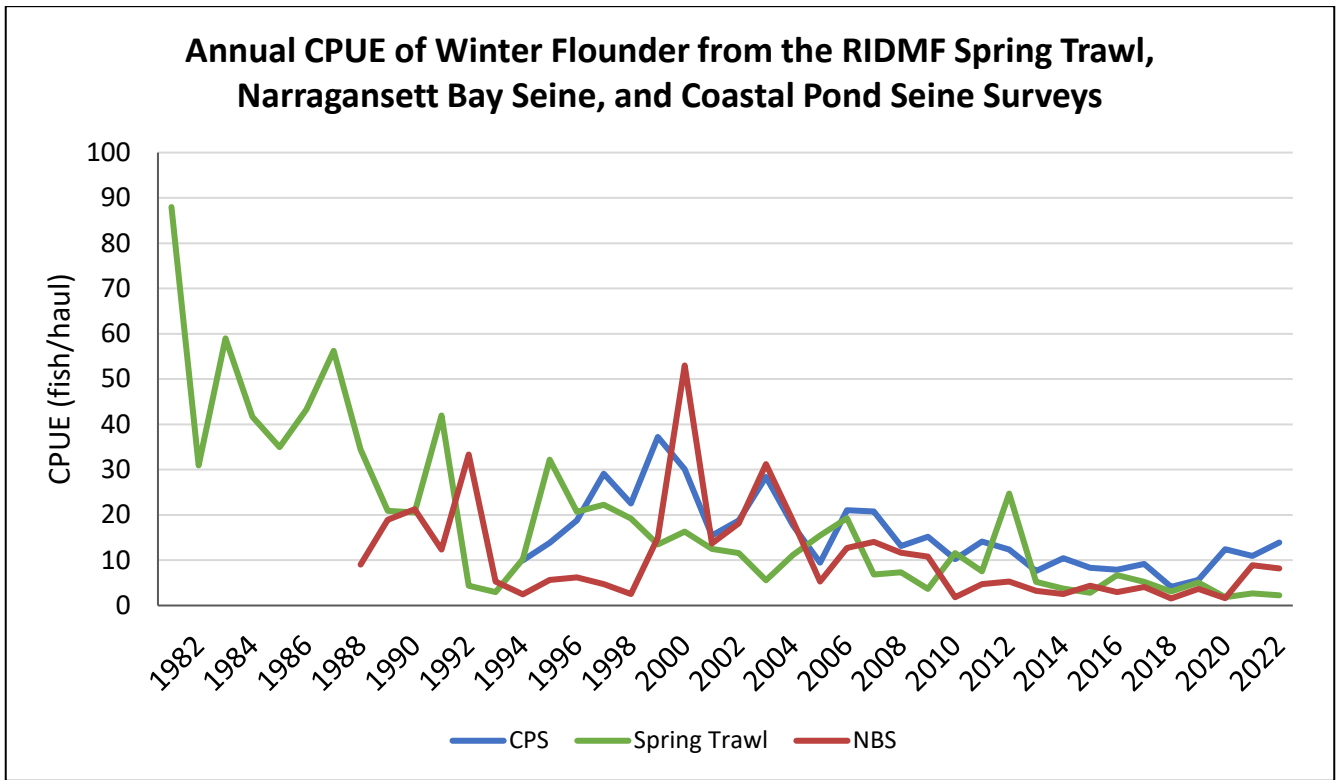


Figure 10: Abundance indices (fish/haul) from the Coastal Pond Survey and the Adult Winter Flounder Tagging Survey for winter flounder.

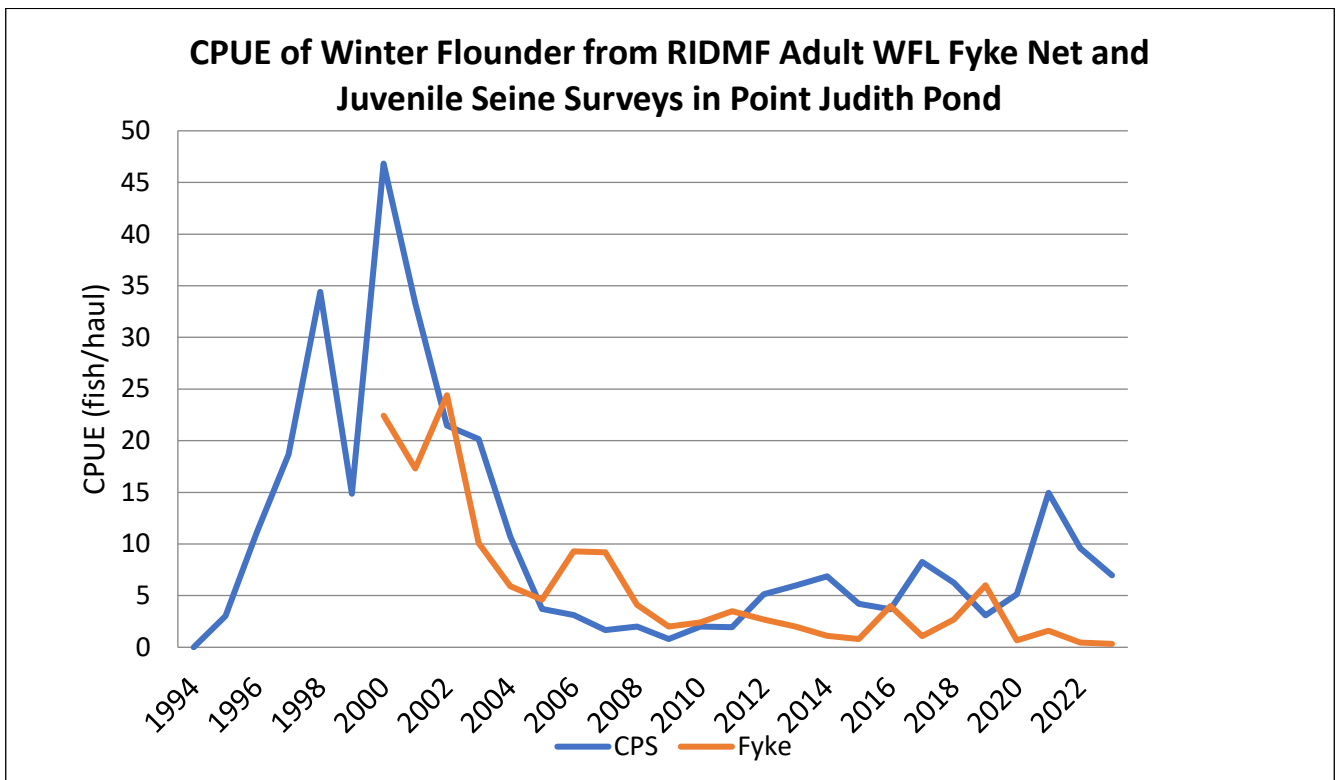


Figure 11. Time series of abundance indices for bluefish from the coastal pond survey. Solid line is a linear regression. Grey dashed line is time series median.

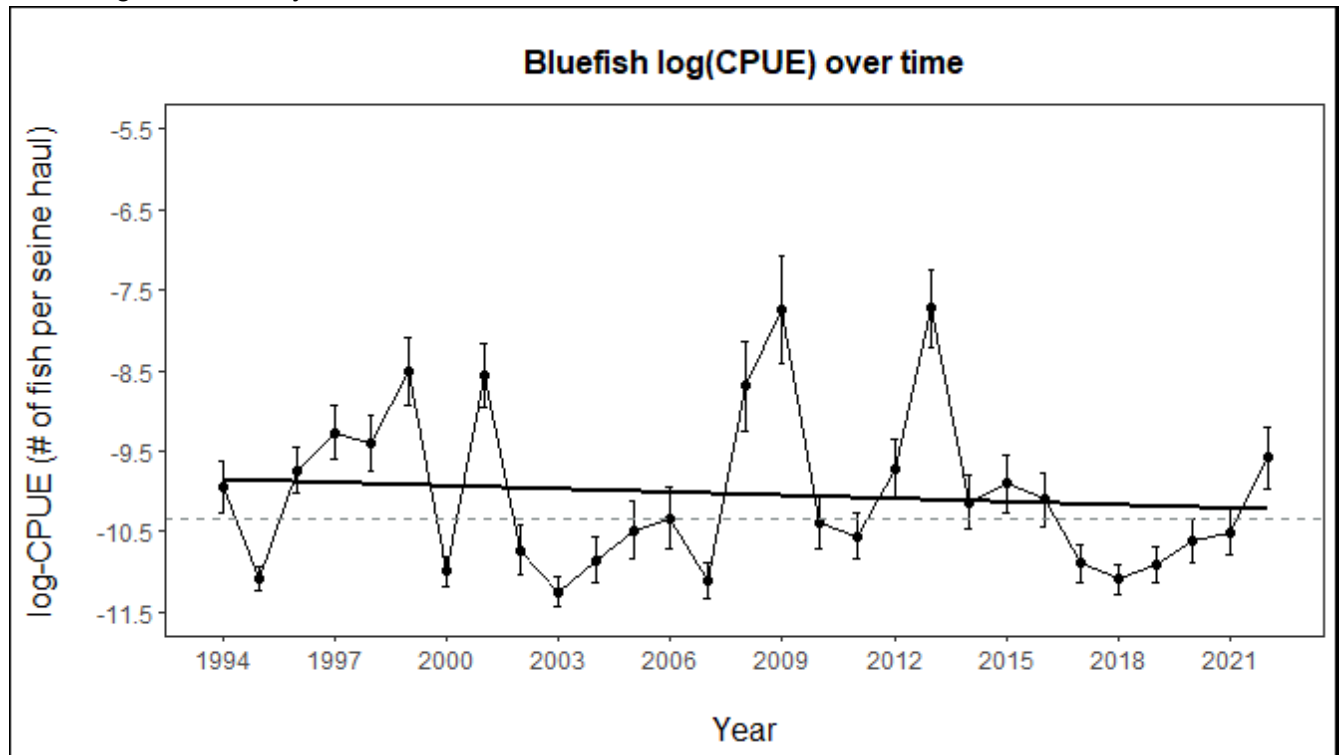


Figure 12. Time series of abundance indices for tautog from the coastal pond survey. Solid line is a linear regression. Grey dashed line is time series median.

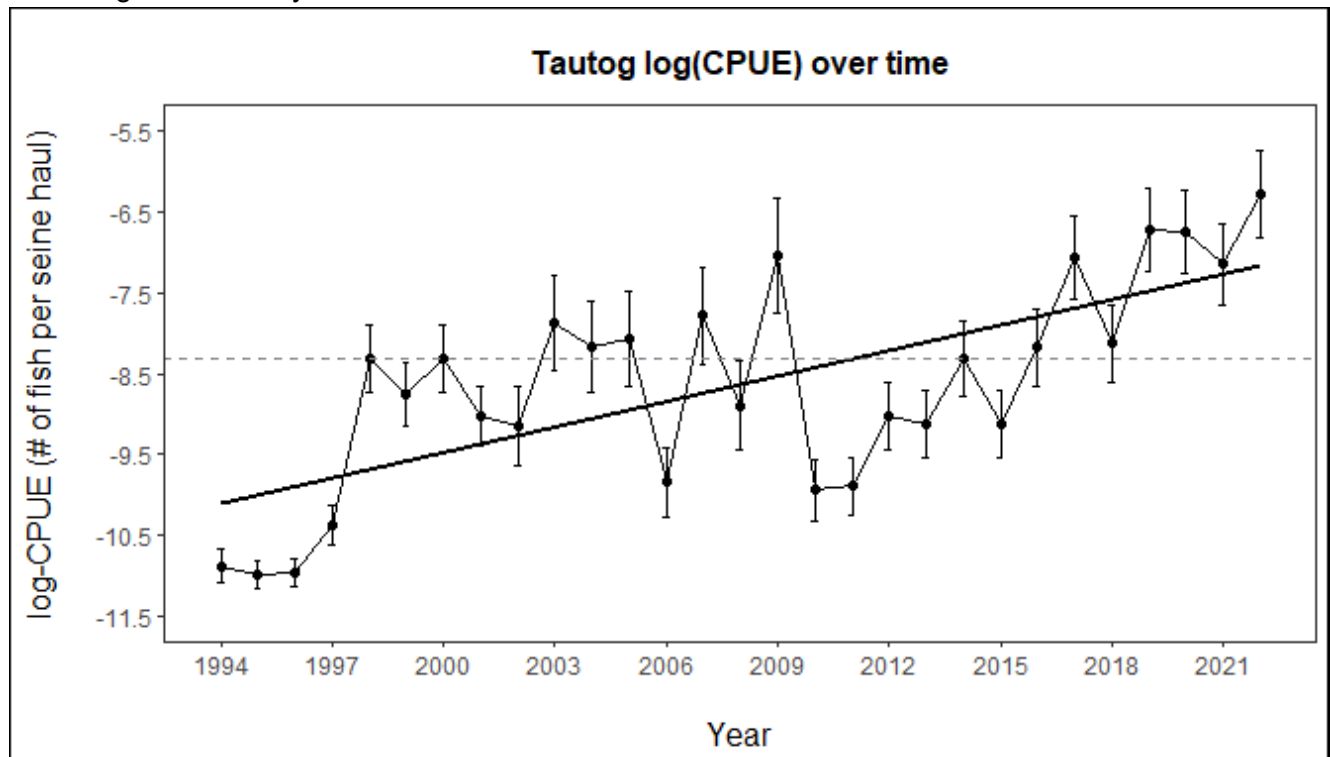


Figure 13. Time series of abundance indices for black sea bass from the coastal pond survey. Solid line is a linear regression. Grey dashed line is time series median.

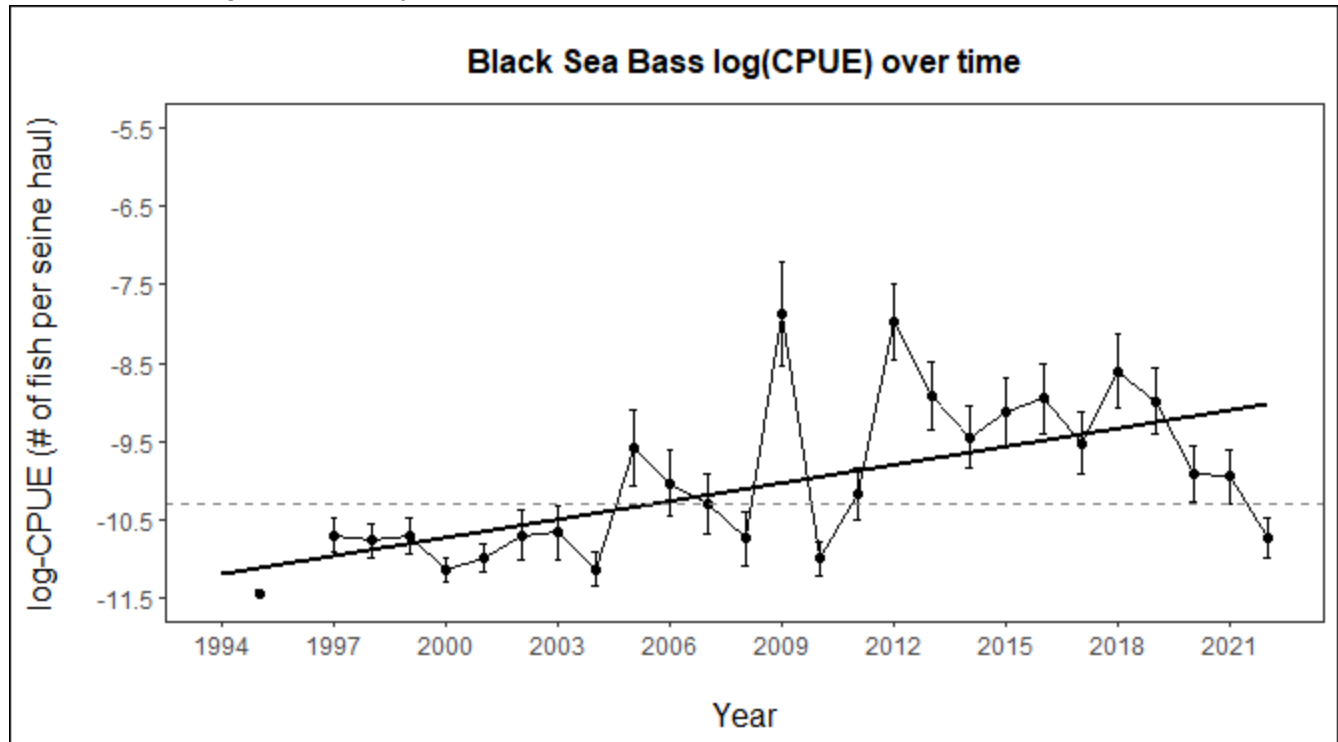


Figure 14. Time series of abundance indices for scup from the coastal pond survey. Solid line is a linear regression. Grey dashed line is time series median.

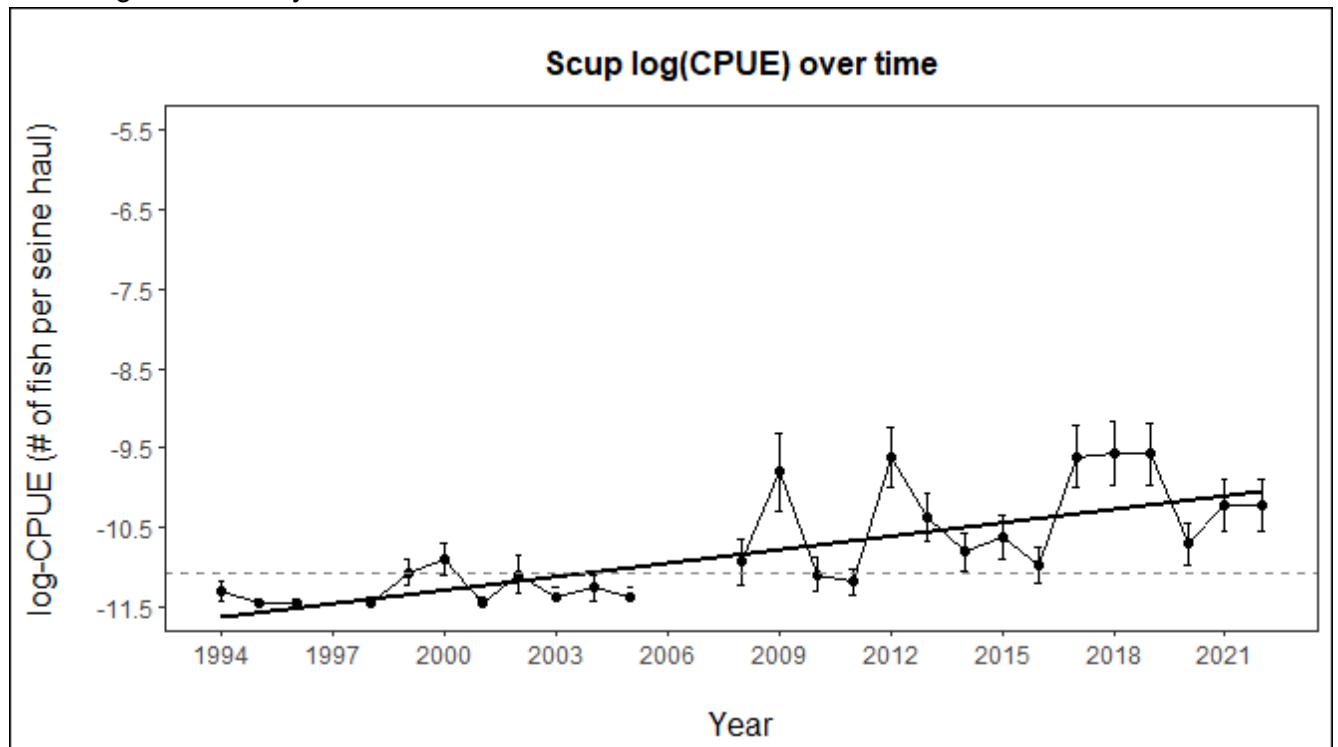


Figure 15. Time series of log-transformed abundance indices for clupeids from the coastal pond survey. Lines are loess smoothing curves with approximate 95% confidence intervals in grey.

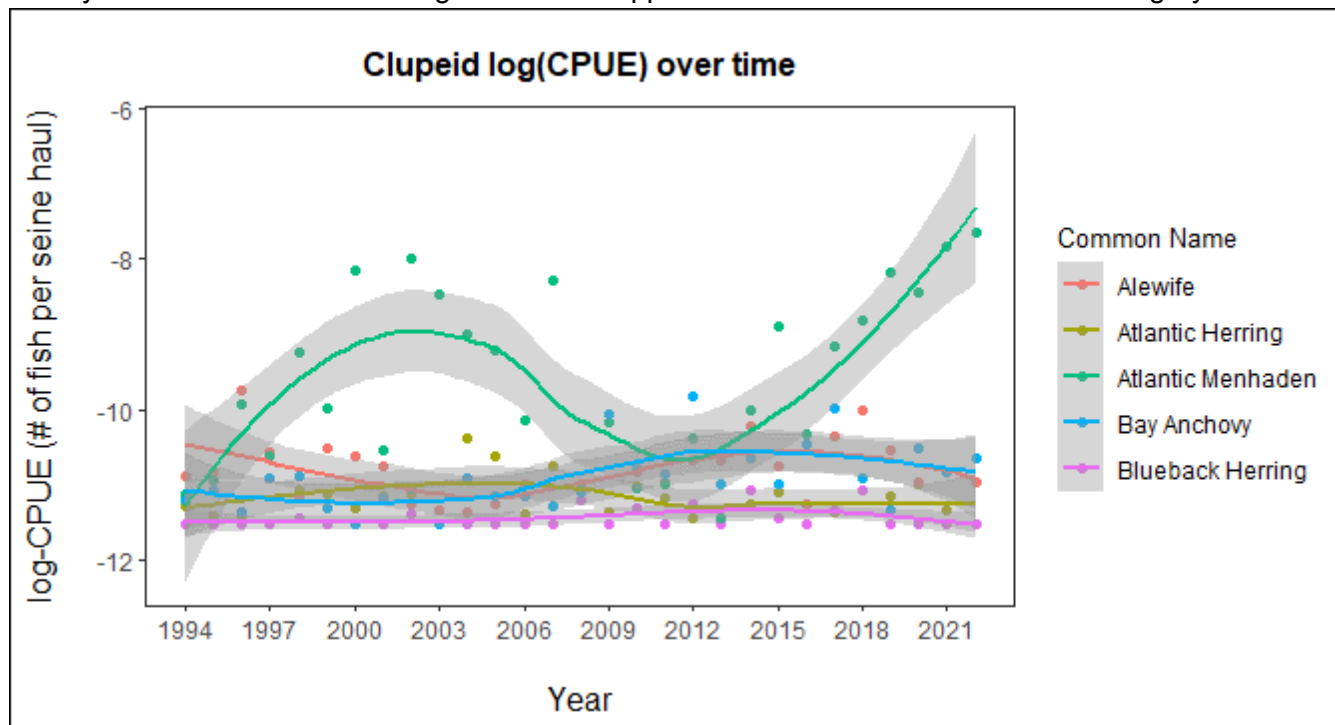


Figure 16. Time series of log-transformed abundance indices for baitfish from the coastal pond survey. Lines are loess smoothing curves with approximate 95% confidence intervals in grey.

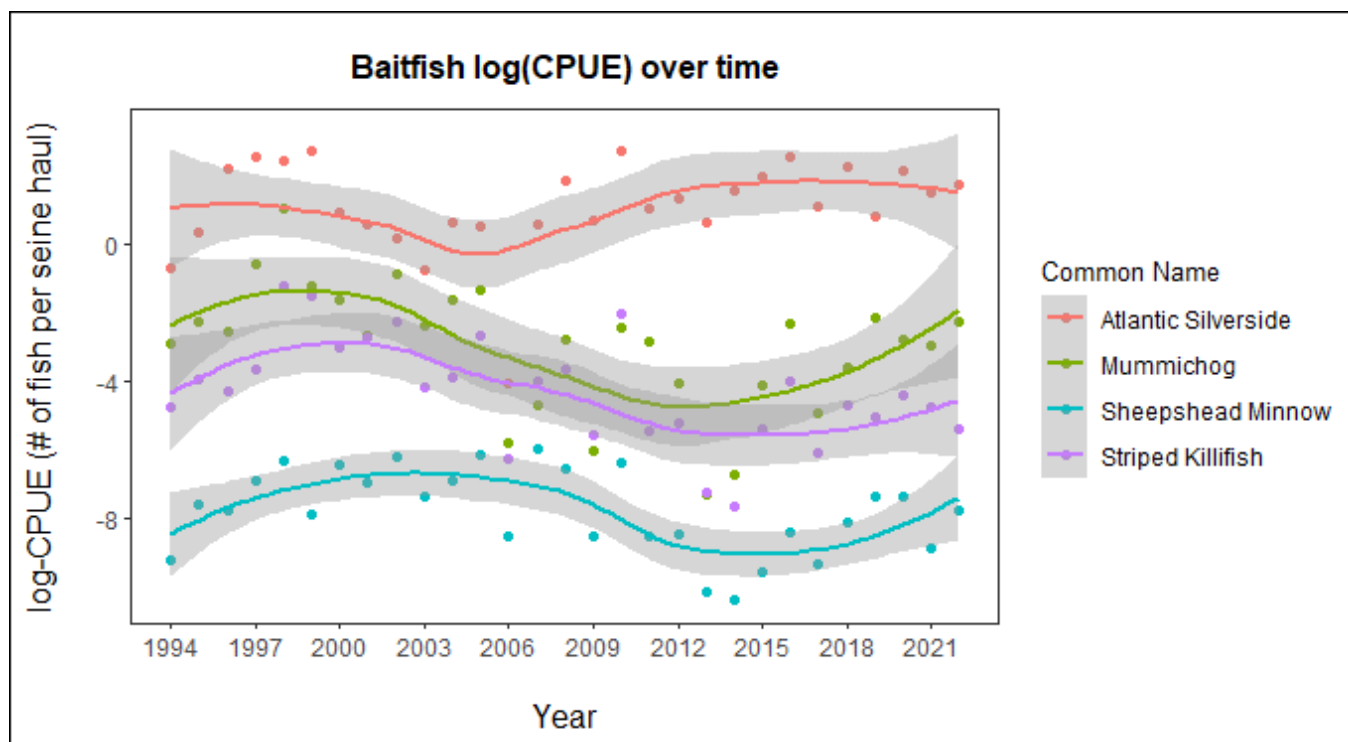
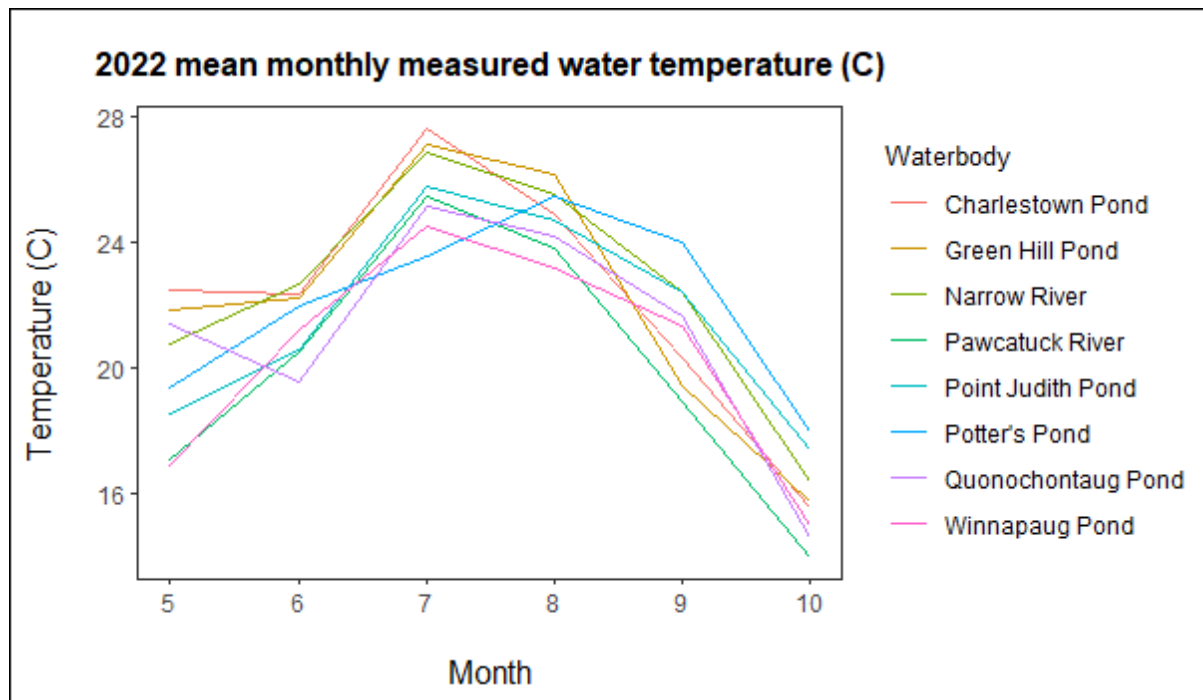


Figure 17. Average recorded water temperature in the coastal ponds by month for 2022.



Appendix 1: Catch frequency of all species by station for 2022 Coastal Pond Survey.

Species	CP1	CP2	CP3	CP4	GH1	GH2	NR1	NR2	NR3	PJ1	PJ2	PJ3	PJ4	PP1	PP2	PR1	PR2	PR3	QP1	QP2	QP3	WP1	WP2	WP3
ALEWIFE (ALOSA PSEUDOHARENGUS)		2					1			4		21							35					
ALLIGATORFISH (ASPIDOPHOROIDES MONOPTERYGIUS)									1															
ANCHOVY BAY (ANCHOA MITCHILLI)	2		1		50									23	1				1					3
BASS STRIPED (MORONE SAXATILIS)									1				23											
BLUE CRAB (CALLINECTES SAPIDIUS)							5	2	1	1						1	1	1			1			3
BLUE CRAB FEMALE (CALINECTES SAPIDIUS)	9	2	17	7	8	10	46	4	9	10	1		6	3	2	7		2	4	1	3			8
BLUE CRAB MALE (CALINECTES SAPIDIUS)	9	10	13	5	11	14	49	4	10	10			7	6	5	9	2	3	4		5	1	6	6
BLUEFISH (POMATOMUS SALTATRIX)		7	1	2					2	21	1	1	1	3			1	7	17	4	22	5		5
CUNNER (TAUTOGOLABRUS ADSPERSUS)			5								1		1		1		2		6	1				9
EEL AMERICAN (ANGUILLA ROSTRATA)	2		2			1	5	1	1							1								3
FLOUNDER SMALLMOUTH (ETROPUS MICROSTOMUS)																			1		1			6
FLOUNDER SPOTFIN (CYCLOPSETTA FIMBRIATA)																								1
FLOUNDER SUMMER (PARALICHTHYS DENTATUS)	3	1		1	1			3	1	3	1		3	1	1		2		4		1			1
FLOUNDER WINTER (PSEUDOPLEURONECTES AMERICANUS)	90	248	84	9	8	62	23	12	87	7	30	105	25	2	3	260	69	13	161	12	135	316	188	58
FLYINGFISH MARGINED (CYPSELURUS CYANOPTERUS)										1														
GOBIES (GOBIIDAE)																			2					
GOBY NAKED (GOBIOSOMA BOSCI)	1	2			13	4	2			1			1	19				1	4		1			
Green Crab (Carcinus maenas)	63	15	30					107	73	1	38	15	10			4	2	2	2	34	1	144	122	10
GRUBBY (MYOXOCEPHALUS AENAEUS)	1	1	1						16	1	6					3	2	1				8	6	
HAKE SPOTTED (UROPHYCIS REGIA)																					1			
HALFBEAK SILVERSTRIPE (HYPORHAMPHUS UNIFASCIATUS)																							1	
HOGCHOKER (TRINECTES MACULATUS)		1																						
HORSESHOE CRAB (LIMULUS POLYPHEMUS)																	1							
HORSESHOE CRAB FEMALE (LIMULUS POLYPHEMUS)																1			1		1			1
HORSESHOE CRAB MALE (LIMULUS POLYPHEMUS)										1						2			4		1			
JACK CREVALLE (CARANX HIPPOS)					5															1	4			
KILLIFISH STRIPED (FUNDULUS MAJALIS)	127		103	83		1	20	146		29	63	445	16		31	89	311	5	32	235	47	112	29	179
KINGFISH NORTHERN (MENTICIRRHUS SAXATILIS)	2	1						6	2				1		20	2	4		6					
MANTIS SHRIMP (SQUILLA MANTIS)	48																							

Species	CP1	CP2	CP3	CP4	GH1	GH2	NR1	NR2	NR3	PJ1	PJ2	PJ3	PJ4	PP1	PP2	PR1	PR2	PR3	QP1	QP2	QP3	WP1	WP2	WP3
MENHADEN ATLANTIC (BREVOORTIA TYRANNUS)	591	3759	4015			3		1654	6	89	1366	15	1	127	2724		1015	32	205	725	40285	3702	2007	581
MINNOW SHEEPSHEAD (CYPRINODON VARIEGATUS)	31	2	200	9	60	66	10	480			32	4		5	4	7			3		2	13	18	224
MOJARRA SPOTFIN (EUCINOSTOMUS ARGENTEUS)						1																		
MULLET WHITE (MUGIL CUREMA)	387	1					16				1			1					3	1	13		2	16
MUMMICHOG (FUNDULUS HETEROCLITUS)	73	297	1380	36	51	243	182	645	30	437	190	259	14	109	77	14		8	8	24	2	785	253	143
NEEDLEFISH ATLANTIC (STRONGYLURA MARINA)					1			2												4				2
PERCH WHITE (MORONE AMERICANA)							450	190	5															
PIPEFISH NORTHERN (SYNGNATHUS FUSCUS)	2	4	1			1	2	2	2	5	2		1	11	5	1	2	1	2		2	2	2	1
PUFFER NORTHERN (SPHROIDES MACULATUS)		7					1		1				1			1			1	4		12		2
RAINWATER KILLIFISH (LUCANIA PARVA)	78	24	204	3	7	53	3	8	3	55	4			54	100				4	4			2	10
SAND LANCE AMERICAN (AMMODYTES AMERICANUS)																1								
SCUP (STENOTOMUS CHRYSOPS)		87	1				5								3	30	8	13	69	1				
SEA BASS BLACK (CENTROPYSTIS STRIATA)	12	3						7	3											1				4
SEAHORSE LINED (HIPPOCAMPUS ERECTUS)																	1							
SEAROBIN NORTHERN (PRIONOTUS CAROLINUS)	1	1																						1
SEAROBIN STRIPED (PRIONOTUS EVOLANS)	2	2		1				2	4							4				1	1	4		8
SENNET NORTHERN (SPHYRAENA BOREALIS)	1	1				1				1	15				4									
SILVERSIDE ATLANTIC (MENIDIA MENIDIA)	643	1491	644	1497	912	284	139	478	898	830	168	922	258	258	140	121	75	600	185	1146	310	521	1001	277
SPOT (LEIOSTOMUS XANTHURUS)					1		12																	4
SQUIRRELFISHES (HOLOCENTRIDAE)														1										
STICKLEBACK FOURSPINE (APELTES QUADRACUS)	37	12	5			14		22	21	3			1	5	3	3	3	9	2				92	2
STICKLEBACK THREESPINE (GASTEROSTEUS ACULEATUS)	1		1					1																
TAUTOG (TAUTOGA ONITIS)	32		5					10	15	46	14	8	19	9	18	8	5	32	32	14	23	9	38	9
TOADFISH OYSTER (OPSANUS TAU)	1					7		1	1		1		1	15	4									
TOMCOD ATLANTIC (MICROGADUS TOMCOD)																1	2	18						
WEAKFISH (CYNOSCION REGALIS)															26				14					

The Rhode Island Chapter of The Nature Conservancy  
Annual Performance Report

Submitted to

The Rhode Island Department of Environmental Management  
Division of Fish and Wildlife

Title: Block Island Seine Survey

Cooperative Agreement Award Number: 3425240

Award Term: January 15, 2020 to December 31, 2024

Reporting Period: January 1, 2022 to December 31, 2022

Prepared By

Diandra Verbeyst (Great Salt Pond Scientist)

Approved By

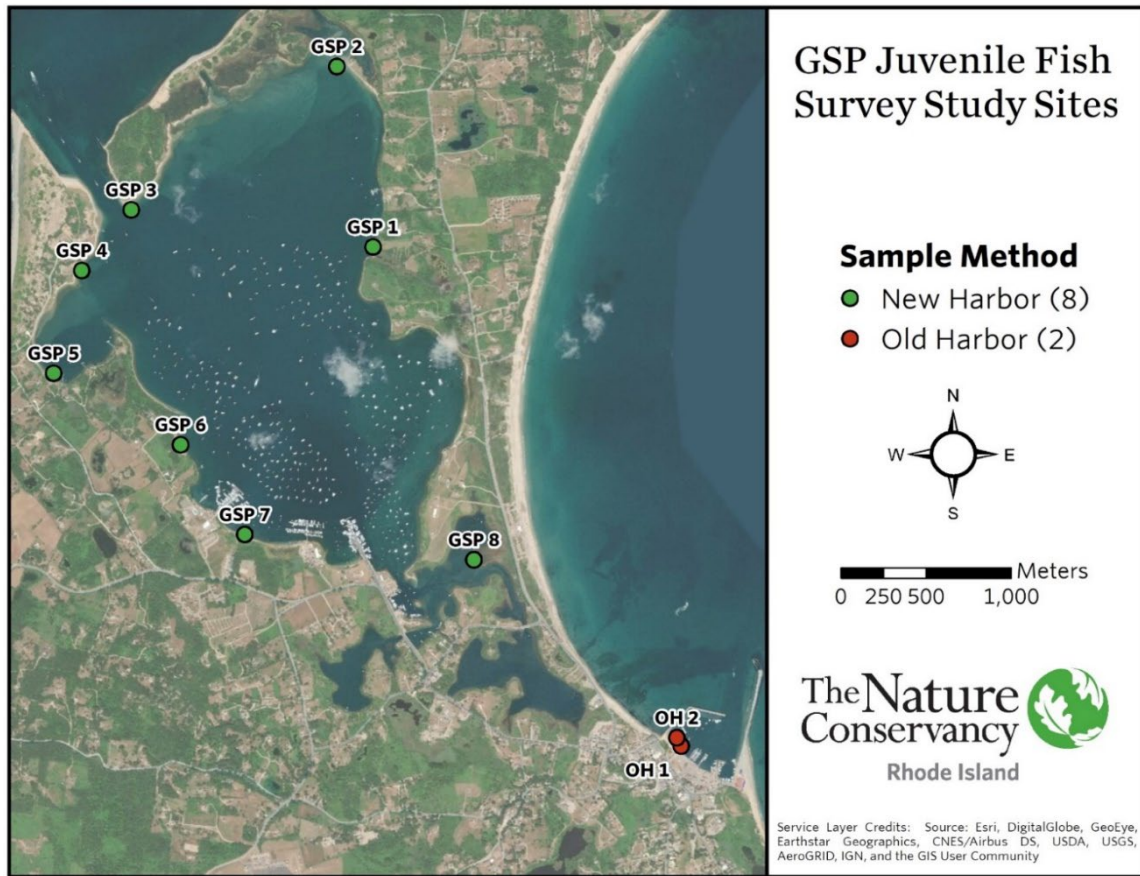
Scott Comings, Associate State Director

The Nature Conservancy Rhode Island Chapter  
159 Waterman Street  
Providence, RI 02906





Map of study area and sampling locations.



## **SUMMARY:**

During the 2022 season, a total of 60 seines were hauled across 10 sites in May through October resulting in the enumeration of 35,448 individuals. 34,842 of those individuals were finfish and 606 were other marine invertebrates. Of the animals caught, 3,750 individuals were measured, and 61 species were identified (see Table 1). Despite the additional considerations for safely working in the field during the COVID-19 pandemic, all scoped work was completed. All raw data have been shared with the appropriate staff of the Division of Marine Fisheries (DMF) and The Nature Conservancy (TNC) for incorporation into existing datasets.

For the entire time series (2014-2022), all individuals of the target species: winter flounder, summer flounder, tautog, scup, and black sea bass were enumerated and measured. The abundance indices for the target species only target young-of-the-year (YOY) individuals. Adults and juveniles of other species collected were not differentiated for data analysis or descriptive purposes. Presence and relative abundance of three forage species: silversides spp., common mummichog, and striped killifish were noted in this report. Presence and absence of bluefish and members of the Clupeidae family: Atlantic menhaden and river herring (alewife and blueback herring) were also included in this report. Since 2020 the gender and total carapace length of any blue crab, green crab, and horseshoe crab were measured and recorded. Data on weather, depth, water temperature, salinity, and dissolved oxygen were also recorded at each station since that start of the Block Island (BI) time series.

## **TARGET DATE:**

December 31, 2022

## **NEXT STEPS:**

Investigators intend to continue sampling with the same methodology for the 2023 field season. Additionally, the Great Salt Pond (GSP) project team will coordinate with the primary investigators of the Coastal Ponds (CP) and Providence River Estuary (PRE) juvenile fish surveys to evaluate variations in fish assemblages across study areas in Rhode Island (RI).

## **INTRODUCTION:**

Estuaries provide essential nursery habitat for about two-thirds of the economically important fish species along the East Coast of the United States (Boesch and Turner 1984; Able 2005). In Rhode Island waters, more than 70% of commercially and recreationally important fish species are estimated to use estuaries for a portion of their life cycle, particularly early life stages (Meng and Powell 1999). While the linkage between habitat and fish production continues to be studied, it remains clear that many fisheries are concentrated on species that use estuaries as nurseries and identifying and valuing these ecosystems is a critical part of their conservation.

On Block Island, Rhode Island, the defining estuary is the Great Salt Pond. The Great Salt Pond is a 1,000-acre navigable estuary found in the center of the island. Having unique offshore features, the Great Salt Pond is generally known for its deeper depths, varied slopes, structure, and rich bottom communities (Hale 2000; Katz 2000). Although many studies have described the Great Salt Pond to be highly productive, there has been limited historic and empirical data to support these claims. In fact, a subsequent literature review revealed that one of the more recent finfish surveys documented in the Great Salt Pond was in 1992 as a part of a master's thesis (Neuman 1993). This gap in information

further supports the critical need to better understand the Great Salt Pond and its role in supporting fish populations.

In 2014, the Division of Marine Fisheries and The Nature Conservancy entered into a cooperative agreement and established the juvenile fish seine survey on Block Island. Through a holistic approach to monitoring, fish assemblages, water quality, and benthic habitat were evaluated in the Great Salt Pond and Old Harbor. Not only did the initial results show that the study area supported recreationally and commercially important juvenile finfish, but it also recognized that these areas could support habitat improvements aimed at increasing fish recruitment. As the habitat and water quality of the Great Salt Pond and Old Harbor continue to change, this seine survey will serve to document how these changes affect fish assemblage on Block Island over time. It also provides time series comparisons for other established seine surveys happening in the Providence River Estuary and Coastal Ponds of southern Rhode Island. Continuation of this survey has proven to be a valuable tool for the Division of Marine Fisheries and The Nature Conservancy for assessing fish populations across Rhode Island waters.

## **METHODS:**

All 8 stations in the GSP and 2 stations in Old Harbor (OH) were sampled at monthly intervals from May through October. Sampling occurred on the incoming tide and in the rocky intertidal zone at depths shallower than 2m. At each site a 130' long, 5.5' deep, ¼" mesh net beach seine was used to collect species. This net was also outfitted with a midpoint pocket, weighted footrope, and a floated headrope, all consistent with the net used in the YOY Survey of Selected RI Coastal Ponds and Embayments (conducted as part of F-61-R-23, Job #3). For sampling in the GSP, the net was deployed by boat along the shoreline to create a semi-circle set for the seine haul. In OH, sampling required investigators to set and haul the net without a vessel. The average area swept of the net was calculated to be 2,112sq ft. The net was then hauled by hand from both ends toward the beach. Animals caught were transferred into a large water-filled tote. All collected animals were identified to genus or species and measured and enumerated to the nearest centimeter for total length (TL) (except for flounder species which were measured to the nearest millimeter). Additionally, the gender and total carapace length of any blue crabs, green crabs, or horseshoe crabs were recorded. When appropriate, species were subsampled by measuring the first 20 individuals identified and then counting the remainder. Upon completion, all animals were released back into the water at the collection site. At each sampling site, water temperature (°C), salinity (ppt), dissolved oxygen (mg/L), water depth, and transparency were recorded with a Professional Plus series handheld YSI multiparameter meter and Secchi disk. The YSI multiparameter meter was calibrated monthly throughout the sampling season according to manufacturer recommendations.

## **RESULTS & DISCUSSION:**

For the 2022 field sampling season, a total of 60 seines were hauled across the 10 sampling sites. A total of 35,448 individuals were identified and enumerated, and 3,750 of those were measured. A total of 61 species were caught (Table 1). Of the species caught, only finfish were included in the results below (all crustaceans were excluded).

Excluding Atlantic menhaden from the analysis, a mean of  $128.40 \pm 101.46$  SE finfish were caught per haul in 2022. Catch per haul across sites was greatest at the sand flat in OH (OH 2) at  $1020.00 \pm 931.13$  SE and lowest at the Ball O'Brien site in the GSP (GSP 7) at  $11.33 \pm 10.35$  SE (Figure 1). Catch per

haul across months was greatest in September at  $731.50 \pm 602.06$  SE and lowest in October at  $38.90 \pm 25.17$  SE (Figure 2).

### *TARGET SPECIES*

#### Winter Flounder (*Pseudopleuronectes americanus*)

Of the total 185 winter flounder caught in 2022 seines, 172 individuals were YOY, and 13 individuals were age 1+ (max length = 220 mm; Able and Fahay 1998; Berry et al. 1965; Meng et al. 2000). Winter flounder were collected during all months and caught at all stations except for GSP 7 (Ball O'Brien site) in 2022 (Table 2). The most abundant site for winter flounder was the inner pond site in the GSP (GSP 8) at a catch per haul of  $8.00 \pm 3.21$  SE (Figure 3a). The most abundant month for winter flounder was June at a catch per haul of  $4.80 \pm 2.28$  SE fish/seine haul (Figure 3b). In past survey seasons, the sites in OH (OH 1-2) were recorded as sites of highest abundance for the BI time series. The 2022 juvenile winter flounder abundance index was  $3.08 \pm 0.60$  SE fish/seine haul, which is lower than the 2021 index of  $4.62 \pm 1.02$  SE. The BI survey's highest abundance index for juvenile winter flounder was recorded in 2016 at a catch per haul of  $10.22 \pm 3.59$  SE fish/seine haul.

#### Summer Flounder (*Paralichthys dentatus*)

A total of 15 summer flounder were caught in 2022 beach seines ranging in size from 30mm to 120mm. Summer flounder were caught at 5 of the 10 stations: GSP 3 (Beane Point), GSP 4 (Coast Guard Station), GSP 8 (Inner Pond), OH 1 (eelgrass bed), and OH 2 (sand flat). Summer flounder were most abundant at the OH sites and had slight deviations between catch per hauls:  $1.00 \pm 0.41$  SE at OH 1 (eelgrass bed) and  $1.00 \pm 0.75$  SE at OH 2 (sand flat) (Figure 3a). In 2022, one individual was caught in May, three were caught in June, and the remaining nine were caught between August and October (Figure 3b). Since the start of the BI time series, summer flounder has been the least abundant catch for the interest group.

#### Tautog (*Tautoga onitis*)

During the 2022 survey 381 tautog were collected and ranged in size from 2cm to 35cm. This total number is an increase from the 2021 survey when 357 juveniles were collected. The 2022 abundance index was  $6.35 \pm 1.57$  SE, an increase from the 2021 index  $5.95 \pm 1.37$  SE. Juvenile tautog were caught at every station in 2022. The species was most abundant at OH 1 (eelgrass bed) with a catch per haul of  $17.67 \pm 8.10$  SE (Figure 3a). Tautog were most abundant in September with a catch per haul of  $13.70 \pm 5.85$  SE (Figure 3b). For the BI time series, all survey years except 2016 and 2019 recorded highest abundance of tautog in September.

#### Black Sea Bass (*Centropristis striata*)

One hundred and eighty-five black sea bass were caught in 2022, which is a slight decrease from the 195 individuals that were collected in 2021. The number of black sea bass has been highly variable from year-to-year during the time series survey, with 2015 and 2019 numbers standing out as significantly higher across survey years. In 2022, black sea bass individuals collected during sampling ranged in size between 2cm and 11cm. The highest mean monthly abundance for 2022 occurred in September at  $8.90 \pm 5.40$  SE (Figure 3b). Black sea bass were caught at all stations apart from GSP 8

(Inner Pond). The Coast Guard Station (GSP 4) had the highest mean abundance of  $17.67 \pm 8.55$  SE (Figure 3a).

The abundance index for black sea bass in 2022 was  $3.08 \pm 1.17$  SE fish/seine haul. This is slightly lower than the 2021 index of  $3.25 \pm 1.19$  SE fish/seine haul. While the 2022 index decreased from the previous season's index, the 2022 abundance was greater than past sampling years (2014 and 2017) when less than 25 individuals were collected during the season. The fall index dropped down from the high values in 2015 and 2016 but did show increase in abundance starting in 2018. This recruitment signal in recent years was also observed all along the Northern Atlantic coast (Tuckey and Fabrizio 2019). While investigators note that indices rise and fall, the presence of black sea bass has been increasingly prevalent across regional seine surveys (NEFSC 2017).

#### Scup (*Stenotomus chrysops*)

A total of 24 scup were caught in 2022 from June through October, a slight increase from 2021 when 17 scup were collected. The total survey abundance for 2022 was  $0.40 \pm 0.21$  SE fish/seine haul. Scup were caught at 4 of the 10 sites: Harris Point (GSP 1), Cormorant Cove (GSP 5), and both sites in OH (OH 1-2). Scup were most abundant at the sand flat site in OH (OH 2) with a catch per haul of  $2.83 \pm 1.74$  SE (Figure 3a). Most individuals were caught in October at a catch per haul of  $1.20 \pm 1.20$  SE in 2022 (Figure 3b). Scup caught in 2022 ranged in size between 3cm and 28cm, representing ages-0-to-age-6 based on mean length-at-age data from a combination of studies based out of the Mid-Atlantic, southern New England, Georges Bank, Gulf of Maine, and Nova Scotia (Penttila et al. 1989).

#### *OTHER SPECIES OF INTEREST*

#### Bluefish (*Pomatomus saltatrix*)

A total of 79 bluefish were caught in 2022, which is an increase from the 33 individuals that were caught in 2021. The total mean abundance per haul was  $1.32 \pm 1.03$  SE ranging in size from 6cm to 18cm. Bluefish were found from August through October at stations GSP 4 (Coast Guard Station), OH 1 (eelgrass bed), and OH 2 (sand flat). Bluefish were most abundant at the eelgrass site in OH (OH 1) with a catch per haul of  $11.00 \pm 9.33$  SE. The most individuals were caught in September at a catch per haul of  $7.10 \pm 6.17$  SE in 2022.

#### Family Clupeidae

In 2022, three species of clupeids were collected during the sampling season: alewife, Atlantic Menhaden, and blueback herring. While other species of clupeids have been collected in past BI surveys (Atlantic herring and hickory shad), they were not captured during the 2022 season. Due to the difficulty of separating juvenile alewives from juvenile blueback herring without sacrificing them, both species are collectively referred to as river herring. Investigators also acknowledge that although large schools of clupeid species were not encountered in the 2022 survey, they were most likely present in the system, particularly in large abundances, and may have been missed while sampling.

#### Atlantic Menhaden (*Brevoortia tyrannus*)

Atlantic menhaden was the most frequent clupeid species documented in 2022, with 7,704 individuals caught in the GSP and OH between September and October. This is an increase from the 2021 survey

when several schools of menhaden were caught from July through October, totaling 1,835 individuals. The total survey mean abundance index was  $128.40 \pm 101.46$  SE in 2022. Menhaden were caught at 5 out of 10 sites in the GSP (GSP 1-3, 7-8), and both sites in OH (OH 1-2). The species was most abundant at the sand flat site in OH (OH 2) with a catch per haul of  $1020.00 \pm 931.13$  SE. The highest number of individuals were caught in September at a catch per haul of  $731.50 \pm 602.06$  SE. Menhaden TL measurements ranged from 3cm to 13cm in 2022.

Juvenile menhaden have been observed in very large schools on BI since 2015. This behavior often results in single large catches resulting in high abundance indices and large standard errors. It also contributes to the variability of their spatial and temporal abundance from year to year. In 2022, there were minimal instances in which more than 1,000 individuals were caught in a single haul. Because of these characteristics, it is difficult to develop an abundance index that will accurately reflect the number of juveniles observed in the field rather than the number represented in the samples.

#### River Herring (*Alosa pseudoharengus* & *Alosa aestivalis*)

A total of 45 river herring were caught in 2022. Both alewife and blueback herring are classified as river herring in this survey. River herring ranged in size from 1cm to 13cm and were found in August and September at both sites in OH (OH 1-2) with a total survey mean abundance of  $0.75 \pm 0.45$  SE fish/seine haul in 2022.

#### Forage Fish Species

Forage fish species are commonly encountered across stations and months during the sampling season. In 2022, silversides, striped killifish, and common mummichog comprised more than 69.7% of the total catch, which is lower than percentages recorded for previous survey years. While other baitfish species such as sheepshead minnow were encountered this season in abundance, we selected the species below since their presence have been the most notable and reported on since the start of the time series.

#### Silversides spp. (*Menidia* spp.)

Silversides had the highest abundance of all finfish species caught during the 2022 survey. The species has been ranked as the most abundant finfish species since the start of the BI survey in 2014. For the purposes of this survey and streamlining report criteria, Atlantic silverside and inland silversides are collectively referred to as silversides (*Menidia* spp.).

A total of 18,478 silversides were caught in 2022. The total mean abundance was  $307.97 \pm 80.06$  SE in 2022 and was higher than last year's index of  $222.27 \pm 70.15$  SE, making it the second highest abundance index for the overall time series. The species was most abundant at the sand flat site in OH (OH 2) with a catch per haul of  $1213.17 \pm 551.47$  SE in 2022. The highest number of silversides were caught in September at a catch per haul of  $761.40 \pm 298.22$  SE in 2022, which is consistent with past survey records. Silversides ranged in size from 1cm to 15cm and were found in all months and stations.

#### Striped Killifish (*Fundulus majalis*)

A total of 5,738 striped killifish were collected in 2022 and ranged in size from 1cm to 13cm. The species ranked third in highest abundance this season, which is consistent with previous survey years when the species was ranked either second or third for all species caught. In 2022, striped killifish

occurred at all stations except OH 1-2 and during all months except for May. The total mean abundance was  $95.63 \pm 31.30$  SE in 2022, which is higher than the 2021 index of  $38.25 \pm 12.27$  SE. In 2022, the highest number of striped killifish were caught in September at a catch per haul of  $272.10 \pm 104.26$  SE, and they were most abundant at Andy's Way (GSP 2) with a catch per haul of  $500.83 \pm 220.91$  SE.

#### Common Mummichog (*Fundulus heteroclitus*)

Four hundred and ninety-eight mummichogs were caught during the 2022 survey. The individuals ranged in size from 3cm to 12cm in 2022. The species was caught at all stations this season except at OH 1. In 2022, mummichogs were most abundant in August at a catch per haul of  $35.20 \pm 30.06$  SE and had the highest abundance at the Andy's Way (GSP 2), with a catch per haul of  $57.33 \pm 45.48$  SE in 2022. The total mean abundance was  $8.30 \pm 5.09$  SE in 2022. Catch frequencies of mummichogs have been variable across survey years for the BI time series.

#### *WATER QUALITY DATA*

Water quality data for the 2022 season can be found in Table 3. In the GSP, water temperature ranged from 13.9°C in May to 25.0°C in August. In OH, water temperature ranged from 13.7°C in May and 21.8°C in August. The mean salinity of the 8 sites in the GSP was  $31.10\text{ppt} \pm 0.08$  SE, and the mean salinity of the 2 sites in OH were  $31.89\text{ppt} \pm 0.08$  SE. The lowest dissolved oxygen value recorded across the GSP sites was 7.06mg/L in September at Andy's Way (GSP 2), while the mean was  $8.68\text{mg/L} \pm 0.14$  SE. In 2022, the eelgrass site in OH (OH 1) recorded the lowest dissolved oxygen value at 8.14mg/L in August, with a mean of  $8.98\text{mg/L} \pm 0.21$  SE between the OH sites.

#### **SUMMARY:**

In 2022, investigators caught 52 species of finfish representing 32 families. These numbers are fairly consistent with 2021 when 54 species from 30 families were collected. The number of finfish individuals caught in 2022 increased from the 2021 survey, with 34,842 collected in 2022, and 19,203 collected in 2021. This year also marked the highest number of individual species caught over the last 9 years of the BI juvenile fish survey. Frequency of all species caught by station during the 2022 BI survey can be found in the appendix. Additional data is available upon request.

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**FIGURES:**

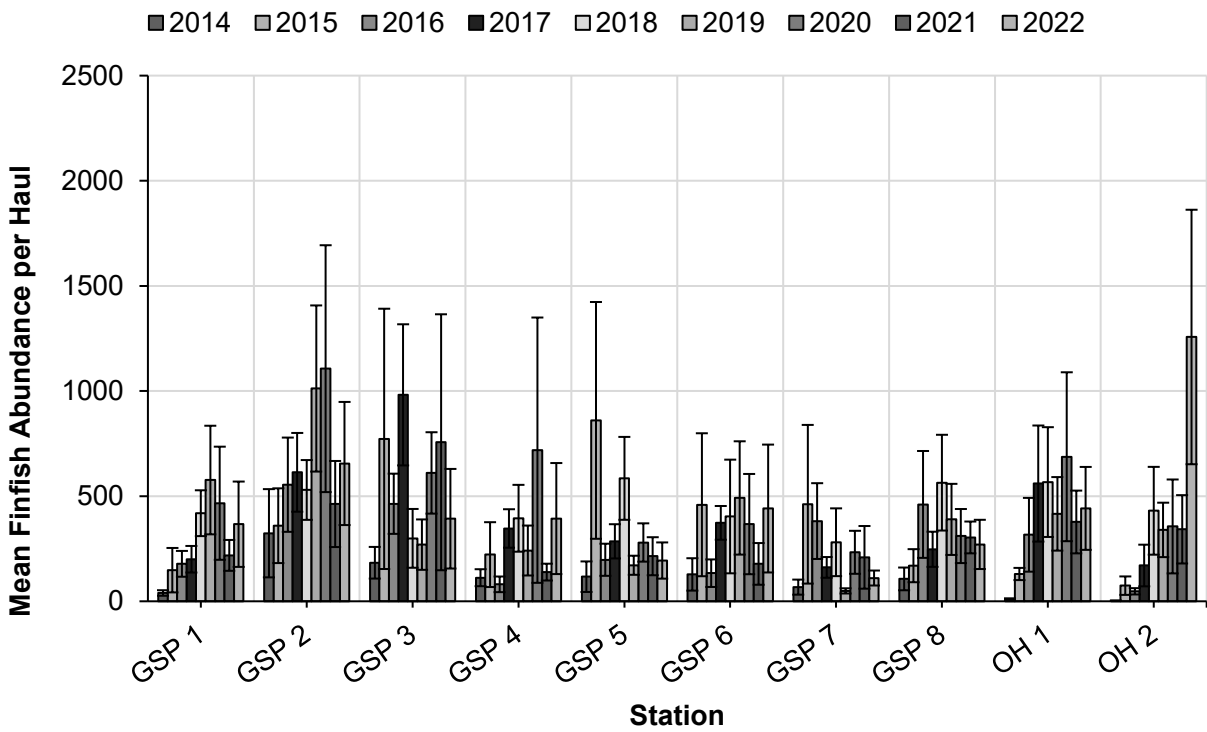


Figure 1. Mean abundance of finfish across stations ( $\pm$  SE) in 2014-2022 beach seines.

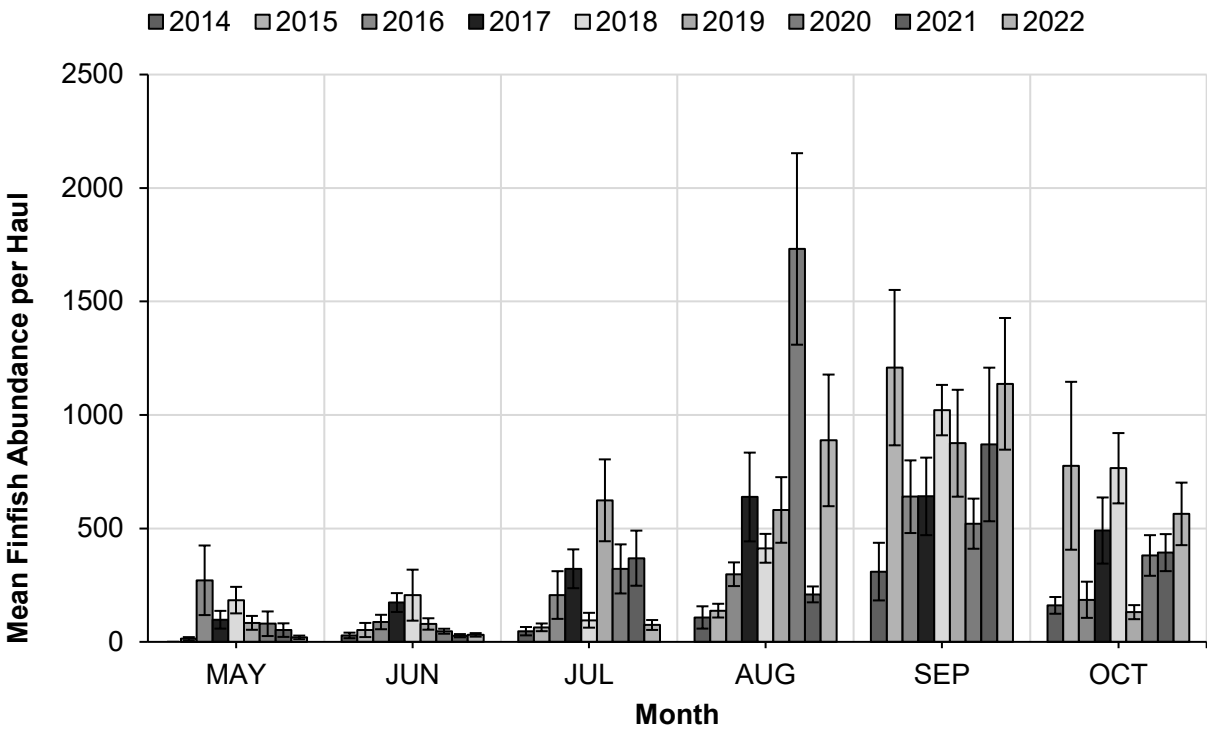


Figure 2. Mean abundance of finfish caught each month ( $\pm$  SE) in 2014-2022 beach seines.

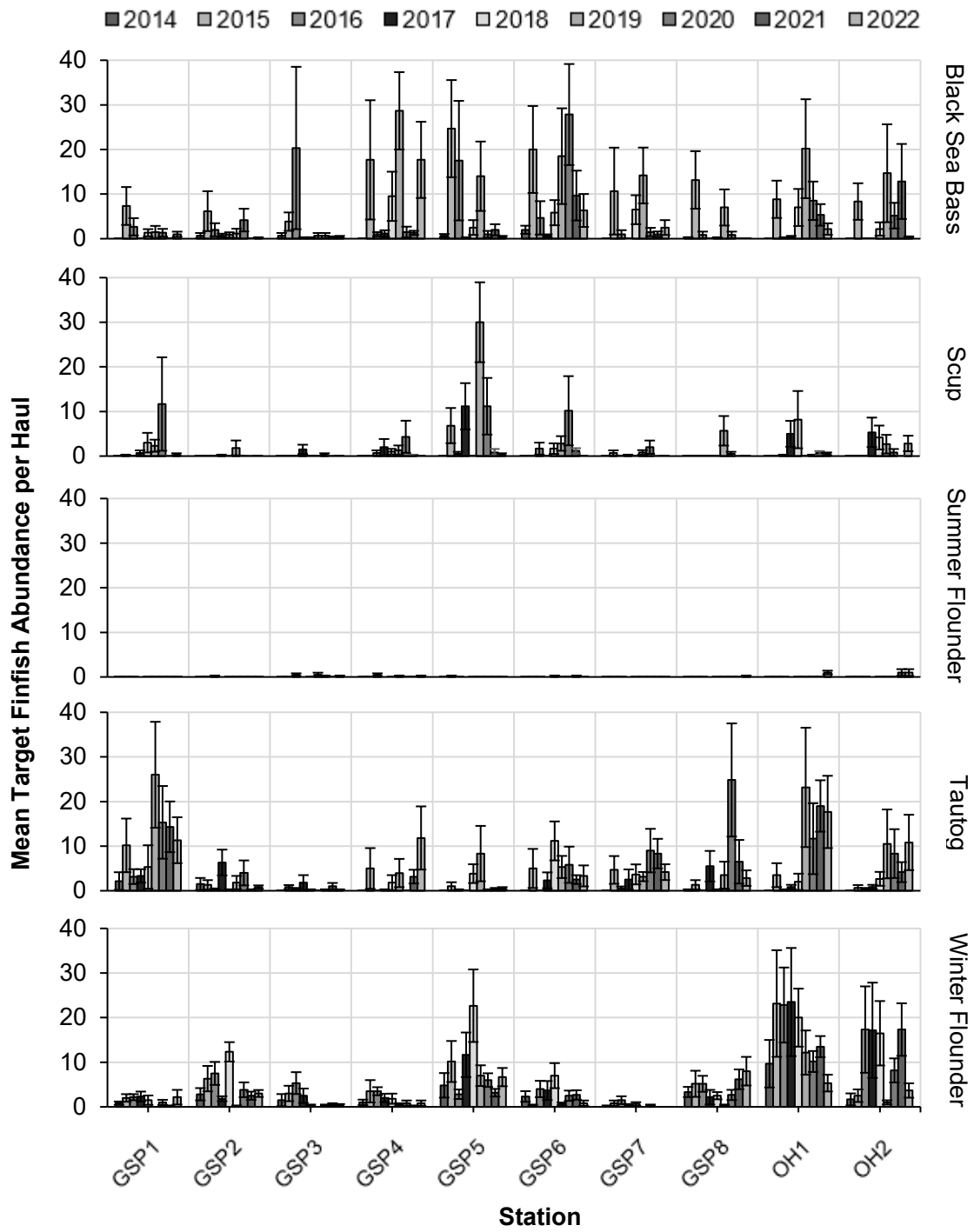


Figure 3a. Mean abundance of target finfish caught by site ( $\pm$  SE) in 2014-2022 beach seines.

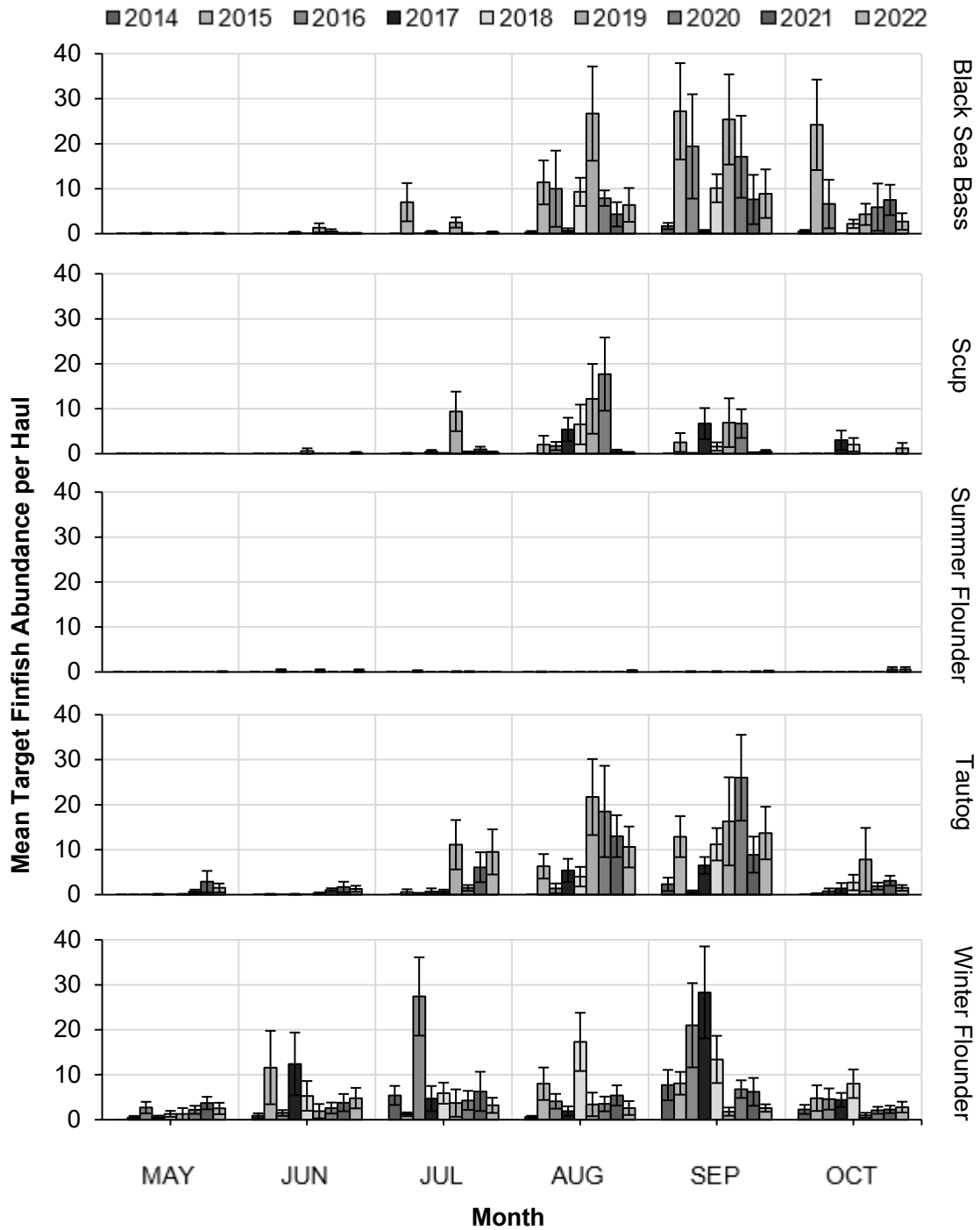


Figure 3b. Mean target finfish per seine haul ( $\pm$  SE) plotted for each month during the 2014-2022 field seasons.

**TABLES:**

Table 1. Common, scientific names, and total abundance of all species collected in beach seines during 2022.

<b>Common Name</b>	<b>Scientific Name</b>	<b>Abundance</b>
Silversides spp.	<i>Atherinopsidae spp.</i>	18478
Atlantic Menhaden	<i>Brevoortia tyrannus</i>	7704
Striped Killifish	<i>Fundulus majalis</i>	5738
Mummichog	<i>Fundulus heteroclitus</i>	498
Tautog	<i>Tautoga onitis</i>	381
Cunner	<i>Tautogolabrus adspersus</i>	380
American Sand Lance	<i>Ammodytes americanus</i>	366
Green Crab Male	<i>Carcinus maenas</i>	309
Green Crab Female	<i>Carcinus maenas</i>	207
Black Sea Bass	<i>Centropristis striata</i>	185
Winter Flounder	<i>Pseudopleuronectes americanus</i>	185
Sheepshead Minnow	<i>Archosargus probatocephalus</i>	182
Bay Anchovy	<i>Anchoa mitchilli</i>	94
Pollock	<i>Pollachius virens</i>	86
Northern Sennet	<i>Sphyraena borealis</i>	85
Bluefish	<i>Pomatomus saltatrix</i>	79
Grubby	<i>Myoxocephalus aeneus</i>	56
Rainwater Killifish	<i>Lucania parva</i>	45
River Herring (Alewife, Blueback Herring)	<i>Alosa pseudoharengus, Alosa aestivalis</i>	45
Northern Pipefish	<i>Syngnathus fuscus</i>	37
Blue Crab Male	<i>Calinectes sapidus</i>	34
Scup	<i>Stenotomus chrysops</i>	24
White Mullet	<i>Mugil curema</i>	24
Blue Crab Female	<i>Calinectes sapidus</i>	23
Oyster Toadfish	<i>Opsanus tau</i>	23
Crevalle Jack	<i>Caranx hippos</i>	19
Chain Pipefish	<i>Syngnathus louisianae</i>	16
Striped Searobin	<i>Prionotus evolans</i>	15
Summer Flounder	<i>Paralichthys dentatus</i>	15
Spider Crab Male	<i>Libinia emarginata</i>	13
Horse-eye Jack	<i>Caranx latus</i>	11
Northern Kingfish	<i>Menticirrhus saxatilis</i>	10
Pinfish	<i>Lagodon rhomboides</i>	8
Yellow Jack	<i>Caranx bartholomaei</i>	7

Table 1. (continued)

<b>Common Name</b>	<b>Scientific Name</b>	<b>Abundance</b>
Bay Scallop	<i>Argopecten irradians</i>	5
Longfin Squid	<i>Loligo pealei</i>	5
Striped Bass	<i>Morone saxatilis</i>	5
Atlantic Cod	<i>Gadus moruha</i>	4
Lady Crab Male	<i>Ovalipes ocellatus</i>	4
Bay Whiff	<i>Citharichthys spilopterus</i>	3
Fourspine Stickleback	<i>Apeltes quadracus</i>	3
Fourspot Flounder	<i>Paralichthys oblongus</i>	3
Northern Puffer	<i>Sphoeroides maculatus</i>	3
Northern Searobin	<i>Prionotus carolinus</i>	3
American Eel	<i>Anguilla rostrata</i>	2
Lined Seahorse	<i>Hippocampus erectus</i>	2
Mantis Shrimp	<i>Squilla empusa</i>	2
Pigfish	<i>Orthopristis chrysoptera</i>	2
Rock Gunnel	<i>Pholis gunnellus</i>	2
Smallmouth Flounder	<i>Etropus microstomus</i>	2
Spot	<i>Leiostomus xanthurus</i>	2
Threespine Stickleback	<i>Gasterosteus aculeatus</i>	2
Atlantic Tomcod	<i>Microgadus tomcod</i>	1
Flame Box Crab Male	<i>Calappa flammea</i>	1
Horseshoe Crab Male	<i>Limulus polyphemus</i>	1
Lady Crab Female	<i>Ovalipes ocellatus</i>	1
Leopard Searobin	<i>Prionotus scitulus</i>	1
Naked Goby	<i>Gobiosoma bosc</i>	1
Round Scad	<i>Decapterus punctatus</i>	1
Snakefish	<i>Trachinocephalus myops</i>	1
Spider Crab Female	<i>Libinia emarginata</i>	1
Spotfin Morraja	<i>Eucinostomus argenteus</i>	1
Twospot Flounder	<i>Bothus robinisi</i>	1
Windowpane	<i>Scophthalmus aquosus</i>	1

Table 2. Abundances of winter flounder in 2022 beach seines.

Month	Station										Mean	SD	SE
	GSP 1	GSP 2	GSP 3	GSP 4	GSP 5	GSP 6	GSP 7	GSP 8	OH 1	OH 2			
MAY	0	4	2	0	13	1	0	0	4	1	2.50	4.01	1.27
JUN	0	6	0	0	14	0	0	21	4	3	4.80	7.21	2.28
JUL	11	0	0	0	2	0	0	2	15	2	3.20	5.33	1.69
AUG	0	2	0	1	2	4	0	16	1	0	2.60	4.88	1.54
SEP	0	2	0	4	3	0	0	7	6	4	2.60	2.63	0.83
OCT	2	4	0	0	6	0	0	2	2	12	2.80	3.79	1.20
<b>Mean</b>	2.17	3.00	0.33	0.83	6.67	0.83	0.00	8.00	5.33	3.67			
<b>SD</b>	4.02	1.91	0.75	1.46	5.02	1.46	0.00	7.85	4.61	3.94			
<b>SE</b>	1.64	0.78	0.30	0.60	2.05	0.60	0.00	3.21	1.88	1.61			
<b>Total</b>	13	18	2	5	40	5	0	48	32	22			
													<b>Total Fish</b>
													<b>185</b>

Table 3. Temperature, salinity, and dissolved oxygen by station and month during 2022 beach seines.

Site	Month	Temp. (°C)	Sal. (ppt)	DO (mg/L)	Site	Month	Temp. (°C)	Sal. (ppt)	DO (mg/L)
GSP 1 (Harris Point)	MAY	13.9	30.71	10.12	GSP 5 (Cormorant Cove)	MAY	15.7	30.75	10.06
	JUN	21.8	30.92	9.15		JUN	18.9	31.05	9.11
	JUL	22.0	31.22	8.16		JUL	21.1	30.24	9.06
	AUG	22.3	31.66	7.79		AUG	22.9	32.09	8.08
	SEP	22.2	31.04	7.38		SEP	21.0	31.82	7.60
	OCT	16.4	30.14	8.36		OCT	16.4	30.90	9.16
GSP 2 (Andy's Way)	MAY	14.1	31.03	9.99	GSP 6 (Bonnell Beach)	MAY	16.2	30.66	10.10
	JUN	21.1	30.83	9.44		JUN	19.5	31.14	9.81
	JUL	22.5	30.99	9.08		JUL	21.5	31.05	9.12
	AUG	23.4	31.48	7.54		AUG	22.4	31.72	8.12
	SEP	23.1	32.09	7.06		SEP	22.1	31.44	7.11
	OCT	17.1	30.69	8.37		OCT	16.6	30.23	9.09
GSP 3 (Beane Point)	MAY	15.6	31.08	10.01	GSP 7 (Ball O'Brien)	MAY	15.9	30.51	9.64
	JUN	19.5	30.91	9.59		JUN	19.5	30.82	9.90
	JUL	21.2	31.03	8.83		JUL	21.8	31.11	8.57
	AUG	23.7	31.80	8.06		AUG	22.9	31.35	7.91
	SEP	22.2	32.15	7.64		SEP	22.2	31.25	7.29
	OCT	16.6	31.44	8.39		OCT	16.6	30.75	9.24
GSP 4 (Coast Guard Station)	MAY	15.4	30.88	9.94	GSP 8 (Inner Pond)	MAY	18.0	30.28	10.00
	JUN	19.5	30.90	9.68		JUN	20.1	30.73	9.25
	JUL	20.9	30.78	9.00		JUL	21.6	30.66	9.21
	AUG	25.0	32.03	8.10		AUG	24.4	30.27	7.77
	SEP	21.7	32.04	7.39		SEP	22.6	30.84	8.06
	OCT	17.0	31.50	8.01		OCT	16.9	31.67	7.41
OH 1 (Eelgrass Bed)	MAY	13.7	31.59	9.61	OH 2 (Sand Flat)	MAY	13.7	31.63	9.47
	JUN	19.1	31.98	10.02		JUN	19.2	31.92	10.06
	JUL	21.2	31.47	9.18		JUL	21.2	31.50	9.07
	AUG	21.5	32.22	8.14		AUG	21.8	32.26	8.18
	SEP	21.0	32.04	8.16		SEP	21.7	32.05	8.20
	OCT	16.1	32.01	8.84		OCT	16.1	8.18	8.85

# APPENDIX

Catch frequency of all species by station for 2022 BI seine survey.

Species	GSP1 (Harris Point)	GSP2 (Andy's Way)	GSP3 (Beane Point)	GSP4 (Coast Guard)	GSP5 (Cormorant Cove)	GSP6 (Bonnell Beach)	GSP7 (Ball O'Brien)	GSP8 (Inner Pond)	OH1 (Eelgrass Bed)	OH2 (Sand Flat)
American Eel										2
American Sand Lance		2	24	32	124	6			178	
Atlantic Cod		3							1	
Atlantic Menhaden	71	295	333				68	250	567	6120
Atlantic Tomcod									1	
Bay Anchovy			83			11				
Bay Scallop				2	3					
Bay Whiff			2	1						
Black Sea Bass	6	1	2	106	2	38	15		13	2
Bluefish				4					66	9
Blue Crab Male	3				1		1	3	8	18
Blue Crab Female	3				1		1	1	2	15
Chain Pipefish	1	1		1		1	2	1	5	4
Crevalle Jack									16	3
Cunner	85	1	1	112	7	30	8	6	67	63
Flame Box Crab Male								1		
Fourspine Stickleback								3		
Fourspot Flounder				2						1
Green Crab Female	5	17	4	26	6	20	48	6	48	27
Green Crab Male	14	21	7	32	14	36	51	14	54	66
Grubby	2	1		4	8	9	7		8	17
Horse-eye Jack									10	1
Horseshoe Crab Male	1									
Lady Crab Female							1			
Lady Crab Male		1	1		1		1			
Leopard Searobin				1						
Lined Seahorse						1				1
Longfin Squid					3	2				
Mantis Shrimp										2
Mummichog	26	344	5	17	7	9	44	45	1	
Naked Goby								1		
Northern Kingfish							1			9
Northern Pipefish	1		2	2		1			26	5
Northern Puffer				1		2				
Northern Searobin					1					2
Northern Sennet	39	3	36		3	2	2			
Oyster Toadfish								23		
Pigfish								2		
Pinfish									7	1
Pollock							13		66	7
Rainwater Killifish	3	18	1			2	13	8		
River Herring (Alewife & Blueback Herring)		9							21	15
Rock Gunnel						1		1		
Round Scad				1						
Scup	2				2				3	17
Sheepshead Minnow	41	99	20	2	10	9		1		
Silversides spp.	1676	418	1290	1502	524	2100	459	1245	1985	7279
Smallmouth Flounder				1	1					
Snakefish			1							
Spider Crab Female		1								
Spider Crab Male	4	1	1				1	5		1
Spot									2	
Spotfin Morraja				1						
Striped Bass	2						1		2	
Striped Killifish	234	3005	883	495	431	397	74	219		
Striped Searobin		3				3				9
Summer Flounder			1	1				1	6	6
Tautog	68	5	2	70	3	20	25	17	106	65
Threespine Stickleback								2		
Twospot Flounder		1								
White Mullet									22	2
Windowpane			1							
Winter Flounder	13	18	2	5	40	5		48	32	22
Yellow Jack									7	



**APPENDIX**

Species presence by station for May 2022 beach seines.

<b>MAY</b>	<b>Station</b>										
<b>Species</b>	<b>GSP1</b>	<b>GSP2</b>	<b>GSP3</b>	<b>GSP4</b>	<b>GSP5</b>	<b>GSP6</b>	<b>GSP7</b>	<b>GSP8</b>	<b>OH1</b>	<b>OH2</b>	<b>Total</b>
Atlantic Cod									1		<b>1</b>
Black Sea Bass									1		<b>1</b>
Blue Crab Male				1					1	1	<b>3</b>
Chain Pipefish									1	1	<b>2</b>
Cunner	1		1				1				<b>3</b>
Green Crab Female	1	1	1	1	1	1	1	1	1	1	<b>10</b>
Green Crab Male	1	1	1	1	1	1	1	1	1	1	<b>10</b>
Grubby				1							<b>1</b>
Northern Pipefish									1		<b>1</b>
Pollock							1		1	1	<b>3</b>
Rock Gunnel						1					<b>1</b>
Silversides spp.	1	1		1	1			1			<b>5</b>
Spider Crab Male							1				<b>1</b>
Summer Flounder									1		<b>1</b>
Tautog	1	1					1		1		<b>4</b>
Winter Flounder		1	1		1	1			1	1	<b>6</b>

**APPENDIX**

Species presence by station for June 2022 beach seines.

<b>JUN</b>	<b>Station</b>										
<b>Species</b>	<b>GSP1</b>	<b>GSP2</b>	<b>GSP3</b>	<b>GSP4</b>	<b>GSP5</b>	<b>GSP6</b>	<b>GSP7</b>	<b>GSP8</b>	<b>OH1</b>	<b>OH2</b>	<b>Total</b>
American Eel									1	1	
American Sand Lance		1	1								2
Bay Scallop				1	1						2
Black Sea Bass								1			1
Blue Crab Male							1		1		2
Chain Pipefish		1									1
Cunner								1			1
Fourspot Flounder									1		1
Green Crab Female	1	1	1	1	1	1	1	1	1	1	10
Green Crab Male	1	1	1	1	1	1	1	1	1	1	10
Grubby						1		1	1		3
Horseshoe Crab Male	1										1
Longfin Squid						1					1
Mummichog								1			1
Naked Goby								1			1
Northern Pipefish								1			1
Rainwater Killifish								1			1
Scup									1		1
Silversides spp.	1	1	1	1		1	1	1	1	1	9
Spider Crab Male		1	1					1			3
Spider Crab Female		1									1
Striped Killifish	1							1			2
Summer Flounder									1		1
Tautog	1			1	1				1	1	5
Winter Flounder		1			1			1	1	1	5

**APPENDIX**

Species presence by station for July 2022 beach seines

<b>JUL</b>	<b>Station</b>										
<b>Species</b>	<b>GSP1</b>	<b>GSP2</b>	<b>GSP3</b>	<b>GSP4</b>	<b>GSP5</b>	<b>GSP6</b>	<b>GSP7</b>	<b>GSP8</b>	<b>OH1</b>	<b>OH2</b>	<b>Total</b>
Black Sea Bass									1	1	2
Blue Crab Female				1						1	2
Blue Crab Male	1									1	2
Chain Pipefish						1		1	1		3
Cunner	1							1	1		3
Green Crab Female	1	1		1	1	1	1	1	1	1	9
Green Crab Male		1		1	1	1	1	1	1	1	8
Grubby				1	1				1	1	4
Lady Crab Male		1									1
Mantis Shrimp										1	1
Mummichog	1	1	1			1					4
Northern Pipefish				1					1	1	3
Northern Puffer				1							1
Northern Sennet	1	1									2
Pinfish									1	1	2
Rainwater Killifish	1										1
Scup	1								1		2
Silversides spp.	1	1	1	1	1	1	1	1	1	1	10
Spider Crab Male								1			1
Striped Bass	1								1		2
Striped Killifish	1	1	1	1	1			1			6
Striped Searobin		1				1					2
Tautog	1			1					1	1	4
Winter Flounder	1				1			1	1	1	5

**APPENDIX**

Species presence by station for August 2022 beach seines.

<b>AUG</b>	<b>Station</b>										
<b>Species</b>	<b>GSP1</b>	<b>GSP2</b>	<b>GSP3</b>	<b>GSP4</b>	<b>GSP5</b>	<b>GSP6</b>	<b>GSP7</b>	<b>GSP8</b>	<b>OH1</b>	<b>OH2</b>	<b>Total</b>
Atlantic Cod		1									1
Bay Scallop				1	1						2
Bay Whiff			1	1							2
Black Sea Bass	1	1	1	1	1	1					6
Bluefish				1							1
Blue Crab Male								1	1	1	3
Chain Pipefish				1		1	1	1			4
Crevalle Jack									1	1	2
Cunner	1			1	1	1	1	1	1		7
Fourspine Stickleback								1			1
Green Crab Female		1		1	1	1	1	1	1	1	8
Green Crab Male	1	1	1	1	1	1	1	1	1		9
Grubby	1			1	1	1	1		1	1	7
Horse-eye Jack									1	1	2
Lady Crab Male					1						1
Leopard Searobin				1							1
Lined Seahorse						1					1
Longfin Squid					1						1
Mummichog	1	1	1		1	1	1				6
Northern Kingfish							1				1
Northern Pipefish	1			1					1	1	4
Northern Puffer						1					1
Northern Sennet			1		1	1	1				4
Oyster Toadfish								1			1
Rainwater Killifish	1	1	1				1	1			5
River Herring		1							1	1	3
Rock Gunnel								1			1
Round Scad				1							1
Scup					1						1
Sheepshead Minnow		1	1								2
Silversides spp.	1	1	1	1	1	1	1	1	1	1	10
Smallmouth Flounder				1							1
Snakefish			1								1
Spider Crab Male	1										1
Spotfin Morraja				1							1
Striped Killifish	1	1	1	1	1	1	1	1			8
Striped Searobin		1				1					2
Summer Flounder			1						1	1	3
Tautog	1	1		1	1	1	1	1	1	1	9
Threespine Stickleback								1			1
White Mullet									1	1	2
Windowpane			1								1
Winter Flounder		1		1	1	1		1	1		6

**APPENDIX**

Species presence by station for September 2022 beach seines.

SEP	Station										
Species	GSP1	GSP2	GSP3	GSP4	GSP5	GSP6	GSP7	GSP8	OH1	OH2	Total
American Sand Lance			1						1		2
Atlantic Menhaden		1	1						1	1	4
Bay Anchovy			1								1
Black Sea Bass	1			1		1	1		1	1	6
Bluefish									1	1	2
Blue Crab Female	1								1	1	3
Blue Crab Male	1								1	1	3
Chain Pipefish	1										1
Crevalle Jack									1		1
Cunner	1			1			1		1	1	5
Flame Box Crab Male								1			1
Fourspot Flounder				1							1
Green Crab Female	1			1		1			1		4
Green Crab Male	1	1		1	1	1	1		1	1	8
Grubby	1			1		1	1		1	1	6
Horse-eye Jack									1		1
Lady Crab Male			1								1
Lined Seahorse										1	1
Mummichog	1	1		1			1	1			5
Northern Kingfish										1	1
Northern Pipefish			1			1			1	1	4
Northern Searobin										1	1
Oyster Toadfish								1			1
Rainwater Killifish	1	1				1	1	1			5
River Herring										1	1
Scup									1	1	2
Sheepshead Minnow	1	1			1			1			4
Silversides spp.	1	1	1	1	1	1	1	1	1	1	10
Spider Crab Male	1										1
Spot									1		1
Striped Killifish	1	1	1	1	1	1	1	1			8
Summer Flounder				1					1		2
Tautog	1	1		1		1		1	1	1	7
Twospot Flounder		1									1
Winter Flounder		1		1	1			1	1	1	6
Yellow Jack									1		1

**APPENDIX**

Species presence by station for October 2022 beach seines.

OCT	Station										
Species	GSP1	GSP2	GSP3	GSP4	GSP5	GSP6	GSP7	GSP8	OH1	OH2	Total
American Sand Lance				1	1	1					3
Atlantic Menhaden	1						1	1			3
Atlantic Tomcod								1			1
Bay Anchovy						1					1
Bay Scallop				1							1
Black Sea Bass				1			1				2
Bluefish								1			1
Blue Crab Female							1	1			2
Blue Crab Male							1	1		1	3
Cunner		1		1		1					3
Green Crab Female				1		1		1			4
Green Crab Male		1		1		1	1		1	1	6
Grubby		1							1	1	3
Lady Crab Female							1				1
Lady Crab Male										1	1
Mummichog	1	1	1	1	1	1			1		7
Northern Kingfish										1	1
Northern Pipefish								1			1
Northern Searobin					1						1
Pigfish								1			1
Pollock							1				1
Scup										1	1
Sheepshead Minnow	1	1	1	1	1	1					6
Silversides spp.	1	1	1	1	1	1	1	1	1	1	10
Smallmouth Flounder					1						1
Spider Crab Male										1	1
Striped Bass							1				1
Striped Killifish	1	1	1	1	1	1	1				7
Striped Searobin										1	1
Summer Flounder								1		1	2
Tautog	1		1	1		1	1		1		6
Winter Flounder	1	1			1			1	1	1	6

**APPENDIX**

Abundances of summer flounder in 2022 beach seines.

	Station										Mean	SD	SE	
	GSP 1	GSP 2	GSP 3	GSP 4	GSP 5	GSP 6	GSP 7	GSP 8	OH 1	OH 2				
<b>Summer Flounder</b>														
MAY	0	0	0	0	0	0	0	0	1	0	0.10	0.32	0.10	
JUN	0	0	0	0	0	0	0	0	3	0	0.30	0.95	0.30	
JUL	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	
AUG	0	0	1	0	0	0	0	0	1	1	0.30	0.48	0.15	
SEP	0	0	0	1	0	0	0	0	1	0	0.20	0.42	0.13	
OCT	0	0	0	0	0	0	0	1	0	5	0.60	1.58	0.50	
<b>Mean</b>	0.00	0.00	0.17	0.17	0.00	0.00	0.00	0.17	1.00	1.00				
<b>SD</b>	0.00	0.00	0.37	0.37	0.00	0.00	0.00	0.37	1.00	1.83	<b>Total Fish</b>			
<b>SE</b>	0.00	0.00	0.15	0.15	0.00	0.00	0.00	0.15	0.41	0.75	<b>15</b>			
<b>Total</b>	0	0	1	1	0	0	0	1	6	6				

**APPENDIX**

Abundances of tautog in 2022 beach seines.

		Station										Mean	SD	SE
		GSP 1	GSP 2	GSP 3	GSP 4	GSP 5	GSP 6	GSP 7	GSP 8	OH 1	OH 2			
<b>Tautog</b>	<b>Month</b>													
	MAY	1	1	0	0	0	0	10	0	3	0	1.50	3.14	0.99
	JUN	1	0	0	2	2	0	0	0	7	1	1.30	2.16	0.68
	JUL	16	0	0	3	0	0	0	0	35	41	9.50	15.88	5.02
	AUG	9	2	0	49	1	16	9	11	6	3	10.60	14.40	4.55
	SEP	37	2	0	15	0	3	0	6	54	20	13.70	18.51	5.85
	OCT	4	0	1	2	0	1	6	0	1	0	1.50	2.01	0.64
	<b>Mean</b>	11.33	0.83	0.17	11.83	0.50	3.33	4.17	2.83	17.67	10.83			
	<b>SD</b>	12.61	0.90	0.37	17.33	0.76	5.76	4.34	4.26	19.85	15.20	<b>Total Fish</b>		
	<b>SE</b>	5.15	0.37	0.15	7.08	0.31	2.35	1.77	1.74	8.10	6.21	<b>381</b>		
	<b>Total</b>	68	5	1	71	3	20	25	17	106	65			



**APPENDIX**

Abundances of black sea bass in 2022 beach seines.

	Station										Mean	SD	SE	
	GSP 1	GSP 2	GSP 3	GSP 4	GSP 5	GSP 6	GSP 7	GSP 8	OH 1	OH 2				
<b>Black Sea Bass</b>														
<b>Month</b>														
MAY	0	0	0	0	0	0	0	0	1	0	0.10	0.32	0.10	
JUN	0	0	0	0	0	0	0	0	1	0	0.10	0.32	0.10	
JUL	0	0	0	0	0	0	0	0	2	1	0.30	0.67	0.21	
AUG	3	1	2	35	2	21	0	0	0	0	6.40	11.90	3.76	
SEP	3	0	0	55	0	17	4	0	9	1	8.90	17.09	5.40	
OCT	0	0	0	16	0	0	11	0	0	0	2.70	5.81	1.84	
<b>Mean</b>	1.00	0.17	0.33	17.67	0.33	6.33	2.50	0.00	2.17	0.33				
<b>SD</b>	1.41	0.37	0.75	20.95	0.75	9.03	4.07	0.00	3.13	0.47				
<b>SE</b>	0.58	0.15	0.30	8.55	0.30	3.69	1.66	0.00	1.28	0.19				
<b>Total</b>	6	1	2	106	2	38	15	0	13	2				
											<b>Total Fish</b>	<b>185</b>		

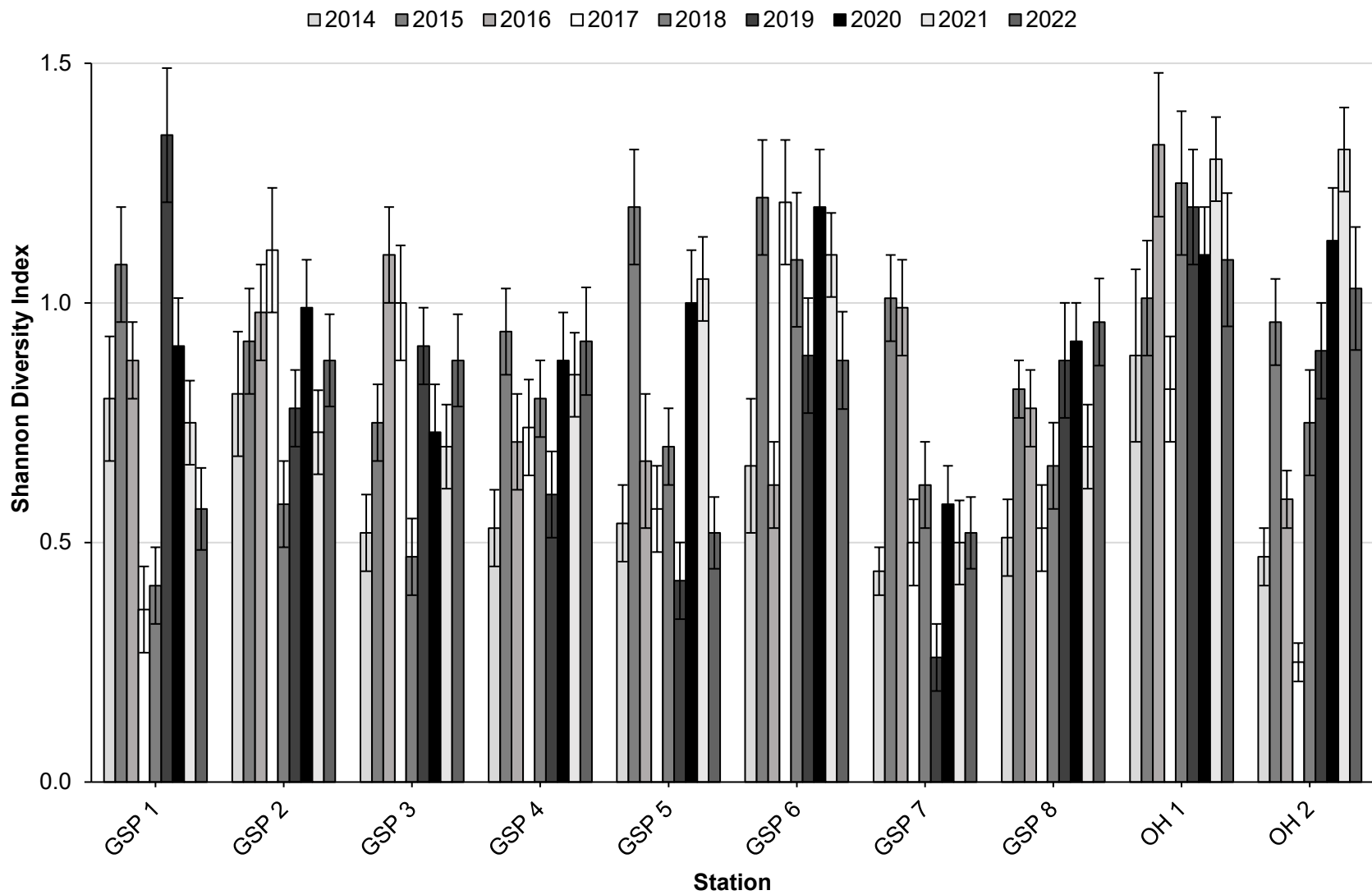
**APPENDIX**

Abundances of scup in 2022 beach seines.

		Station										Mean	SD	SE
		GSP 1	GSP 2	GSP 3	GSP 4	GSP 5	GSP 6	GSP 7	GSP 8	OH 1	OH 2			
<b>Scup</b>	<b>Month</b>													
	MAY	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
	JUN	0	0	0	0	0	0	0	0	0	2	0.20	0.63	0.20
	JUL	2	0	0	0	0	0	0	0	1	0	0.30	0.67	0.21
	AUG	0	0	0	0	2	0	0	0	0	0	0.20	0.63	0.20
	SEP	0	0	0	0	0	0	0	0	2	3	0.50	1.08	0.34
	OCT	0	0	0	0	0	0	0	0	0	12	1.20	3.79	1.20
<b>Mean</b>	0.33	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.50	2.83				
<b>SD</b>	0.75	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.76	4.26				
<b>SE</b>	0.30	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.31	1.74				
<b>Total</b>	2	0	0	0	2	0	0	0	3	17				
												<b>Total Fish</b>	<b>24</b>	

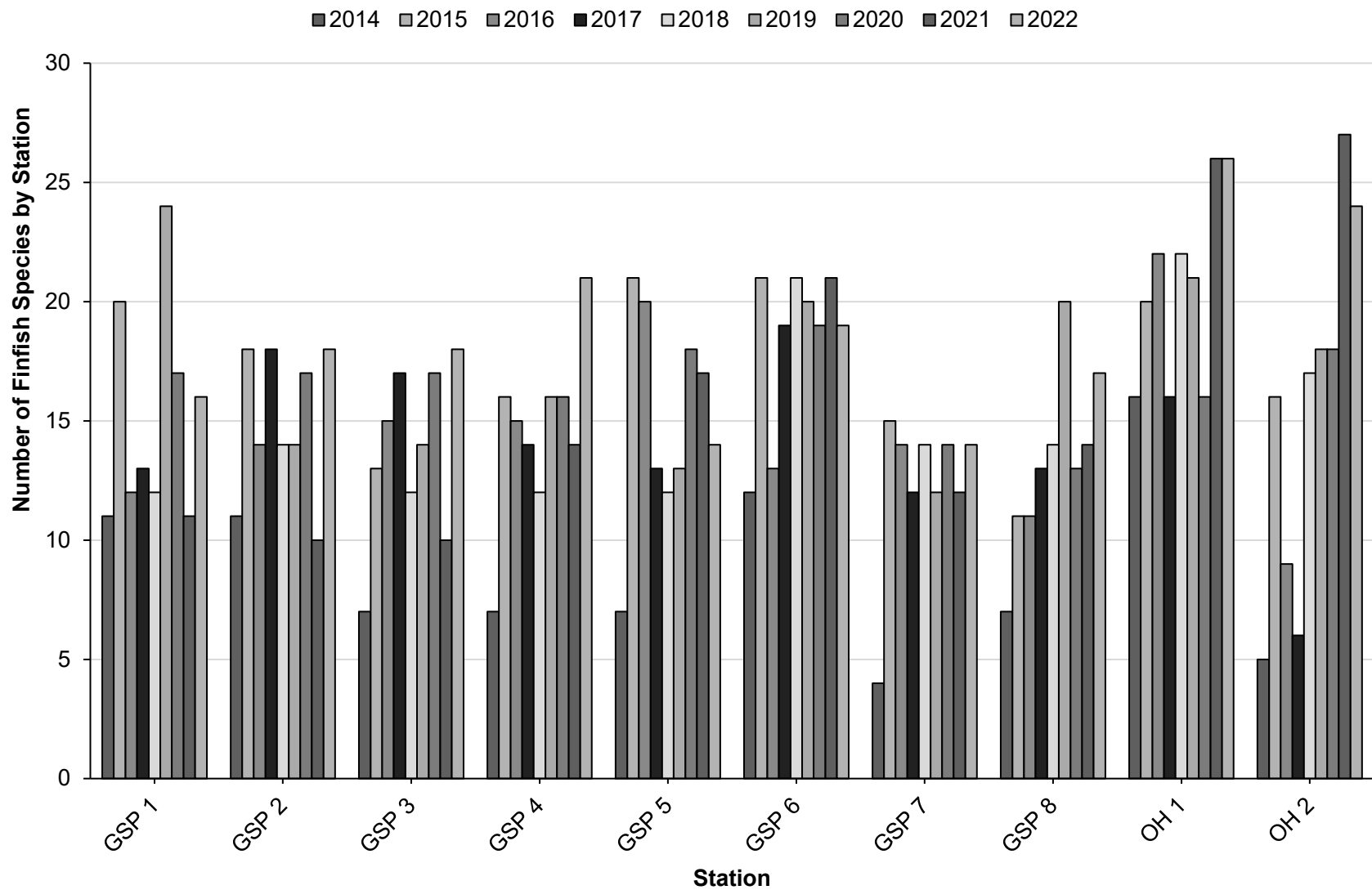
## APPENDIX

Mean Shannon diversity across stations in 2014-2022 beach seines.



# APPENDIX

Cumulative number of finfish species by station in 2014-2022 beach seines.



**ASSESSMENT OF RECREATIONALLY IMPORTANT  
FINFISH STOCKS IN RHODE ISLAND WATERS  
NARRAGANSETT BAY JUVENILE FINFISH SURVEY**

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**2022**

## PERFORMANCE REPORT

STATE: Rhode Island

PROJECT NUMBER: F-61-R

SEGMENT NUMBER: 24

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

PERIOD COVERED: 1 January 2021 - 31 December 2022

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 (*Cynoscion 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 2022 with the standard 61 x 3.05 m beach seine. Adults and juveniles of sixty-three were collected during the 2022 survey, which is a decrease from the 2021 survey. For comparison eighty species were collected in 2015, the highest number of species and families collected since the survey began. For the entire survey time series (1988 – 2022), 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 (with the exception of blue crabs, horseshoe crabs and squid). Data on weather, water temperature, salinity, and dissolved oxygen were recorded at each station.

**TARGET DATE:** December 2022

**SIGNIFICANT DEVIATIONS:** There were no significant deviations to methodology in 2022.

**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.

**REMARKS:** Abundance trends derived from adult data collected from the RIDMF 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 for a set of target species. The first iteration analyzed 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 most of the target species do not have any significant long-term trend, bluefish ( $p = 0.009$ ) and winter flounder ( $p = 3.8149e-5$ ) are showing a decreasing trend (Table 1a). Tautog ( $p = 0.003$ ), and Striped Bass ( $p = 0.0006$ ) show a positive increasing trend in the shortened 10-year analysis (Table 1b). Menhaden and River Herring show no abundance trend for either the full dataset or the past ten years (Table 1a, b).

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 2022.

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 2022 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-three percent of the seine hauls for 2022. This is a decrease from 2021 when they were present in fifty-one percent of the hauls. A total of 326 fish were collected in 2022 (all of the fish collected in 2022 would be considered young-of-the-year (YOY) according to Table 2 winter flounder maximum size by month). This is a decrease from the 798 individuals collected during the 2021 survey. They were present at seventeen of the eighteen stations and were collected in all months (Table 9).

The 2022 juvenile winter flounder standardized abundance index was  $3.62 \pm 1.64$  fish/seine haul; this is less than the 2021 index of  $8.86 \pm 4.21$  S.E. fish/seine haul. Figure 2 shows the standardized annual abundance indices since 1988. The Mann-Kendall test showed a significant decreasing abundance trend for this species for the full dataset, but no short-term trend in the last 10 years (Table 1a, b).

June had the highest mean monthly abundance of  $8.28 \pm 4.43$  S.E. fish/seine haul. Chepiwanoxet (Sta. 3), Pojac Point (Sta. 4), and Hog Island (Sta. 9) had the highest mean station abundance of  $27.20 \pm 16.85$ ,  $9.20 \pm 6.60$  S.E., and  $6.80 \pm 3.60$  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.

Winter flounder length frequency data from the 2022 survey indicate that all of 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 2022 abundance index continues to be lower than most years since 2000, the survey high. The Division of Marine Fisheries' trawl survey data (sampling both adults and juveniles) saw a slight increase in winter flounder from 2020 to 2021. 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 2018. The Mann-Kendall trend analysis shows a decreasing trend in the abundance of juvenile winter flounder in Narragansett Bay over the entire time series, and no trend indicated for the shortened 10-year time series in the terminal year of 2012 has dissipated, 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 2022 survey 1,780 juvenile and 8 adult (>26 cm length) tautog (*Tautoga onitis*) were collected. This is a decrease from the 2021 survey when 1,500 juveniles and 4 adults were collected. The 2021 abundance index was  $19.78 \pm 4.00$  S.E. fish/seine haul, an increase from the 2021 index  $16.67 \pm 5.71$  S.E. (Figure 3). As indicated in the introduction, based on this survey data, it can be concluded that the spawning closure enacted in 2006 and then extended in 2010 may be having an impact on the number of juveniles produced during the spring as there appears to be an increasing trend since this time period. The last 10-year time series Mann-Kendall test shows a significant increasing trend ( $p = 0.003$ ) during the 2022 analysis. It may take some time for a slow growing species such as tautog to recoup its spawning stock biomass to levels that will have significant impacts and major increases in biomass; therefore, we will continue to monitor this species closely in the coming years.

Juvenile tautog were collected in seventy percent of the seine hauls in 2022 (Table 10). This is a slight increase from 2021 when they were present in sixty-six percent of the seine hauls. July and August had the highest mean monthly abundances of  $55.83 \pm 0.17$  S.E. and  $26.94 \pm 0.3$  S.E. 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. Hog Island (Sta. 16) had the highest mean station abundance of  $50.00 \pm 21.52$  S.E. which was driven by high sampling numbers in July, August and September (116, 57, and 71 total fish respectively) when there was a large amount of seaweed accumulated at the sampling station, which provided preferred habitat to many juvenile finfish. Patience (Sta. 5) and Dyer Island (Sta. 12) had the next highest abundances with a mean station abundance of  $33.0 \pm 17.52$  S.E. and  $32.0 \pm 16.71$  S.E. fish/seine haul respectively. The Mann-Kendall test showed no long-term trend in juvenile abundance, but a short-term increase in abundance for juvenile tautog is present for the 10-year series (Table 1a, b). It is plausible that the spawning closure is positively impacting the juvenile tautog population, and the increasing trend in the Mann-Kendall test supports this. 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 (ASMFC 2016).

Our Narragansett Bay trawl survey had an increase in biomass and abundance for tautog from 2020 to 2021. 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 2022 survey 236 juvenile bluefish (*Pomatomus saltatrix*) were collected. This is a significant decrease from the 2,515 juveniles collected in 2021. Juveniles were present in twenty-five percent of the seine hauls and were collected at fifteen of the eighteen stations (Table 11). They were present in all months sampled, with the highest abundance occurring in September. June and October 2022 had very few juvenile bluefish collected during the survey, which is most likely due to the colder water temperatures (16 – 22.7° C in June and October). Since this survey began and prior to 2016, only two hundred ninety-six juvenile bluefish have been collected in October, in eleven different years (1990, 1997, 1999, 2005, 2011, 2012, 2015, 2016, 2017, 2020, and 2021), and only when water temperatures were 16 – 21° C.

The abundance index for 2022 was  $2.62 \pm 0.71$  S.E. fish/seine haul. This is a decrease from the 2021 abundance index of  $27.94 \pm 1.99$  S.E. fish/seine haul (Figure 4). The Mann-Kendall test showed no trend in the 10-year abundance, however there is a significant decrease in long-term abundance trend for this species (Table 1a, b).

September had the highest mean monthly abundance of  $9.50 \pm 0.47$  S.E. fish/seine haul, which was driven by a large catch (78) at Spar Island (Sta. 12) (Table 11). July and August are typically the months of highest juvenile abundance for this species. There appears to be a shift to their presence in September as water temperatures remain warmer longer into the fall months, as seen in the 2022 survey data.

Length frequency data for 2022 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).

### Striped Bass

During the 2022 survey 243 striped bass (*Morone saxatilis*) were collected. This is an increase from 2021 which had an abundance of 63 fish. Striped bass were present in eight percent of the seine hauls and were collected at six of the eighteen stations (Table 14). They were present in June and July.

The abundance index for 2022 was  $2.7 \pm 0.47$  S.E. fish/seine haul. This is slightly higher than in 2021, which had an abundance index of  $0.7 \pm 0.41$  S.E. fish/seine haul (Figure 8). The Mann-Kendall test showed no abundance trend for this species for the entire dataset but a significant increasing trend for the shortened 10-year series (Table 1a, b).

July had the highest mean monthly abundance of  $12.39 \pm 0.17$  S.E. fish/seine haul (Table 12). June had the second highest mean monthly abundance at  $1.11 \pm 0.94$  S.E. fish/seine haul.

September is usually one of the months with the highest abundance for the entire time series. However, during 2022 there were no striped bass collected in the survey (Table 12).

In 2022, striped bass were only present at 6 stations, Gaspee Point (Sta. 1), Chepiwanoxet (Sta. 3), Patience Island (Sta. 5), Potters Cove (Sta. 8), Rose Island (Sta. 10), and Dyer Island (Sta. 16). The highest abundance was found at Gaspee Point with  $44.0 \pm 44.0$  S.E. fish/seine haul, which was driven by a single catch of 220 fish in July. 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 2022 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, although in recent years there seems to be a very slight upward trend. 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.

### Clupeidae

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.

### River Herring

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 of Fish and Wildlife'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 thirteen percent of the seine hauls and were collected at nine of the eighteen stations during 2022 and were present during each month of the survey. A total of 63 juveniles were collected in 2022, a decrease from the number collected in 2021 (2,326 fish).

The highest mean monthly abundance for 2022 occurred during June and was  $2.94 \pm 2.40$  S.E. fish/seine haul. Chepiwanoxet (Sta. 3) and Fogland (Sta. 14) had the highest mean station abundance of  $8.60 \pm 8.60$  S.E. and  $2.00 \pm 1.55$  S.E., respectively (Table 13). Chepiwanoxet experienced a single large catch in June (43 fish), which drove the mean station abundance. 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 2022 was  $0.7 \pm 0.76$  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. Due to these fluctuations, there was no significant trend in the Mann-Kendall test for both the long-term and short-term (10-year) abundance data (Table 1a & 1b).

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 vice 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

Fourteen thousand, nine hundred and eighty-four Atlantic menhaden (*Brevoortia tyrannus*) were collected during the 2022 survey, a significant increase from 2021 when 375 fish were caught. The 2017 abundance is one of the highest in recent years; the last high abundance was 2007, when eight thousand two hundred fifty-three juveniles were collected. They were present in twenty-eight percent of the seine hauls and were collected at sixteen of the eighteen stations (Table 12).

The highest mean monthly abundance for 2022 occurred during September and was  $463.94 \pm 461.71$  S.E. fish/seine haul. Conimicut Point (Sta. 2) had the highest mean station abundance of  $1,663.00 \pm 1,662.50$  S.E. (Table 14), which was driven by a single large catch in September of 8,313 fish. 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 2022 was  $166.49 \pm 31.25$  S.E. fish/seine haul. This is an increase from 2021 ( $4.17 \pm 11.88$  S.E. fish/seine haul, Figure 7). The standardized index indicates an increased abundance during the 2000s followed by lower numbers through the 2010s. In the most recent years an increasing abundance is evident. Our Narragansett Bay trawl survey showed a decrease in menhaden abundance from 2018 to 2019. The trawl survey catches juveniles as well as some age one fish. The Mann-Kendall test showed no long-term abundance trend and no 10-year trend for this species (Table 1a and 1b).

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 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 (Appendix A).

### Weakfish

There were twenty weakfish, *Cynoscion regalis*, collected during the 2022 survey. Weakfish were present in six percent of the seine hauls and were collected at of the eighteen stations during 2022, decrease from the number collected in 2021 (58 fish). 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 typically collected most frequently.

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. There, have been 11 years since 1988 where no fish have been caught. Seven of the 11 total zero catch years occur after 2004. 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.

### Black Sea Bass

Six hundred and twenty-three black sea bass (*Centropristis striata*) were caught in 2022, a significant increase from the 41 fish that were collected in 2021. The number of black sea bass has been highly variable from year to year during the time series of this survey, but the high abundance during 2012 and 2015 (Figure 10) stand out as unique. Black sea bass were caught in thirty-seven percent of the seine hauls in 2022.

The highest mean monthly abundances for 2022 occurred during July and August at  $14.22 \pm 0.17$  S.E. fish/seine haul and  $17.94 \pm 0.3$  S.E. fish/seine haul, respectively. Black sea bass were caught at 16 of the 18 stations; Conimicut Point (Sta. 2), Pojac Point (Sta. 4), and Patience Island (Sta. 5) had the highest mean station abundances of  $23.60 \pm 16.61$  S.E.,  $30.20 \pm 28.96$  S.E. and  $16.40 \pm 13.60$  S.E. fish/seine haul, respectively (Table 15).

The abundance index for 2022 was  $6.92 \pm 2.16$  S.E. fish/seine haul. This was an increase from the 2021 index  $0.46 \pm 0.13$  S.E. (Figure 10). Our Narragansett Bay trawl survey had an increase in the abundance of black sea bass from 2020 to 2021 in the spring and fall. 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 but did show a small increase in abundance from 2016 to 2018. This recruitment signal in recent years was seen not only in RI waters, but all along the Northern 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 (NEFSC 2016).

#### Other important species

Juveniles of other commercial or recreationally important species were also collected during the 2022 survey. These juveniles included scup (*Stenotomus chrysops*), and Northern kingfish (*Menticirrhus saxatilis*).

Two thousand six hundred and sixty-seven juvenile and adult scup were collected in 2022 during July, August, September, and October, an increase from 2021 when 583 scup were collected. Nine hundred and ninety-five Northern kingfish were collected in 2022 and were present in the greatest numbers during July and August. This is an increase from 2021 when 1,755 Northern kingfish were caught. Twenty-five summer flounder were caught in 2022. Twenty-four smallmouth flounder was caught in 2022, relative to the sixty-eight smallmouth flounder that were caught in 2011, and the one that was caught in 2021, the decrease in abundance continued in 2022. 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. No juvenile Haddock were caught in 2022, unlike June 2016 when 44 juvenile haddock were caught, or June 2015 when 27 were caught. They were caught primarily in the lower portion of the bay. 2015 was the first recorded observance of juvenile Haddock in the history of the survey, this species will continue to be monitored in future years to see if there is an increasing abundance over time in Narragansett 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.

Water temperatures during the 2022 survey ranged from a low of 15.4°C at Patience Island (Sta. 5) in October to a high of 28.0°C at Chepiwanoxet (Sta. 3) in August.

Salinities ranged from 20.6 *ppt* at Gaspee Point (Sta. 1) in June to 29.8 *ppt* at Rose Island (Sta. 10) in September.

Dissolved oxygen ranged from 5.1 *ppm* at the Warren River (Sta. 17) in July to a high of 11.7 *ppm* at Spectacle Cove (Sta. 13) in October.

**SUMMARY:** In summary, data from the 2022 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, tautog, river herring, menhaden and

striped bass, showed no long-term abundance trends but indicated a significant long-term decrease in bluefish and winter flounder abundance. There are some species abundance trends from this survey that agree with those from our coastal pond survey and/or trawl survey, however, in some instances they do not relate. 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.

Sixty-three, both vertebrates and invertebrates, were collected in 2022. This is slightly 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 2022 there were no tropical species collected during the survey. While tropical and subtropical species are typically collected during this survey most years, 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.

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## FIGURES

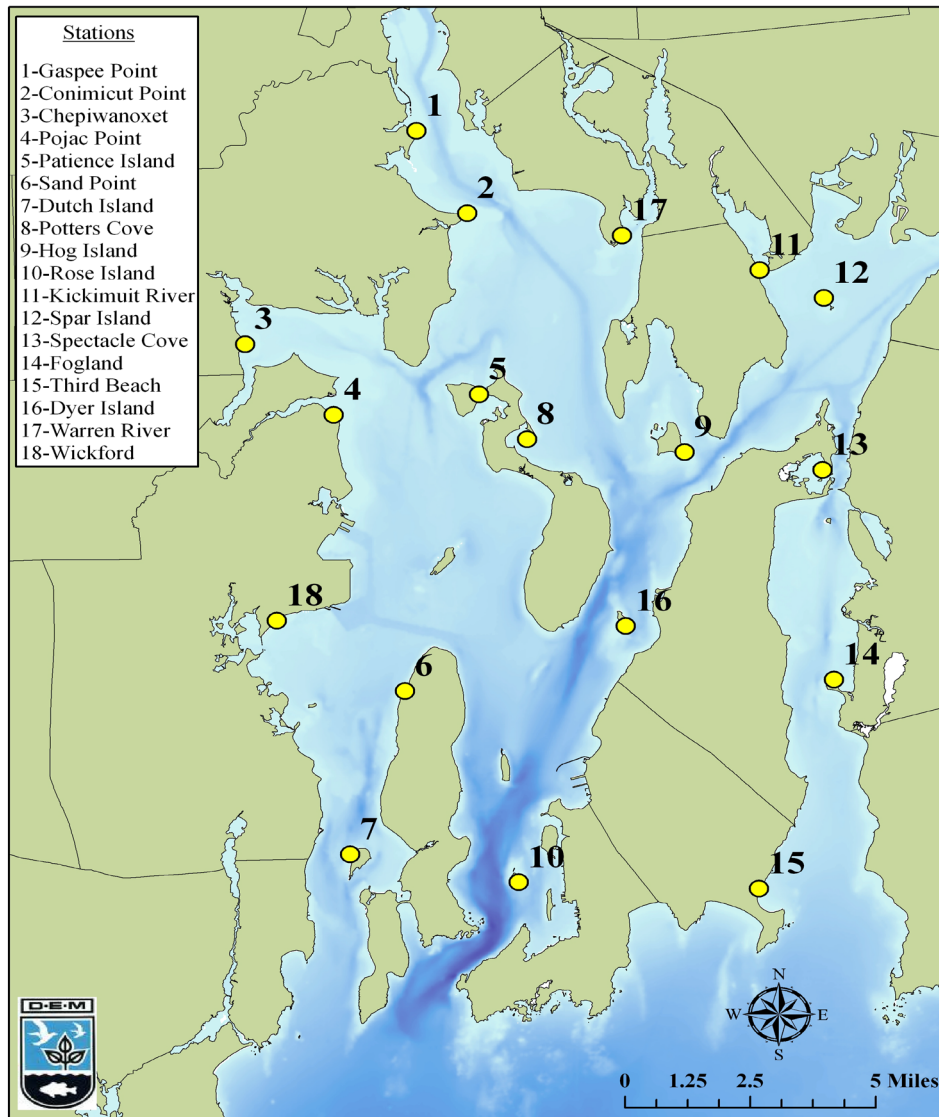


Figure 1. Survey station location map.

### Winter Flounder Abundance

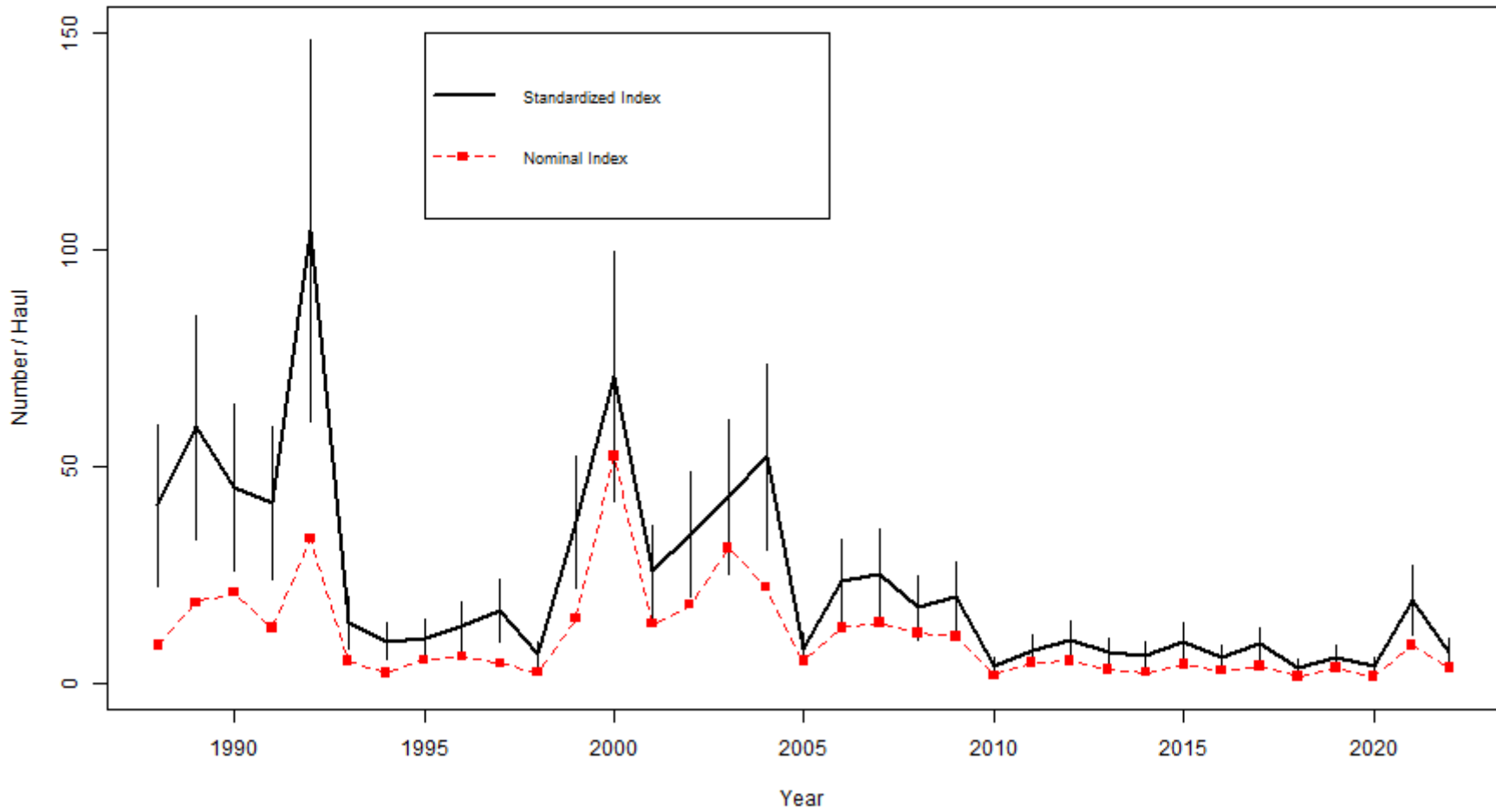


Figure 2. Juvenile winter flounder standardized abundance index 1988 – 2022 (see appendix A for standardization methodology).

### Tautog Abundance

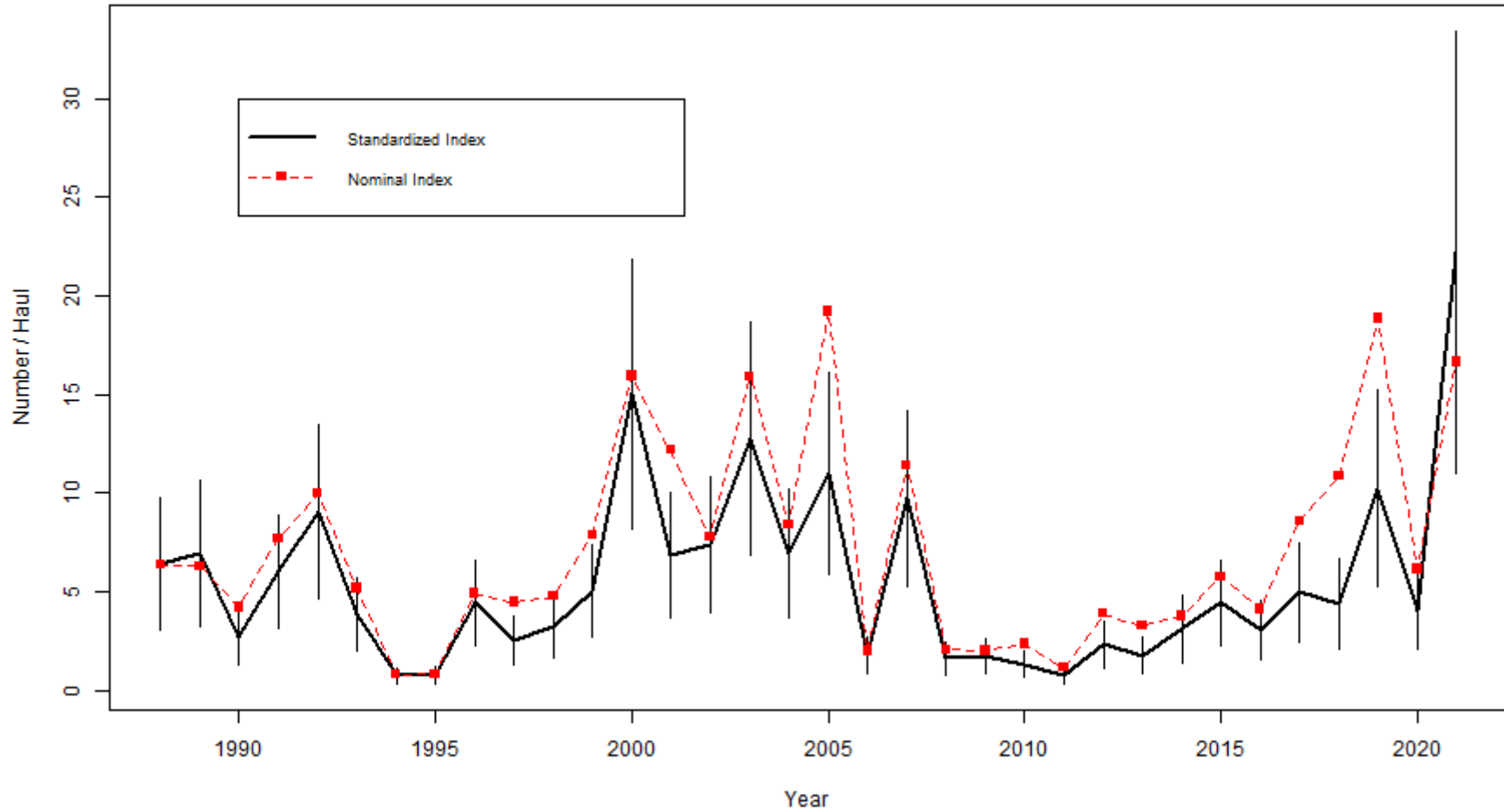


Figure 3. Juvenile tautog standardized annual abundance index 1988 – 2022 (see appendix A for standardization methodology).

### Bluefish Abundance

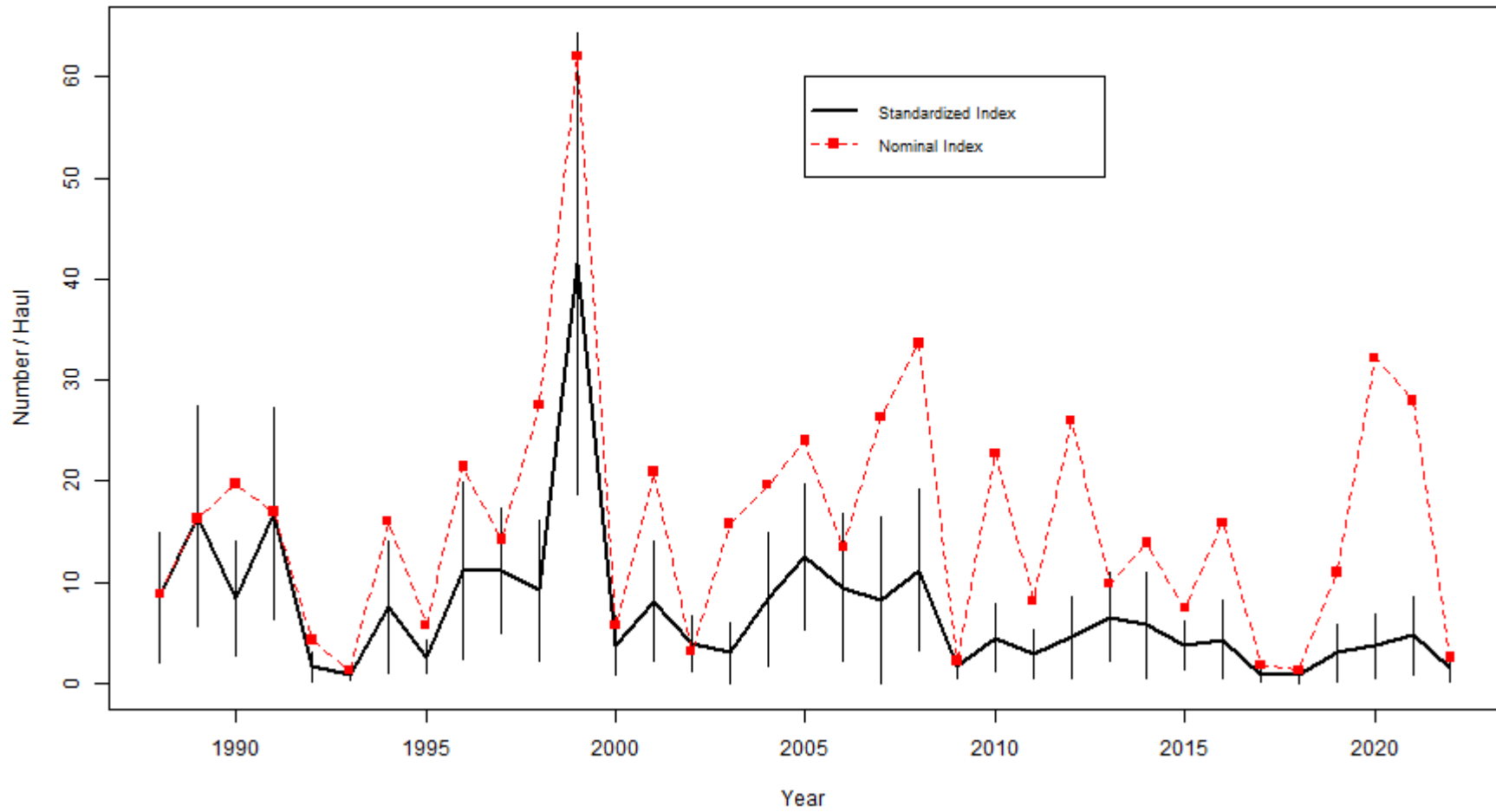


Figure 4. Juvenile bluefish standardized annual abundance index 1988 – 2022 (see appendix A for standardization methodology).

### River Herring Abundance

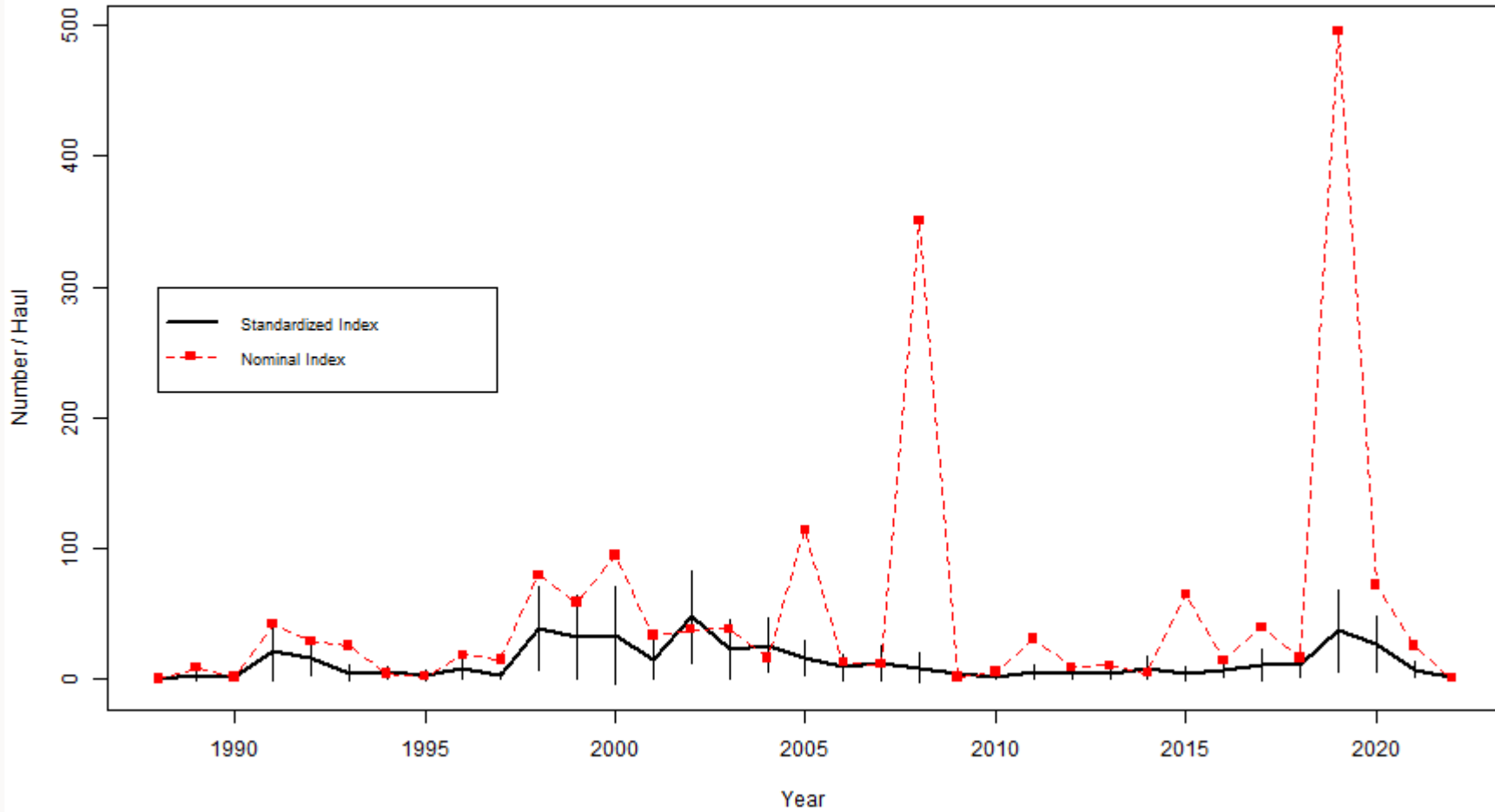
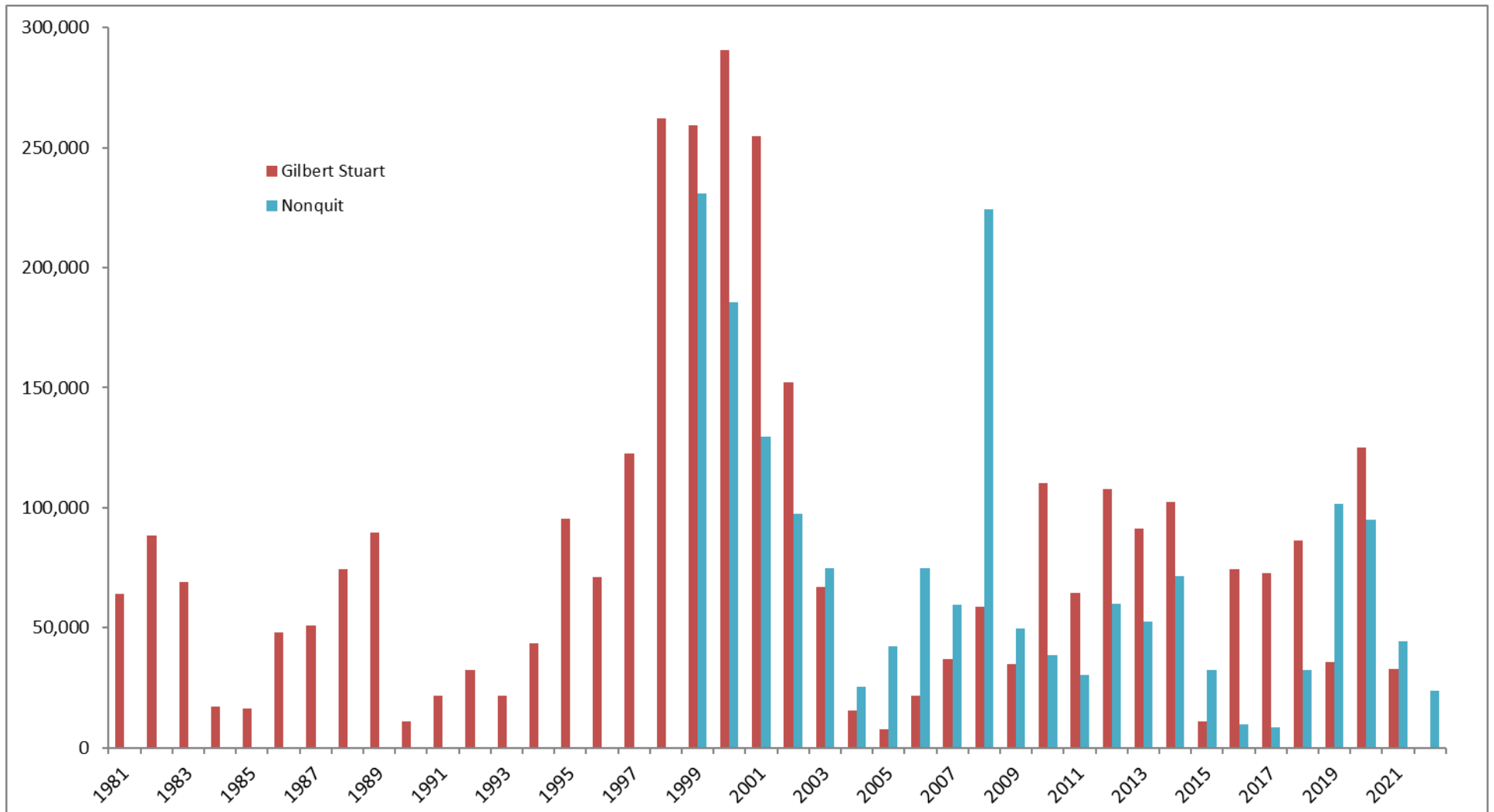


Figure 5. Juvenile river herring standardized annual abundance index 1988 – 2022 (see appendix A for standardization methodology).



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

Figure 6. River herring spawning stock size from monitoring at two locations 1999 – 2022.

### Menhaden Abundance

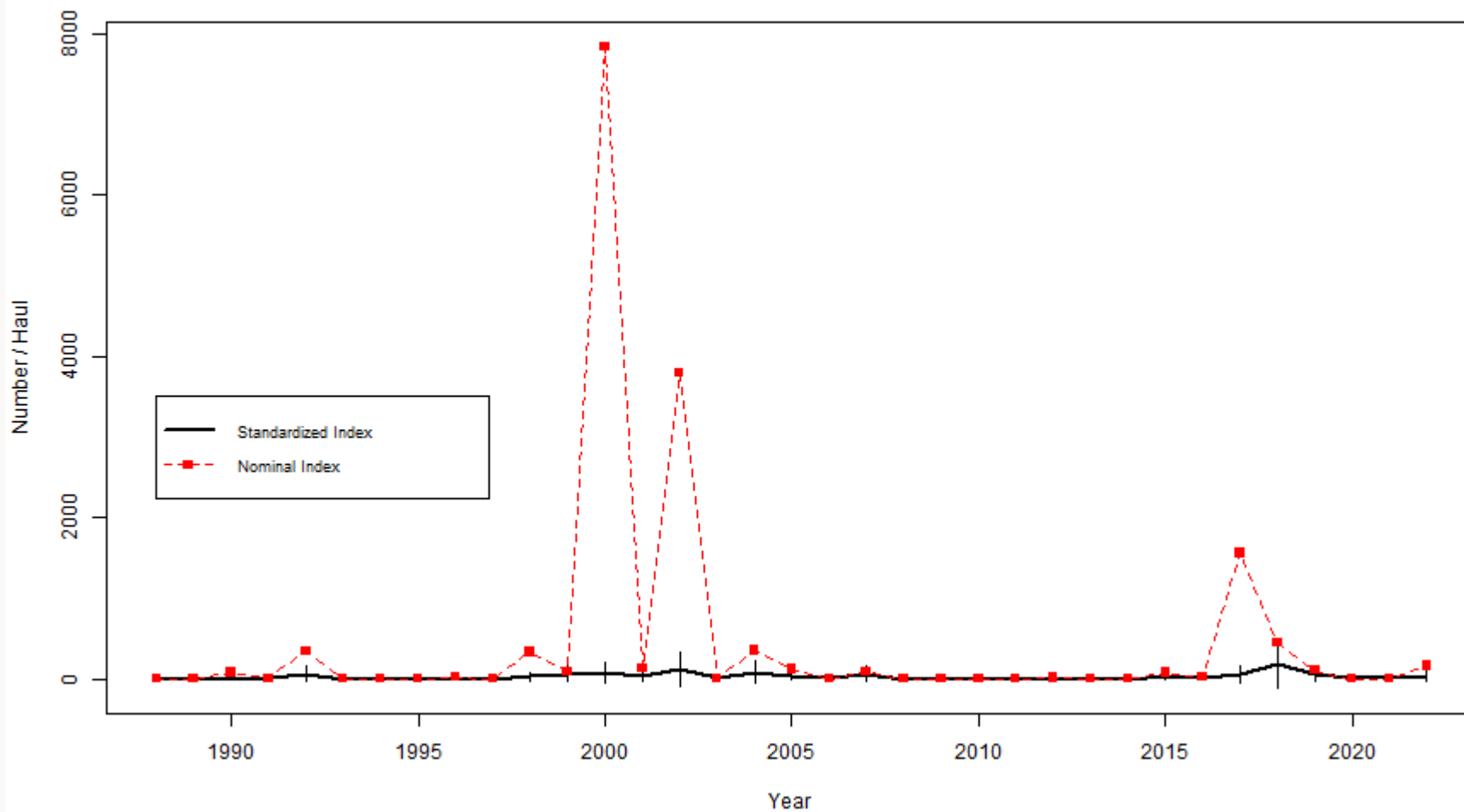


Figure 7. Juvenile menhaden standardized annual abundance index 1988 – 2022 (see appendix A for standardization methodology).

### Striped Bass Abundance

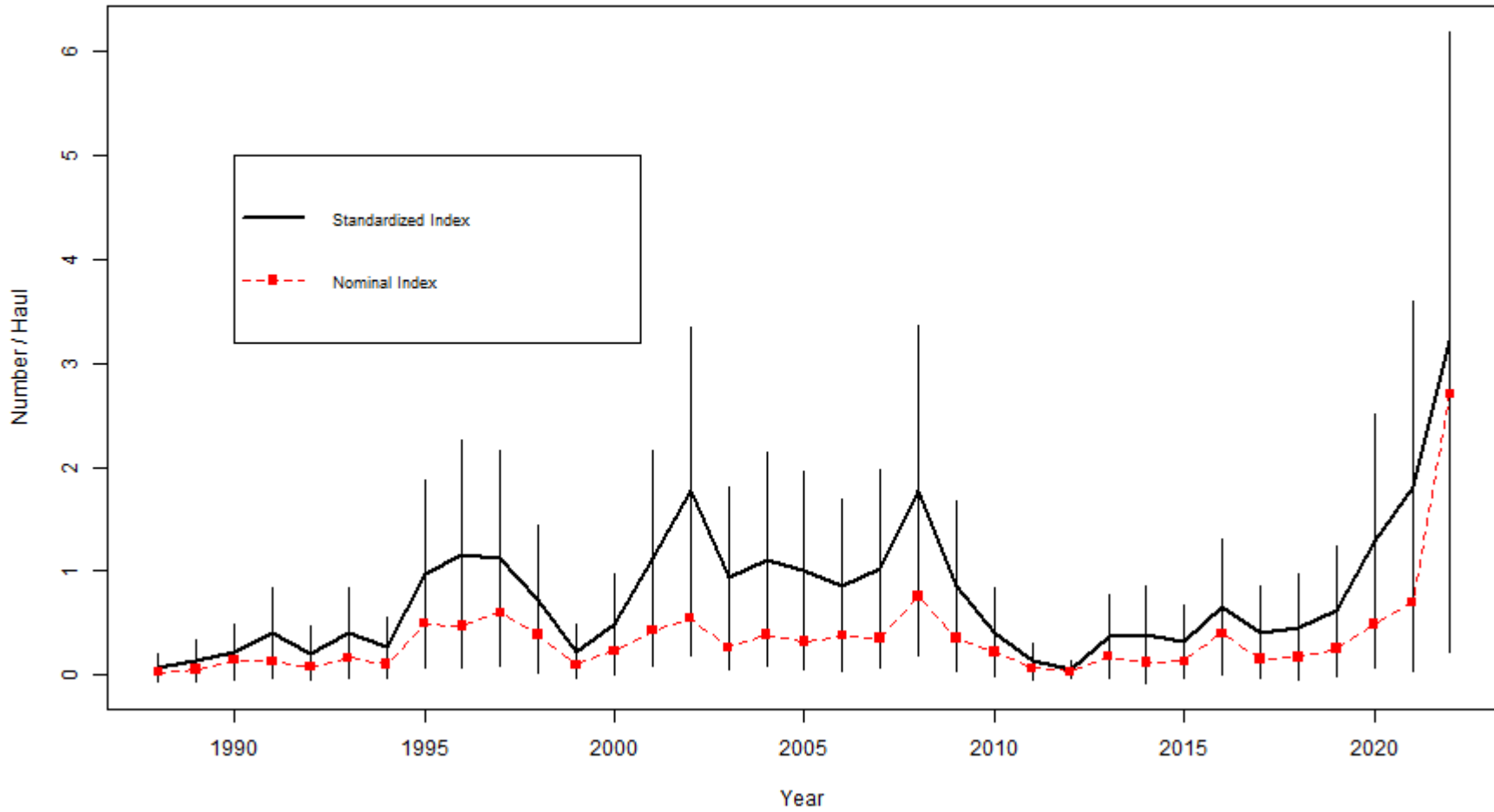


Figure 8. Striped bass standardized annual abundance index 1988 – 2022 (see appendix A for standardization methodology).



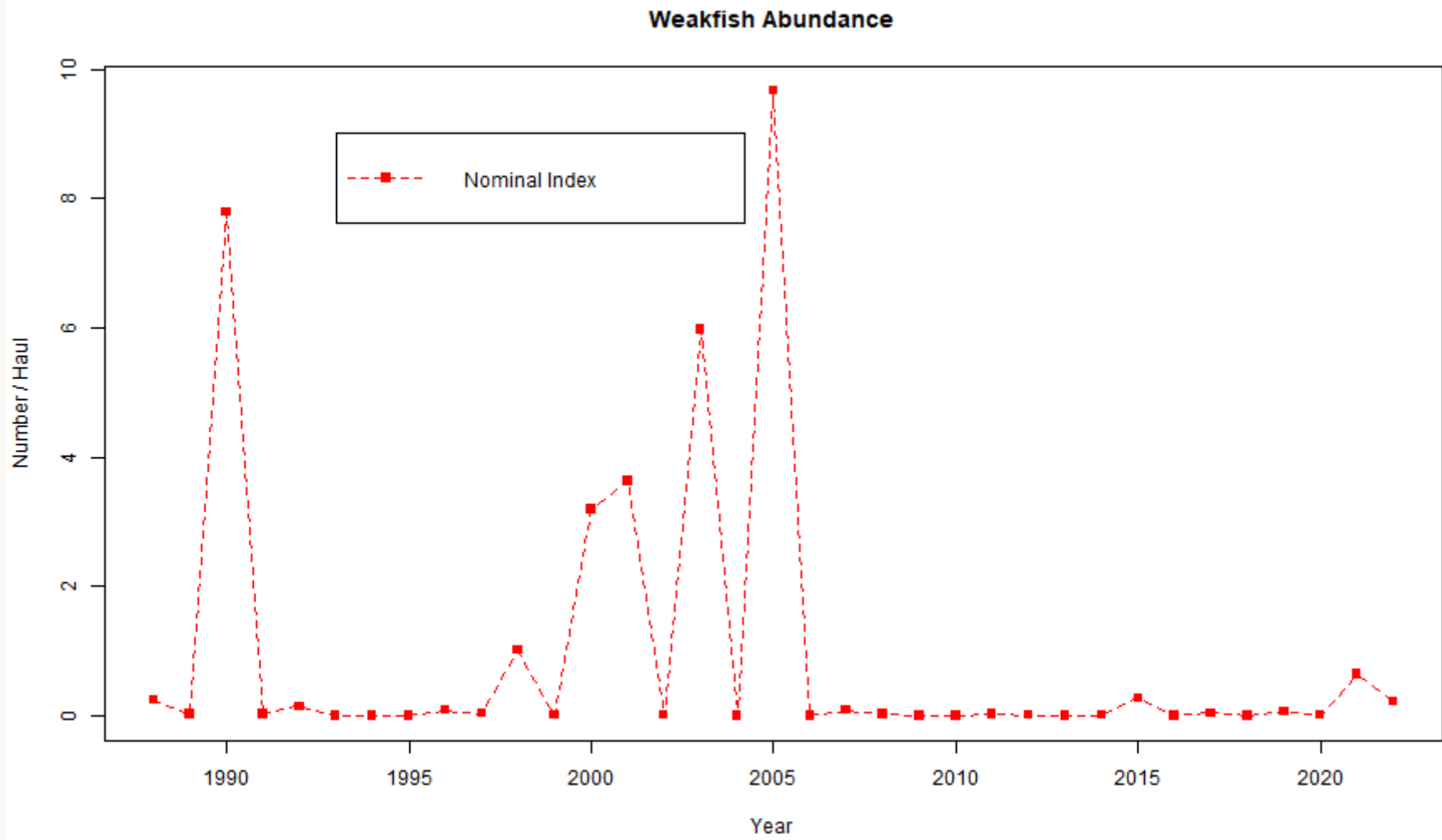


Figure 9. Weakfish annual abundance index 1988 – 2022.

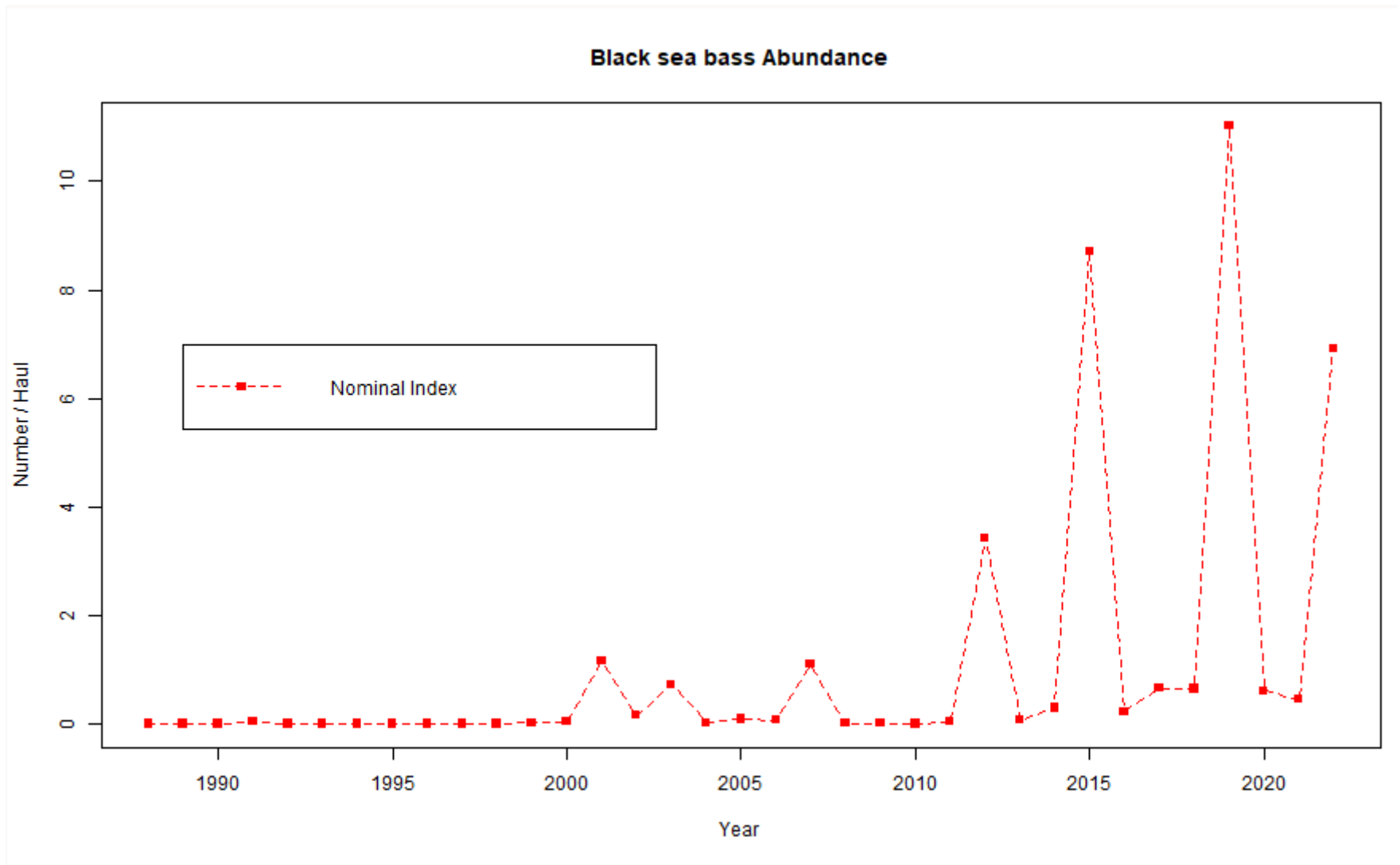


Figure 10. Black sea bass annual abundance index 1988 – 2022.

## TABLES

Table 1a. Mann-Kendall test for target species abundance trend analysis (Full dataset; 1988 - 2022).

Mann-Kendall test	Winter Flounder	Tautog	Bluefish	River Herring	Menhaden	Striped Bass
S	-291	-21	-185	21	93	133
n Observations	35	35	35	35	35	35
Variance	4958.333	165	4958.333	4958.333	4958.333	4958.333
Tau	-0.489	-0.382	-0.311	0.0353	0.156	0.224
2-sided p value	3.8149e-5	0.11947	0.0089735	0.45856	0.19137	0.060849
$\alpha$	0.05	0.05	0.05	0.05	0.05	0.05
Significant Trend	Yes ↓	No	Yes ↓	No	No	No

Table 1b. Mann-Kendall test for target species abundance trend analysis (2012 - 2022).

Mann-Kendall test	Winter Flounder	Tautog	Bluefish	River Herring	Menhaden	Striped Bass
S	-13	39	-21	13	19	45
n Observations	10	10	10	10	10	10
Variance	165	165	165	165	165	165
Tau	-0.236	0.709	-0.382	0.236	0.345	0.818
2-sided p value	0.3502	0.0030935	0.11947	0.3502	0.16112	0.00061393
$\alpha$	0.05	0.05	0.05	0.05	0.05	0.05
Significant Trend	No	Yes ↑	No	No	No	Yes ↑

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 2022.

JUNE Species	Station																		Grand Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
<i>Alosa aestivalis</i> &/or <i>pseudoharengus</i>			43	2										8					53
<i>Ammodytes americanus</i>																1			1
Amphipoda order			X																X
<i>Anchoa mitchilli</i>	2																		2
<i>Anguilla rostrata</i>							1							1					2
<i>Apeltes quadracus</i>											2		1						3
<i>Arcopectin irradians</i>													X						X
<i>Brevoortia tyrannus</i>	1																		1
<i>Calinectes sapidus</i>			1	9				1						9				6	26
<i>Caranx hippos</i>	1																		1
<i>Carcinus maenus</i>				X	X			X	X		X	X	X	X					X
<i>Crangon septemspinosa</i>	X	X		X					X		X				X		X		X
<i>Crepidula fornicata</i>	X								X								X		X
<i>Etropus microstomus</i>															2			1	3
<i>Fundulus heteroclitus</i>	3			1		58			31				10						103
<i>Fundulus majalis</i>	231	1	2		60	11			23				59						387
<i>Gobiosoma bosc</i>	1	1						2					2	1		1	4		12
<i>Hemigrapsus sanguineus</i>		X						X	X										X
<i>Illex illecebrosus</i>														2					2
Isopoda order															X				X
<i>Libinia emarginata</i>		X						X			X					X			X
<i>Limulus polyphemus</i>		1						1	1										3
<i>Lucania parva</i>			1	1															2
<i>Lunarca ovalis</i>											2								2
<i>Menidia menidia</i>	284	22	5	89	28	5					11	21	61	74	15	41	88	13	757
<i>Mercenaria mercenaria</i>													X						X
<i>Microgadus tomcod</i>		1			2		5		2			5	1	15		8			39
<i>Morone saxatilis</i>			1					17		1						1			20
<i>Myoxocephalus aeneus</i>							5		2	1	2		18	1			1	2	32
<i>Mytilus edulis</i>			X																X
<i>Nassarius obsoletus</i>			X	X			X	X	X					X	X			X	X
<i>Ovalipes ocellatus</i>																		3	3
<i>Pagurus</i> spp		X	X	X	X	X	X	X	X		X		X	X			X	X	X
<i>Palaemonetes vulgaris</i>	X	X	X	X	X				X		X	X	X	X		X	X		X
<i>Panopeus</i> spp			X	X	X			X			X		X						X
<i>Paralichthys dentatus</i>			1											1					2
<i>Pomatomus saltatrix</i>	1																		1
<i>Prionotus carolinus</i>		1																	1
<i>Prionotus evolans</i>								1			1		1						3
<i>Pseudopleuronectes americanus</i>		4	76	35	1			1	4		10		3	1			6	8	149
<i>Scophthalmus aquosus</i>								1							1				2
<i>Sphoeroides maculatus</i>	2				1	3												1	7
<i>Syngnathus fuscus</i>		2		4	2		3			1			4				1		17
<i>Tautoga onitis</i>		7			2		30		4			5	7		5	1			61
<i>Tautoglabrus adspersus</i>					1		9		1										11
<i>Urophycis chuss</i>							3								1	2			6
<b>Grand Total</b>	<b>526</b>	<b>40</b>	<b>130</b>	<b>141</b>	<b>97</b>	<b>77</b>	<b>56</b>	<b>24</b>	<b>68</b>	<b>3</b>	<b>28</b>	<b>31</b>	<b>168</b>	<b>112</b>	<b>19</b>	<b>59</b>	<b>107</b>	<b>28</b>	<b>1714</b>

\* x indicates that the non-target species was collected but the abundance was recorded as abundant, many or few.

Table 4. Species presence by station for July 2022.

JULY Species	Station																		Grand Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
<i>Alosa aestivalis</i> &/or <i>pseudoharengus</i>														2					2
<i>Anguilla rostrata</i>								2											2
<i>Apeltes quadracus</i>				3				1	1		1								6
<i>Arcopectin irradians</i>								1											1
<i>Brevoortia tyrannus</i>								1		5		1		2		1			10
<i>Busycon carica</i>		X																	X
<i>Calinectes sapidus</i>	2		103	3				4					6						118
<i>Carcinus maenus</i>							X	X	X		X		X	X		X			X
<i>Centropristus striata</i>	41	86		4	12			53	19		11	1	5					24	256
<i>Crangon septemspinosa</i>					X									X	X				X
<i>Crepidula fornicata</i>					X														X
<i>Cynoscion regalis</i>	5	1						11					1						18
<i>Cyprinodon variegatus</i>									2		15			1					18
<i>Emerita talpoida</i>															X				X
<i>Etropus microstomus</i>															3				3
<i>Fundulus heteroclitus</i>	351	19	27	1	18	47		57	527		534		9	59				211	1860
<i>Fundulus majalis</i>		14	209		1	25		23	102		112		22	89		1	473	3	1074
<i>Gasterosteus aculeatus</i>											1								1
<i>Gobiosoma bosc</i>			2				1				1	1	2			1			8
<i>Hippocampus</i> genus	1																		1
<i>Illex illecebrosus</i>								3											3
Isopoda order		X							X							X			X
<i>Libinia emarginata</i>	X	X	X		X			X		X		X	X	X					X
<i>Limulus polyphemus</i>		1																1	2
<i>Lucania parva</i>			2	1					2					1				1	7
<i>Menidia menidia</i>	734	109	397	71	230	2482	216	231	457	373	891	1573	530	321	438	237	853	2471	12614
<i>Menticirrhus saxatilis</i>	23	63	18	16	12	1		37	1		4	1	6		29	4	339	40	594
<i>Microgadus tomcod</i>	1							3		1		2				4			11
<i>Morone saxatilis</i>	220				1											2			223
<i>Mugil curema</i>											3								3
<i>Myoxocephalus aeneus</i>		1	3				3		1		10					14		3	35
<i>Mytilus edulis</i>			X		X				X		X	X				X			X
<i>Nassarius obsoletus</i>				X	X														X
<i>Ovalipes ocellatus</i>			28	1											1		12		42
<i>Pagurus</i> spp		X	X	X			X	X		X	X	X	X	X	X		X	X	X
<i>Palaemonetes vulgaris</i>	X	X	X	X	X		X		X	X	X	X	X	X		X		X	X
<i>Panopeus</i> spp	X		X		X		X	X	X	X	X		X			X			X
<i>Paralichthys dentatus</i>											16				1			1	18
<i>Pomatomus saltatrix</i>	1			13				39						6					59
<i>Prionotus carolinus</i>			3					6							4			1	14
<i>Prionotus evolans</i>		7	21	32				6	2		1		2					13	84
<i>Pseudopleuronectes americanus</i>			60	8	7		1	18	21		1	2	8				13	6	145
<i>Sphoeroides maculatus</i>	32	57	56	28	12	21		59	32		10	1	23		1	1	50	122	505
<i>Stenotomus chrysops</i>	98	407	45	146	35		5	54	23	5	78		68		2		51	5	1022
<i>Strongylura marina</i>	3	1								1								26	31
<i>Syngnathus fuscus</i>	6	1	1		7			4	1		3					1		1	26
<i>Tautoga onitis</i>	130	48	89	19	66		9	122	116	40	98	30	77	26		66	49	20	1005
<i>Tautoglabrus adspersus</i>	10	6	2	2	38	4		32	35	42	9					69			249
<b>Grand Total</b>	<b>1658</b>	<b>821</b>	<b>1066</b>	<b>348</b>	<b>439</b>	<b>2580</b>	<b>235</b>	<b>767</b>	<b>1343</b>	<b>466</b>	<b>1799</b>	<b>1612</b>	<b>759</b>	<b>507</b>	<b>479</b>	<b>401</b>	<b>2118</b>	<b>2672</b>	<b>20070</b>

\* x indicates that the non-target species was collected but the abundance was recorded as abundant, many or few.

Table 5. Species presence by station for August 2022.

AUGUST Species	Station																		Grand Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
<i>Alosa aestivalis</i> &/or <i>pseudoharengus</i>		1					1	1							1				4
Amphipoda order													X						X
<i>Anguilla rostrata</i>							2												2
<i>Arcopectin irradians</i>														1					1
<i>Brevoortia tyrannus</i>		1		590	1	1	58		2	5	2105	2576				16			5355
<i>Calinectes sapidus</i>	2	1	514		1			1			1		5	2	3	1			531
<i>Carcinus maenus</i>					X							X	X	X		X			X
<i>Centropristus striata</i>	1	30	2	146	70			1	2	4			13	8	1	18	1	26	323
<i>Crangon septemspinosa</i>						X													X
<i>Crassostrea virginica</i>												1							1
<i>Crepidula fornicata</i>	X				X							X							X
<i>Cynoscion regalis</i>																1			1
<i>Cyprinodon variegatus</i>			1								1								2
<i>Emerita talpoida</i>					X														X
<i>Fundulus heteroclitus</i>	189	17	317	98		48		23	16	1	438		48	484		1	6X		1740
<i>Fundulus majalis</i>	464	203	65	211	10	48		43	32		84	8	63	65		2	84	13	1395
<i>Gobiosoma bosc</i>			1										1	2					4
<i>Illex illecebrosus</i>								1											1
Isopoda order															X				X
<i>Libinia emarginata</i>								X					X	X	X				X
<i>Limulus polyphemus</i>			1																1
<i>Menidia menidia</i>	1103	750	86	605	283	606	20016	276	47	20795	449	4215	2600	812	2874	3420	581	172	59690
<i>Menticirrhus saxatilis</i>	76	34	1	21	46	1	7	6	2		2	9		6	81		22	2	316
<i>Microgadus tomcod</i>										1						1			2
<i>Mugil curema</i>														1					1
<i>Myoxocephalus aeneus</i>																11			11
<i>Mytilus edulis</i>								X											X
<i>Nassarius obsoletus</i>			X	X					X										X
<i>Opsanus tau</i>		1			1		2						8	11					23
<i>Ovalipes ocellatus</i>		1																	1
<i>Pagurus spp</i>	X	X	X	X		X	X		X	X				X			X	X	X
<i>Palaemonetes vulgaris</i>			X	X	X	X	X			X			X	X					X
<i>Panopeus spp</i>	X					X	X		X		X		X			X			X
<i>Paralichthys dentatus</i>													2		1		1		4
<i>Pomatomus saltatrix</i>		1										1					2		4
<i>Prionotus carolinus</i>		1													1	1	1		4
<i>Prionotus evolans</i>	1	2		21										1	1	1	1	5	33
<i>Pseudopleuronectes americanus</i>	1			2	2		1		4			1			1	5			17
<i>Sphoeroides maculatus</i>	14	5	9	8	12	1	1	9	20	1			12	1	46	4		3	146
<i>Sphyraena borealis</i>															1				1
<i>Stenotomus chrysops</i>	120	10	1	35	707		47	52	21	14			13	137	38	26	3	27	1251
<i>Strongylura marina</i>	5			1				1					14	2			8	14	45
<i>Syngnathus fuscus</i>				3	1		2						4	18	2	3			33
<i>Tautoga onitis</i>	9	3	12	11	84	2	68	9	57	18		18	37	57	3	79	2	16	485
<i>Tautoglabrus adspersus</i>	1	1			21		50	1	17	14			5	25		159			294
<b>Grand Total</b>	<b>1986</b>	<b>1062</b>	<b>1010</b>	<b>1752</b>	<b>1239</b>	<b>707</b>	<b>20256</b>	<b>425</b>	<b>222</b>	<b>20849</b>	<b>3080</b>	<b>6829</b>	<b>2825</b>	<b>1633</b>	<b>3054</b>	<b>3749</b>	<b>766</b>	<b>278</b>	<b>71722</b>

\* x indicates that the non-target species was collected but the abundance was recorded as abundant, many or few.

Table 6. Species presence by station for September 2022.

SEPTEMBER Species	Station																		Grand Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
<i>Aloea aestivalis</i> &/or <i>pseudoharengus</i>																		1	1
<i>Anchoa mitchilli</i>			7																7
<i>Brevoortia tyrannus</i>		8313										17		14		7			8351
<i>Busycon carica</i>	1																		1
<i>Calinectes sapidus</i>	1		51										7						59
<i>Carcinus maenus</i>					X	X								X		X			X
<i>Centropristus striata</i>		2	10	1			3		5				1		5			13	40
<i>Crangon septemspinosa</i>	X										X								X
<i>Crepidula fornicata</i>		X										X							X
<i>Cynoscion regalis</i>			1																1
<i>Cyprinodon variegatus</i>								1											1
<i>Etropus microstomus</i>															6				6
<i>Fundulus heteroclitus</i>	66	3	15					2	6		5		45	9			6		157
<i>Fundulus majalis</i>	378	143	45	18		23		66	53		8		51	30	1	2	5	43	866
<i>Hemigrapsus sanguineus</i>											X								X
<i>Libinia emarginata</i>	X		X		X						X		X						X
<i>Menidia menidia</i>	1108	660	578	1227	148	207	2159	1626	388	203	4	2648	1984	3077	208	8753	26	464	25468
<i>Menticirrhus saxatilis</i>	5	2	4	3	1										63		2	2	82
<i>Mercenaria mercenaria</i>			X									1							1
<i>Mytilus edulis</i>											X	X							X
<i>Nassarius obsoletus</i>			X						X		X			X					X
<i>Neanthes succinea</i>		X																	X
<i>Opsanus tau</i>									1		1								2
<i>Ovalipes ocellatus</i>															1				1
<i>Pagurus spp</i>	X	X	X	X		X	X	X	X		X			X	X	X	X	X	X
<i>Palaemonetes vulgaris</i>	X	X	X	X		X		X	X		X	X	X	X		X		X	X
<i>Panopeus spp</i>	X			X					X		X	X							X
<i>Pomatomus saltatrix</i>	2	8	2	15	1	2		9	11			78	14	7	6	15		1	171
<i>Prionotus carolinus</i>				1											2				3
<i>Prionotus evolans</i>			3																3
<i>Pseudopleuronectes americanus</i>							1		1				1					1	4
<i>Spherooides maculatus</i>	3	2	1		1	1			X			1	4					3	16
<i>Sphyræna borealis</i>							2												2
<i>Stenotomus chrysops</i>	32	52	41	1	100		22		63	2		7	2					70	392
<i>Strongylura marina</i>		4											32				23		59
<i>Syngnathus fuscus</i>	3		19								1								23
<i>Synodus foetens</i>															1				1
<i>Tautoga onitis</i>	22	22	5	1			5		71	15	3		5	24		1		7	181
<i>Tautoglabrus adspersus</i>	1						6		40	12									59
<i>Trachinotus carolinus</i>															3				3
<i>Urosalpinx cinerea</i>												X							X
<b>Grand Total</b>	<b>1622</b>	<b>9211</b>	<b>782</b>	<b>1267</b>	<b>251</b>	<b>233</b>	<b>2198</b>	<b>1703</b>	<b>640</b>	<b>232</b>	<b>22</b>	<b>2752</b>	<b>2146</b>	<b>3161</b>	<b>296</b>	<b>8778</b>	<b>62</b>	<b>605</b>	<b>35961</b>

\* x indicates that the non-target species was collected but the abundance was recorded as abundant, many or few.

Table 7. Species presence by station for October 2022.

OCTOBER Species	Station																		Grand Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
<i>Alosa aestivalis</i> &/or <i>pseudoharengus</i>		1													1		1		3
<i>Apeltes quadracus</i>													4						4
<i>Brevoortia tyrannus</i>		1	1259								1		2		3	1			1267
<i>Busycon carica</i>												1							1
<i>Calinectes sapidus</i>			3	6								4						1	14
<i>Carcinus maenus</i>	X			X	X			X	X		X		X	X					X
<i>Centropristis striata</i>											3					1			4
<i>Crepidula fornicata</i>	X				X	X						X		X				X	X
<i>Cyprinodon variegatus</i>	1					4			4		4		2	1			2		18
<i>Emerita talpoida</i>															X				X
<i>Etropus microstomus</i>														1	11				12
<i>Fundulus heteroclitus</i>	45	2	14	10		6		41	40		179	15	1063	125			15		1555
<i>Fundulus majalis</i>	46	40	197	73	8	42		40	40		56	5	283	20	18		34	18	920
<i>Gobiosoma bosc</i>											1		2						3
<i>Libinia emarginata</i>								X		X		X							X
<i>Limulus polyphemus</i>																1			1
<i>Lucania parva</i>											4		1						5
<i>Menidia menidia</i>	55	50	65	98	54	8	17	43	40	96	3207	93	1496	368	1397	4261	1561	172	13081
<i>Menticirrhus saxatilis</i>															3				3
<i>Nassarius obsoletus</i>			X	X						X				X	X			X	X
<i>Opsanus tau</i>													4						4
<i>Ovalipes ocellatus</i>				1													1		2
<i>Pagurus spp</i>	X	X		X	X			X	X					X	X	X	X	X	X
<i>Palaemonetes vulgaris</i>	X	X	X	X	X	X	X		X		X	X	X	X		X	X	X	X
<i>Panopeus spp</i>					X					X	X	X	X			X			X
<i>Paralichthys dentatus</i>													1						1
<i>Pomatomus saltatrix</i>		1																	1
<i>Pseudopleuronectes americanus</i>				1	4				4	1						1			11
<i>Spherooides maculatus</i>									1										1
<i>Stenotomus chrysops</i>											2								2
<i>Syngnathus fuscus</i>			1	3						1		1	4					1	11
<i>Tautoga onitis</i>			1	1	13		4		2	4		6	5			9	3		48
<i>Tautoglabrus adspersus</i>					14		1			12				2		8		1	38
<i>Urophycis chuss</i>																		1	1
<b>Grand Total</b>	<b>147</b>	<b>95</b>	<b>1540</b>	<b>193</b>	<b>93</b>	<b>60</b>	<b>22</b>	<b>124</b>	<b>131</b>	<b>114</b>	<b>3457</b>	<b>125</b>	<b>2867</b>	<b>517</b>	<b>1433</b>	<b>4282</b>	<b>1617</b>	<b>194</b>	<b>17011</b>

\* x indicates that the non-target species was collected but the abundance was recorded as abundant, many or few.



Table 8. Summary of species occurrence by station in 2021. 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).

ALL MONTHS	Station																		Grand Total
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Grand Total
<i>Alosa aestivalis</i> &/or <i>pseudoharengus</i>		2	43	2			1	1						10	2		1	1	63
<i>Ammodytes americanus</i>																1			1
Amphipoda order			X										X						X
<i>Anchoa mitchilli</i>	2		7																9
<i>Anguilla rostrata</i>							3	2						1					6
<i>Apeltes quadracus</i>				3				1	1		3		5						13
<i>Arcopectin irradians</i>								1					X	1					2
<i>Brevoortia tyrannus</i>	1	8315	1259	590	1	1	58	1	2	10	2106	2594	2	16	3	25			14984
<i>Busycon carica</i>	1	X										1							2
<i>Calinectes sapidus</i>	5	1	672	18	1			6			1	4	27	2	3	1	6	1	748
<i>Caranx hippos</i>	1																		1
<i>Carcinus maenus</i>	X			X	X	X	X	X	X		X	X	X	X		X			X
<i>Centropristus striata</i>	42	118	12	151	82		4	55	28		14	1	19	8	6	19	25	39	623
<i>Crangon septemspinosa</i>	X	X		X	X	X			X		X			X	X		X	X	X
<i>Crassostrea virginica</i>												1							1
<i>Crepidula fornicata</i>	X	X			X	X			X			X		X			X	X	X
<i>Cynoscion regalis</i>	5	1	1					11					1			1			20
<i>Cyprinodon variegatus</i>	1		1			4			7		2X		2	2			2		39
<i>Emerita talpoida</i>					X										X				X
<i>Etropus microstomus</i>													1	22				1	24
<i>Fundulus heteroclitus</i>	654	41	373	110	18	159		123	620	1	1156	15	1175	677		1	292		5415
<i>Fundulus majalis</i>	1119	401	518	302	79	149		172	250		260	13	478	204	19	5	596	77	4642
<i>Gasterosteus aculeatus</i>											1								1
<i>Gobiosoma bosc</i>	1	1	3				1	2			2	1	7	3		2	4		27
<i>Hemigrapsus sanguineus</i>		X						X	X		X								X
<i>Hippocampus</i> genus	1																		1
<i>Illex illecebrosus</i>								4						2					6
Isopoda order		X					X								X				X
<i>Libinia emarginata</i>	X	X	X		X		X	X	X	X	X	X	X	X	X	X		X	X
<i>Limulus polyphemus</i>		2	1					1	1							1	1		7
<i>Lucania parva</i>			3	2					2		4		1	1			1		14
<i>Lunarca ovalis</i>											2								2
<i>Menidia menidia</i>	3284	1591	1131	2090	743	3308	22408	2176	932	21467	4562	8550	6671	4652	4932	16712	3109	3292	111610
<i>Menticirrhus saxatilis</i>	104	99	23	40	59	2	7	43	3		6	10	6	6	176	4	363	44	995
<i>Mercenaria mercenaria</i>			X									1	X						1
<i>Microgadus tomcod</i>	1	1			2		5	3	2	2		7	1	15		13			52
<i>Morone saxatilis</i>	220		1		1			17		1						3			243
<i>Mugil curema</i>											3			1					4

<i>Myoxocephalus aeneus</i>		1	3				8		3	1	12		18	1		25	1	5	78
<i>Mytilus edulis</i>			X		X				X		X	X			X				X
<i>Nassarius obsoletus</i>			X	X	X		X	X	X	X	X			X	X			X	X
<i>Neanthes succinea</i>		X																	X
<i>Opsanus tau</i>		1			1		2		1		1		12	11					29
<i>Ovalipes ocellatus</i>		1	28	2											2		13	3	49
<i>Pagurus spp</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Palaemonetes vulgaris</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
<i>Panopeus spp</i>	X		X	X	X	X	X	X	X	X	X	X	X		X				X
<i>Paralichthys dentatus</i>			1								16		3	1	2		1	1	25
<i>Pomatomus saltatrix</i>	4	10	2	28	1	2		48	11			79	14	13	6	15	2	1	236
<i>Prionotus carolinus</i>		2	3	1				6							7	1	2		22
<i>Prionotus evolans</i>	1	9	24	53				7	2		2		2	2	1	1	14	5	123
<i>Pseudopleuronectes americanus</i>	1	4	136	46	14		3	19	34	1	11	3	12	1	1	6	19	15	326
<i>Scophthalmus aquosus</i>								1							1				2
<i>Sphoeroides maculatus</i>	51	64	66	36	26	26	1	68	53	1	10	2	39	1	47	5	50	129	675
<i>Sphyræna borealis</i>							2								1				3
<i>Stenotomus chrysops</i>	250	469	87	182	842		74	106	107	21	80	7	83	137	40	26	54	102	2667
<i>Strongylura marina</i>	8	5		1				1	1				46	2			57	14	135
<i>Syngnathus fuscus</i>	9	3	21	10	10		5	4	1	2	4	1	12	18	2	4	2	2	110
<i>Synodus foetens</i>															1				1
<i>Tautoga onitis</i>	161	80	107	32	165	2	116	131	250	77	101	59	124	114	3	160	55	43	1780
<i>Tautogolabrus adspersus</i>	12	7	2	2	74	4	66	33	93	80	9		5	27		236		1	651
<i>Trachinotus carolinus</i>															3				3
<i>Urophycis chuss</i>							3								1	2		1	7
<i>Urosalpinx cinerea</i>												X							X
<b>Grand Total</b>	<b>5939</b>	<b>11229</b>	<b>4528</b>	<b>3701</b>	<b>2119</b>	<b>3657</b>	<b>22767</b>	<b>3043</b>	<b>2404</b>	<b>21664</b>	<b>8386</b>	<b>11349</b>	<b>8765</b>	<b>5930</b>	<b>5281</b>	<b>17269</b>	<b>4670</b>	<b>3777</b>	<b>146478</b>

\* x indicates that the non-target species was collected but the abundance was recorded as abundant, many or few.

Table 9. Numbers of juvenile winter flounder per seine haul in 2022.

Month	Station																		Mean	St Dev	SE
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
JUN	0	4	76	35	1	0	0	1	4	0	10	0	3	1	0	0	6	8	8.28	18.80	4.43
JUL	0	0	60	8	7	0	1	18	21	0	1	2	8	0	0	0	13	6	8.06	14.52	3.42
AUG	1	0	0	2	2	0	1	0	4	0	0	1	0	0	1	5	0	0	0.94	1.47	0.35
SEP	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	1	0.22	0.43	0.10
OCT	0	0	0	1	4	0	0	0	4	1	0	0	0	0	0	1	0	0	0.61	1.29	0.30
Mean	0.20	0.80	27.20	9.20	2.80	0.00	0.60	3.80	6.80	0.20	2.20	0.60	2.40	0.20	0.20	1.20	3.80	3.00			
St Dev	0.45	1.79	37.67	14.75	2.77	0.00	0.55	7.95	8.04	0.45	4.38	0.89	3.36	0.45	0.45	2.17	5.76	3.74		Total Fish	
SE	0.20	0.80	16.85	6.60	1.24	0.00	0.24	3.56	3.60	0.20	1.96	0.40	1.50	0.20	0.20	0.97	2.58	1.67			326
Number	1	4	136	46	14	0	3	19	34	1	11	3	12	1	1	6	19	15			

Table 10. Numbers of juvenile tautog per seine haul in 2022.

Month	Station																		Mean	St Dev	SE
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
JUN	0	7	0	0	2	0	30	0	4	0	0	5	0	7	0	5	1	0	3.39	7.12	1.68
JUL	130	48	89	19	66	0	9	122	116	40	98	30	77	26	0	66	49	20	55.83	42.02	0.17
AUG	9	3	12	11	84	2	68	9	57	18	0	18	37	57	3	79	2	16	26.94	28.78	0.3
SEP	22	22	5	1	0	0	5	0	71	15	3	0	5	24	0	1	0	7	10.06	17.36	0.47
OCT	0	0	1	1	13	0	4	0	2	4	0	6	5	0	0	9	3	0	2.67	3.68	0.23
Mean	32.20	16.00	21.40	6.40	33.00	0.40	23.20	26.20	50.00	15.40	20.20	11.80	24.80	22.80	0.60	32.00	11.00	8.60			
St Dev	55.41	19.79	38.08	8.35	39.18	0.89	27.18	53.70	48.13	15.65	43.51	12.13	32.68	22.08	1.34	37.36	21.27	9.15		Total Fish	
SE	24.78	8.85	17.03	3.74	17.52	0.40	12.15	24.01	21.52	7.00	19.46	5.43	14.62	9.88	0.60	16.71	9.51	4.09			1780
Number	161	80	107	32	165	2	116	131	250	77	101	59	124	114	3	160	55	43			

Table 11. Numbers of juvenile bluefish per seine haul in 2022.

Month	Station																		Mean	St Dev	SE
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
JUN	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.24	0.06
JUL	1	0	0	13	0	0	0	39	0	0	0	0	0	6	0	0	0	0	3.28	9.50	0.17
AUG	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0.22	0.55	0.3
SEP	2	8	2	15	1	2	0	9	11	0	0	78	14	7	6	15	0	1	9.50	17.94	0.47
OCT	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.24	0.23
Mean	0.80	2.00	0.40	5.60	0.20	0.40	0.00	9.60	2.20	0.00	0.00	15.80	2.80	2.60	1.20	3.00	0.40	0.20			
St Dev	0.84	3.39	0.89	7.70	0.45	0.89	0.00	16.89	4.92	0.00	0.00	34.77	6.26	3.58	2.68	6.71	0.89	0.45		Total Fish	
SE	0.37	1.52	0.40	3.44	0.20	0.40	0.00	7.55	2.20	0.00	0.00	15.55	2.80	1.60	1.20	3.00	0.40	0.20			236
Number	4	10	2	28	1	2	0	48	11	0	0	79	14	13	6	15	2	1			

Table 12. Numbers of striped bass per seine haul in 2022.

Month	Station																		Mean	St Dev	SE
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
JUN	0	0	1	0	0	0	0	17	0	1	0	0	0	0	0	1	0	0	1.11	3.98	0.94
JUL	220	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	12.39	51.82	0.17
AUG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.3
SEP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.47
OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.23
Mean	44.00	0.00	0.20	0.00	0.20	0.00	0.00	3.40	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00			
St Dev	98.39	0.00	0.45	0.00	0.45	0.00	0.00	7.60	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.89	0.00	0.00			
SE	44.00	0.00	0.20	0.00	0.20	0.00	0.00	3.40	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00			
Number	220	0	1	0	1	0	0	17	0	1	0	0	0	0	0	3	0	0			
																				Total Fish	243

Table 13. Numbers of juvenile river herring per seine haul in 2022.

Month	Station																		Mean	St Dev	SE
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
JUN	0	0	43	2	0	0	0	0	0	0	0	0	0	8	0	0	0	0	2.94	10.18	2.40
JUL	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0.11	0.47	0.11
AUG	0	1	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0.22	0.43	0.10
SEP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.06	0.24	0.06
OCT	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0.17	0.38	0.09
Mean	0.00	0.40	8.60	0.40	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.00	2.00	0.40	0.00	0.20	0.20			
St Dev	0.00	0.55	19.23	0.89	0.00	0.00	0.45	0.45	0.00	0.00	0.00	0.00	0.00	3.46	0.55	0.00	0.45	0.45			
SE	0.00	0.24	8.60	0.40	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.00	0.00	1.55	0.24	0.00	0.20	0.20			
Number	0	2	43	2	0	0	1	1	0	0	0	0	0	10	2	0	1	1			
																				Total Fish	63

Table 14. Numbers of juvenile menhaden per seine haul in 2022.

Month	Station																		Mean	St Dev	SE
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
JUN	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0.24	0.06
JUL	0	0	0	0	0	0	0	1	0	5	0	1	0	2	0	1	0	0	0.56	1.25	0.29
AUG	0	1	0	590	1	1	58	0	2	5	2105	2576	0	0	0	16	0	0	297.50	760.24	179.19
SEP	0	8313	0	0	0	0	0	0	0	0	0	17	0	14	0	7	0	0	463.94	1958.87	461.71
OCT	0	1	1259	0	0	0	0	0	0	0	1	0	2	0	3	1	0	0	70.39	296.64	69.92
Mean	0.20	1663.00	251.80	118.00	0.20	0.20	11.60	0.20	0.40	2.00	421.20	518.80	0.40	3.20	0.60	5.00	0.00	0.00			
St Dev	0.45	3717.46	563.04	263.86	0.45	0.45	25.94	0.45	0.89	2.74	941.27	1150.03	0.89	6.10	1.34	6.75	0.00	0.00			
SE	0.20	1662.50	251.80	118.00	0.20	0.20	11.60	0.20	0.40	1.22	420.95	514.31	0.40	2.73	0.60	3.02	0.00	0.00			
Number	1	8315	1259	590	1	1	58	1	2	10	2106	2594	2	16	3	25	0	0			
																				Total Fish	14,984

Table 15. Numbers of juvenile black sea bass per seine haul in 2022.

Month	Station																		Mean	St Dev	SE
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
JUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0
JUL	41	86	0	4	12	0	0	53	19	0	11	1	5	0	0	0	24	0	14.22	23.63	0.17
AUG	1	30	2	146	70	0	1	2	4	0	0	0	13	8	1	18	1	26	17.94	36.45	0.3
SEP	0	2	10	1	0	0	3	0	5	0	0	0	1	0	5	0	0	13	2.22	3.80	0.47
OCT	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0.22	0.73	0.23
Mean	8.40	23.60	2.40	30.20	16.40	0.00	0.80	11.00	5.60	0.00	2.80	0.20	3.80	1.60	1.20	3.80	5.00	7.80			
St Dev	18.23	37.13	4.34	64.75	30.41	0.00	1.30	23.49	7.83	0.00	4.76	0.45	5.54	3.58	2.17	7.95	10.63	11.63			Total Fish
SE	8.15	16.61	1.94	28.96	13.60	0.00	0.58	10.51	3.50	0.00	2.13	0.20	2.48	1.60	0.97	3.56	4.75	5.20			623
Number	42	118	12	151	82	0	4	55	28	0	14	1	19	8	6	19	25	39			

Table 16. Temperature, salinity, and dissolved oxygen by station and month – 2022

Station		Month					Total Average
		JUN	JUL	AUG	SEP	OCT	
1	Temperature (C)	21.4	26.9	0	22.9	16.4	17.52
	Salinity	20.6	23.7	0	23.8	25.9	18.8
	Dissolved Oxygen	8	6.3	0	5.2	8.3	5.56
2	Temperature (C)	21.9	27.3	0	24	16.8	18
	Salinity	21.6	24.6	0	23	26.3	19.1
	Dissolved Oxygen	9	7.8	0	7.1	8.6	6.5
3	Temperature (C)	22.2	27.2	28	22.5	15.5	23.08
	Salinity	26.5	27.6	27.8	26	27.1	27
	Dissolved Oxygen	7.3	7.3	6.2	5.3	9.2	7.06
4	Temperature (C)	22.6	27.3	27.9	18.6	16	22.48
	Salinity	23.4	28.1	27.8	28.1	26.2	26.72
	Dissolved Oxygen	6.8	8.7	6.6	7.7	8.3	7.62
5	Temperature (C)	20.5	25.5	26	22.3	15.4	21.94
	Salinity	27.1	28.1	28.7	28.2	28	28.02
	Dissolved Oxygen	7.1	6.1	5.3	5.2	7.9	6.32
6	Temperature (C)	20.2	22.1	24.7	19.4	16	20.48
	Salinity	28	28.8	29	29	27.1	28.38
	Dissolved Oxygen	7.4	7.2	5.6	7.4	7.2	6.96
7	Temperature (C)	19.5	22.2	23.6	19	16.1	20.08
	Salinity	28.5	29	27.1	29.5	28.1	28.44
	Dissolved Oxygen	7.8	8.2	6.5	7.6	7.5	7.52
8	Temperature (C)	22.7	27	0	21.8	16.5	17.6
	Salinity	26.6	27.3	0	27.5	28.4	21.96
	Dissolved Oxygen	7.4	8	0	6	8.1	5.9
9	Temperature (C)	22.8	26.3	23.8	22.3	17.2	22.48
	Salinity	27.3	28.1	28.7	28.2	28.6	28.18
	Dissolved Oxygen	9.9	7.2	7.6	6.2	8.2	7.82
10	Temperature (C)	17.6	22.8	21.8	19	17	19.64
	Salinity	29.1	29.1	29.4	29.8	29.5	29.38
	Dissolved Oxygen	9.2	8.3	6.7	8.6	8.9	8.34
11	Temperature (C)	24.3	26.3	24.4	21.8	16.6	22.68
	Salinity	25.8	27.1	28.1	27.4	27.2	27.12
	Dissolved Oxygen	6.2	7.7	6.7	6.9	8.8	7.26
12	Temperature (C)	22	25.9	24.5	21.9	17.1	22.28
	Salinity	25.6	27	28.1	26.7	25.7	26.62
	Dissolved Oxygen	8.5	7.2	6.5	6.3	7.9	7.28
13	Temperature (C)	23.5	25.7	27.2	22.5	17	23.18
	Salinity	27.5	28.1	28.6	28.2	28.4	28.16
	Dissolved Oxygen	8	7.8	6.8	7.4	11.7	8.34
14	Temperature (C)	21.2	25	26.2	21.3	16	21.94
	Salinity	28.1	28.6	28.9	28.6	28.9	28.62
	Dissolved Oxygen	7.1	8.6	6.8	7.1	8.4	7.6
15	Temperature (C)	19.7	23.8	24	20.8	16.1	20.88
	Salinity	28.7	29.1	29.3	29.5	29.6	29.24
	Dissolved Oxygen	7.4	7.6	5.9	6.9	9.1	7.38
16	Temperature (C)	19.8	25	25.9	22.2	19.7	22.52
	Salinity	27.8	28.3	20.7	28.7	29.2	26.94
	Dissolved Oxygen	8.4	7.2	6.9	7	9.5	7.8
17	Temperature (C)	22.2	28	0	22.3	16.6	17.82
	Salinity	25.7	27.1	0	26.9	27.4	21.42
	Dissolved Oxygen	6.1	5.1	0	5.1	8	4.86
18	Temperature (C)	22.2	24.9	25.3	23.4	16.2	22.4
	Salinity	27.7	28.7	28.9	28.2	26.8	28.06
	Dissolved Oxygen	7.9	7.5	6.6	8	7.8	7.56

\*Zero values are from when the YSI was not working.

## **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:

<b>Factor</b>	<b>Levels</b>	<b>Value</b>
Year	35	1988-2022
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](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:

$$\mathbf{Ln(catch) = Year + Month + Station + Temperature + Salinity}$$

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

$$\mathbf{Success = Year + Month + Station + Temperature + Salinity}$$

***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:

<b>Species</b>	<b>Factor</b>	<b>Levels</b>	<b>Value</b>
Winter Flounder	Year	35	1988-2022
	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	35	1988-2022
	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
	Year	35	1988-2022
Striped Bass	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

**2022 Performance Report for Job V:**

**Holistic Fish Habitat Assessment and Fish Productivity Estimations**

Edited By

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Federal Aid in Sportfish Restoration  
F-61-R

**PERFORMANCE REPORT**

**STATE:** Rhode Island

**PROJECT NUMBER:** F-61-R

**SEGMENT NUMBER:** 21

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

**PERIOD COVERED:** January 1, 2022 - December 31, 2022

**JOB NUMBER AND TITLE:** V: Holistic Fish Habitat Assessment and Fish Productivity Estimations

**STAFF:** Pat Barrett (Fisheries Specialist), Eric Schneider (Principal Biologist), and Conor McMannus (Deputy Chief), RI DEM, Div. of Marine Fisheries, Austin Humphries (Associate Professor), University of Rhode Island (URI), Will Helt (Coastal Restoration Scientist) and Heather Kinney (Coastal Restoration Science Technician), The Nature Conservancy of Rhode Island (TNC), and Randall Hughes (Associate Professor) and Jon Grabowski (Assistant Professor), Northeastern University (NU)

**OVERVIEW:**

Rhode Island marine sportfish are supported by a variety of coastal marine habitat types. As such, the preservation of said habitats are critical to sustaining their populations and associated recreational opportunities. However, which habitat types are best suited for sustaining recreational finfish populations has been challenging to assess given the multitude of habitats and varying ways in which fish abundance is monitored across habitat types. This project uses standardized surveys and analytical approaches to holistically assess fish habitat and quantify the fish production of recreationally important species that these habitats support. In doing so, it will result in new insights into the relative differences in the success of different coastal habitats in supporting local fish populations, and thereby provide guidance on future priorities for preserving and restoring certain habitat types. Job V is divided into following projects (A) kelp, (B) artificial reefs, (C) oyster reefs, and (D) eelgrass.

The work from all four projects will begin to codify a “RI Marine Habitat Program” that is proactive in assessing and enhancing sensitive and important marine habitat to support a healthy RI marine ecosystem. Results from this job would support aspects of a Marine Habitat Management and Restoration Plan, which would provide guidance for current (on-going) projects, as well as future work. Results will be a vital resource when prioritizing work and seeking funds via a competitive grant process. By establishing relationships between resource management agencies, environmental non-profits, academics, recreational sport fishing organizations, and commercial fisheries, we aim to facilitate -dialogue on establishing scientifically and socially-sound fish habitat enhancement practices in RI state waters.

**PERFORMANCE REPORT**

**STATE:** Rhode Island

**PROJECT NUMBER:** F-61-R  
**SEGMENT NUMBER:** 21

**PROJECT TITLE:** Holistic Fish Habitat Assessment and Fish Productivity Estimations

**PERIOD COVERED:** January 1, 2022 - December 31, 2022

**JOB NUMBER AND TITLE:** V, Part A: Kelp Monitoring and Productivity Assessment

**STAFF:** Pat Barrett (Fisheries Specialist) and Conor Mcmanus (Deputy Chief) RI DEM, Div. of Marine Fisheries, and Austin Humphries (Associate Professor), University of Rhode Island, URI.

**JOB OBJECTIVE:**

The objectives of this work are:

- 1) Understand how important kelps are in supporting recreationally-important fish species in Rhode Island.
- 2) Assess how changing environmental conditions affect kelps and their associated communities through time.

**TARGET DATE:** December 2024

**INTRODUCTION:**

Kelp forests are abundant and cover approximately 25% of the coastline globally (Krumhansl et al. 2016). Kelps themselves are a critically important ecosystem engineer, forming the foundation of many temperate and boreal coastal ecosystems. For instance, in the Northeast U.S. kelps provide nursery and refuge habitat, as well as food for a myriad of recreationally important fisheries species such as striped bass (*Morone saxatilis*), tautog (*Tautoga onitis*), and scup (*Stenotomus chrysops*). Different aspects of climate change and nutrient dynamics affect kelps, and can therefore have a large impact on goods and services of kelps, including recreational fisheries (Gagné et al. 1982, Smale et al. 2013). Kelps serve as good indicators of change because they are highly responsive to environmental conditions and are directly exposed to a variety of human activities (Wernberg et al. 2013). It is uncertain, however, how such changes will impact kelps, the food webs they support, and the associated fisheries. Thus, we seek to understand how kelp ecosystems may be impacted in the future, and to what extent they will be resilient to changes.

**APPROACH:**

This report summarizes all work conducted for this project between January 1, 2022 and December 31, 2022. During this period conducted fish habitat productivity surveys and

conducted initial statistical analyses to understand how important kelps are in supporting recreationally-important fish species in Rhode Island and assess how changing environmental conditions affect kelps and their associated communities through time.

### *Fish Productivity Assessment*

Sites are chosen in any area of Narragansett Bay and surrounding waters that is composed of primarily rock between 8-12m. All sites selected are sampled annually during the mid to late summer (i.e., July – September) to monitor the local kelp communities at peak diversity and abundance of finfish. Each site has two to four transects sampled to ensure a good site-level description of the community, each separated by at least 100m. Treatment sites should have kelps present, whereas control sites should not. At least one Hobo Onset 64K Pendant Loggers UA-001-64 are placed within the site, set to collect data every 30 mins. Transects are 40m in length and should run roughly parallel to shore following a depth contour line between 8-12m. Five sampling methodologies are used along each transect:

- 1) **Quadrat:** Along each transect, a diver places a 1m<sup>2</sup> PVC frame on the bottom and the diver records the number of all target species. Substrate beneath understory algae is searched, however, neither the substrate nor the organisms attached to it are removed. For a 40m transect line, there are 6 sample points 8m apart, half on the onshore side and half on the offshore side.
- 2) **Uniform point count:** The diver swims the length of the 40m transect centering a 1m PVC stick perpendicular to the transect tape at each 1m interval. The diver then records the species that intersects an imaginary vertical line (operationally defined as a distinct “point” ~2mm in diameter) positioned at each end of the meter stick (n = 80 points per transect). Additionally, the substrate type under each point is noted. If there are multiple species encountered under the point (e.g., algae on top of a tunicate), then all species of plant/animal should be recorded.
- 3) **Swath:** This sampling is performed by a diver swimming the length of the 40m transect twice, once on the onshore and once on the offshore side of the transect. As the diver swims, they use a 1m long PVC stick perpendicular to the transect tape (and approximately 25cm off the bottom) and records the abundance of all targeted species encountered in each 40m x 1m area. The total area sampled is 80 m<sup>2</sup>. The substrate beneath understory algae is searched for target species, as are the undersides of ledges and crevices.
- 4) **Fish counts:** Fish sampling is performed by a diver slowly swimming the length of the 40m transect about 1m above the transect line recording the abundance and size of all fish individuals encountered within a predefined imaginary “cube”. This “cube” extends 3m on either side of the transect tape (6m across) and 3m up from the substrate (3m high). Every fish sighted within the sampling area during the survey is recorded in 10-cm size bins.
- 5) **Morphometrics:** Along the transect, divers should swim and collect 1 adult individual of each species of subsurface kelp every 4 meters (n=10 individuals per transect). This should be completed after all other protocols are carried out to avoid biasing any other results since it is destructive. Back on land or the boat, measure and record the relevant

dimensions of the kelp to determine its biomass (e.g., for *Saccharina latissima*, record blade length and width, and record stipe length).

### *Analytical Approach*

The Uniform Point Count (UPC) survey data was distilled into two categories, substrate and biological cover. The percent substrate for each transect was calculated by multiplying the number of substrate counts per substrate type by the total number of counts per transect (n=80). Biological percent cover is presented as the mean  $\pm$  SE for each site (Fort Wetherill and King's Beach) and grouped by habitat type (Kelp or Control). Control sites are similar in rocky substrate to kelp ones, but contain less than 15% percent kelp coverage on average. The mean percent cover of algae and sessile inverts were used to calculate species richness and diversity, using both the abundance of unique species and the Shannon's H index of diversity respectively.

Kelp and invertebrate densities were determined using the quadrat and swath datasets. The quadrat dataset was used primarily to estimate kelp density as well as any inverts present in the quadrats. For each transect, a mean,  $\pm$  SE, was calculated in order to present a more precise estimate of the overall transect kelp, or invertebrate, density. The swath dataset was used to count the total abundance of rare or less uniformly distributed sessile and mobile invertebrates species. For both the quadrat and swath methods, the average quadrat density or total abundance within the swath were standardized per meter squared. To compare how invertebrate densities differed between the habitat treatments (e.g., control and kelp) we present the average invertebrate density per meter squared, summarized for each site (Fort Wetherill and King's Beach) and grouped by survey method (Quad or Swath). For the two kelp species, *Saccharina latissima* and *Lamanaria digitata*, we leveraged previously collected kelp density data to add to Rhode Island long term kelp dataset to calculate the rate of change for each species since 2016. The rate was estimated using a maximum likelihood approach to fit the mean kelp density data to an exponential decay model to estimate the instantaneous rate change.

Using the fish count survey data, we converted abundance at estimated length, to total fish mass per transect, using the DMF age and growth lab data to convert fish length in cm, to weight in grams. For our target we used RI specific allometric growth models,  $W = \alpha * L^\beta$  (where W = weight, L = length, and alpha and Beta are constants). For species not currently dissected in our growth lab, we used the geometric mean alpha and beta coefficients presented on Fishbase.org. To compare total fish biomass between our kelp and control, we then standardized the total fish mass by dividing the total area surveyed, to get grams per meter squared. For the two years since the beginning of the King's Beach site, we present total fish biomass per habitat treatment,  $\pm$  SE, grouped by site (e.g., Fort Wetherill and King's Beach). In addition to the kelp density data, we also added the total fish biomass estimates to the long-term kelp data set (2016-2022) to investigate fish habitat linkages between kelp habitat and fish biomass over time.

In 2021, we began preliminary modeling efforts looking at the impact of kelp density on the observed biomass of finfish, using a simple linear regression model to predict fish biomass as a function of increasing kelp density. We present observed fish biomass and kelp density data and the significant linear relationship as well as 95% confidence interval obtained resampling the data points via bootstrap methods. We resampled the data 1000 times, each time refitting a new

linear model of fish biomass  $\sim a \cdot \text{kelp density} + b$ . We then used the 97.5 and 2.5 quantiles of the slope and intercept to represent the 95 % CI interval around those predictions. Kelp Morphometrics were summarized using a histogram of blade lengths, for each species, site, and year of the concurrent running surveys (2019, 2020, 2021, 2022). In the future this information will be used to help transform mean kelp density into kelp biomass, using the kelp morphometric data to estimate average kelp mass per transect.

## RESULTS:

In 2022, the kelp monitoring team completed 11 dives and monitored two separate kelp sites located at Fort Wetherill and King's Beach. We also added one control site to the long-term king's beach monitoring location, bringing the total to 11 transects between the two sites (Figures 1 and 2). During the 2022 season, temperature loggers were left in place at the Fort Wetherill locations and continue to collect data.

We found the substrate conditions at each site (e.g. Fort Wetherill and King's Beach) to be fairly uniform between habitat types (e.g. Kelp or Control). On averages the proportion of boulders (large, medium, and small combined) was between 73.33% and 86.66% percent coverage at our transect locations (Figure 3). Both of Sites are at the mouth of Narragansett Bay and represent nearshore rocky reef habitats, typical of the region. Both sites had an average of 30-32% kelp cover (Figure 4), which was up from 18% in 2021 and equal to 30% recorded in 2020. In the absence of kelp, at our control locations (kelp less than 10 percent on average), we found the rocky reef locations to be dominated by a variety a branching and filamentous red alae. Specifically, *Chondrus crispus* and *truncatus*, as well as several *Ceramium* species. In 2022, the algae and invertebrate species richness and diversity at the kelp sites was similar to last year (2021 H; Fort Whetherill: 2.01, and King's Beach 2.35) and equal between sites in 2022 (2022 H; Fort Wetherill:  $2.23 \pm 0.1$  and King;s Beach:  $2.22 \pm 0.17$ )(Table 1). Similar to the UPC, we identified more unique species at the kelp locations with respect to mobile inverts than we did the control locations. Although small, the density of sea stars, urchins, and lobsters were greater at the kelp locations as well. We also found that the density of the northern star coral, *Astrangia Pocolata*, was over greater at the Fort Wetherill sites (Control:  $20.41 \pm 11.41$ ; Kelp:  $9.87 \pm 2.68$ ) than the King's Beach sites locations (Control:  $1 \pm 0.5$ ; Kelp:  $5 \pm 3.26$ ) (Figure 6). We found the average total kelp density (*Saccharina latissima* and *Laminaria digitata*) increase 2022 compared to 2021 and both are back or greater than densities observed in 2019 at both sites (Fort Wetherill:  $8.29 \pm 5.26$ ; King's Beach:  $21.44 \pm 2.8$ ) (Figure 7).

In 2022 we found the average fish biomass greater at both the Fort Wetherill and King's Beach kelp sites than their respective controls. Total fish biomass on the kelp beds averaged  $81.96 \pm 69.94$  and  $40.76 \pm 20.96$  grams per meter squared of kelp habitat at Fort Wetherill and King's Beach location respectively (Figure 8). Overall total biomass was down relative to last year but the relative the kelp sites still had greater biomass than the controls (Figure 8). In the linear regression model we found a positive relationship between fish biomass and kelp density with a (Figure 9). Kelp blade length was summarized using histograms to differentiate the difference between the 2019 - 2022 seasons. Similar to 2021, we found the average blade length for both kelp species to be smaller in 2022 than the previous two years (2019-2020) (Figure 10). Future analyses will use this data set to convert kelp density into biomass.

## **DISCUSSION:**

The global abundance and resilience of kelp species has been impacted by increasing environmental stressors, such as heatwaves and increasing sea surface temperatures and kelp harvest (Wernberg et al 2019). Globally there has only been a modest decline, with kelp average instantaneous rate of change of negative 0.018 per year, However, the regional variation does exist with 28 percent of the kelp systems declining and 38% increasing relative to the global average (Krumhansl 2016). In context for Narraganset Bay kelp beds, the instantaneous rates of change derived for total kelp showed a marginal increase from 2016- 2020 ( $0.04 \pm 0.09$ ), however, the standard error of this estimate does overlap with the global average decline of 0.018 suggesting a non-detectable change compared to the global average. In 2022 we saw the first increases in kelp density since 2020, but a slight decrease in fish biomass. It is crucial tracking these beds through time in order to further define the fish habitat linkages that exist between kelp and fish production. As the work progresses, we will work to incorporate environmental variables into our analyses to determine the impact of changing temperature impacts the kelp system and it's associated inhabitants. For example, we that fish biomass was greatest at the kelp sites and has thus far trended with the overall density of kelp.

This work is crucial to monitor how impacts and changes to kelp beds further impacts sportfish productivity. Our preliminary analyses showed a positive enhancement effect on our target sportfish species with respect to the control sites, or rocky reef habitat that does not have kelp. Using this work to model the fish-habitat linkages we can identify the strength of these relationships and leverage this information to predict how changes in kelp habitat would impact sportfish and the food web in Narragansett Bay.



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Figure 1: Fort Wetherill Kelp Productivity Dive Survey locations. Circles represent the general location of the six transects; Brown = Kelp, Grey = Control.



Figure 2: King's Beach Kelp Productivity Dive Survey locations. Circles represent the general location of the five transects; Brown = Kelp, Grey = Control.

Table 1. Kelp Uniform Point Count survey estimated species richness (R) and diversity (Shannon’s H-index) for each site from 2019-2022.

YEAR	REGION	SITE	HABITAT	R	H
2019	Narragansett Bay	Fort Wetherill	Kelp	13.75 ± 1.25	1.86 ± 0.13
2019	Narragansett Bay	King's Beach	Kelp	17.25 ± 1.38	2.32 ± 0.14
2020	Narragansett Bay	Fort Wetherill	Kelp	18.75 ± 2.29	2.31 ± 0.1
2020	Narragansett Bay	King's Beach	Kelp	17 ± 0.58	2.38 ± 0.09
2021	Narragansett Bay	Fort Wetherill	Kelp	15.2 ± 0.49	2.01 ± 0.08
2021	Narragansett Bay	King's Beach	Kelp	17.33 ± 0.88	2.35 ± 0.11
2022	Narragansett Bay	Fort Wetherill	Kelp	17.25 ± 1.18	2.23 ± 0.1
2022	Narragansett Bay	King's Beach	Kelp	16.33 ± 2.73	2.22 ± 0.17

### Kelp - UPC Substrate

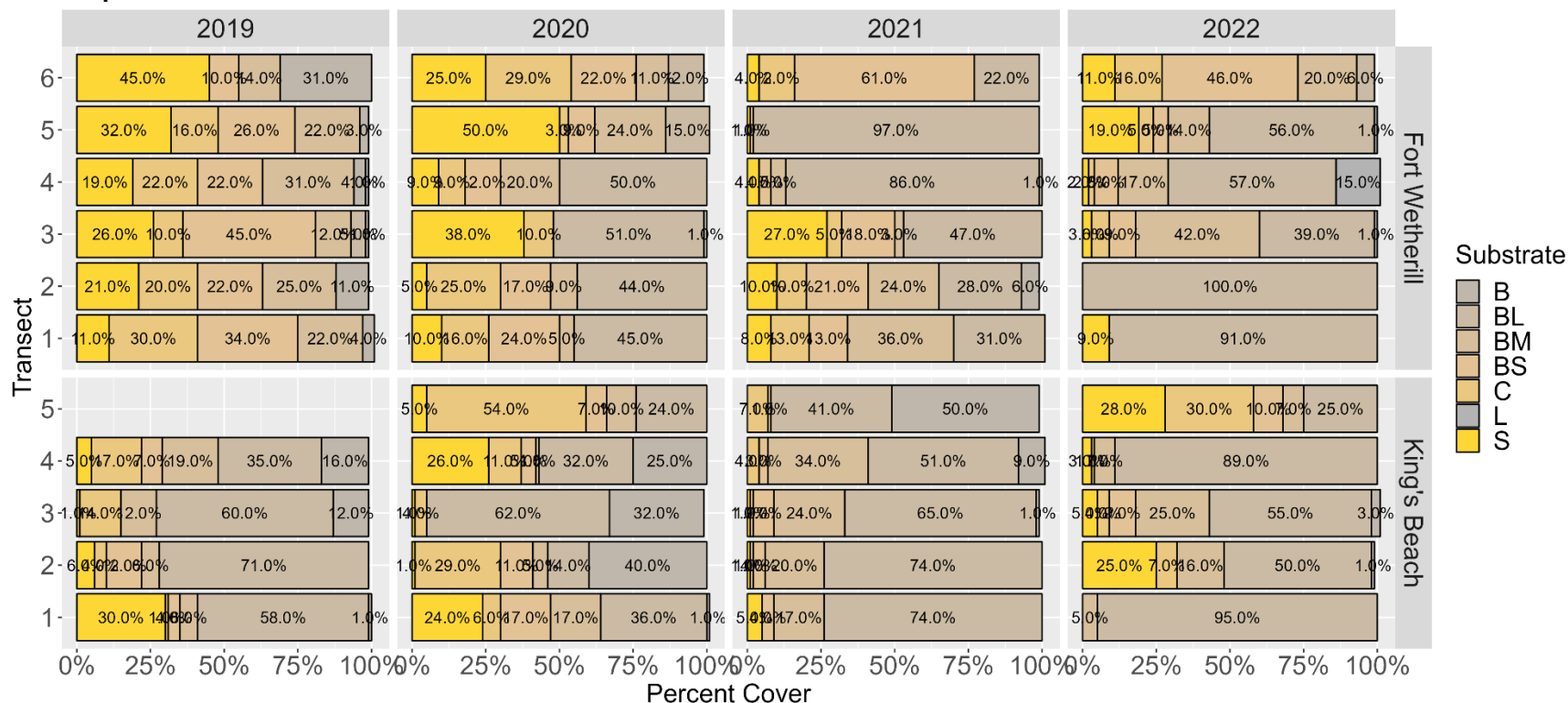


Figure 3. Percent cover of substrate along the y-axis plotted for each transect along the x-axis, for each fish productivity survey. Percent cover is grouped by substrate type (BL = boulder large, BM = boulder medium, BS = boulder small, C= cobble, M = mud/fines, M\_S = sandy mud mix, S = Sand, B = Bedrock, L = Ledge) and faceted Year (2019-2022) and Site (Fort Wetherill and King's Beach).

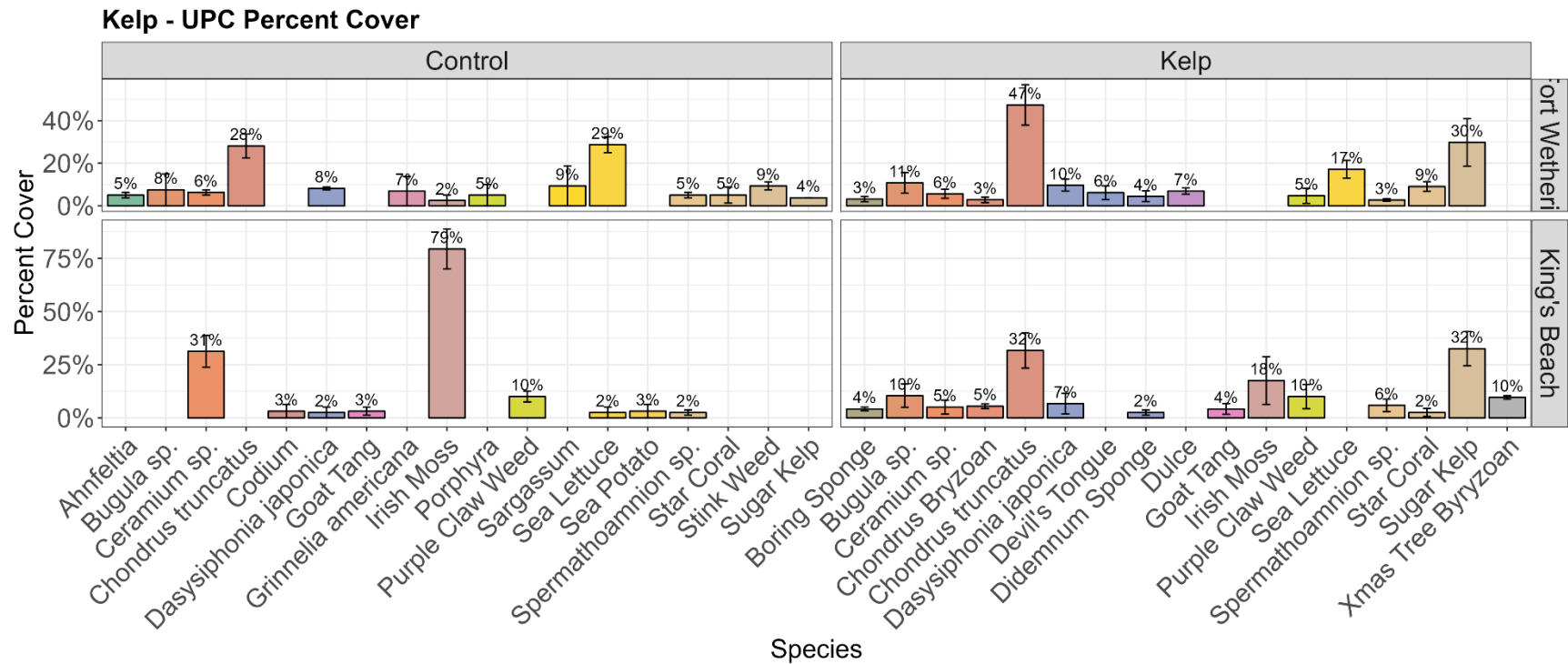


Figure 4. Mean algal and sessile invertebrate cover  $\pm$  SE, for each habitat type (Kelp or Control) grouped by Site (Fort Wetherill and Kings Beach) during the 2022 productivity uniform point count survey.

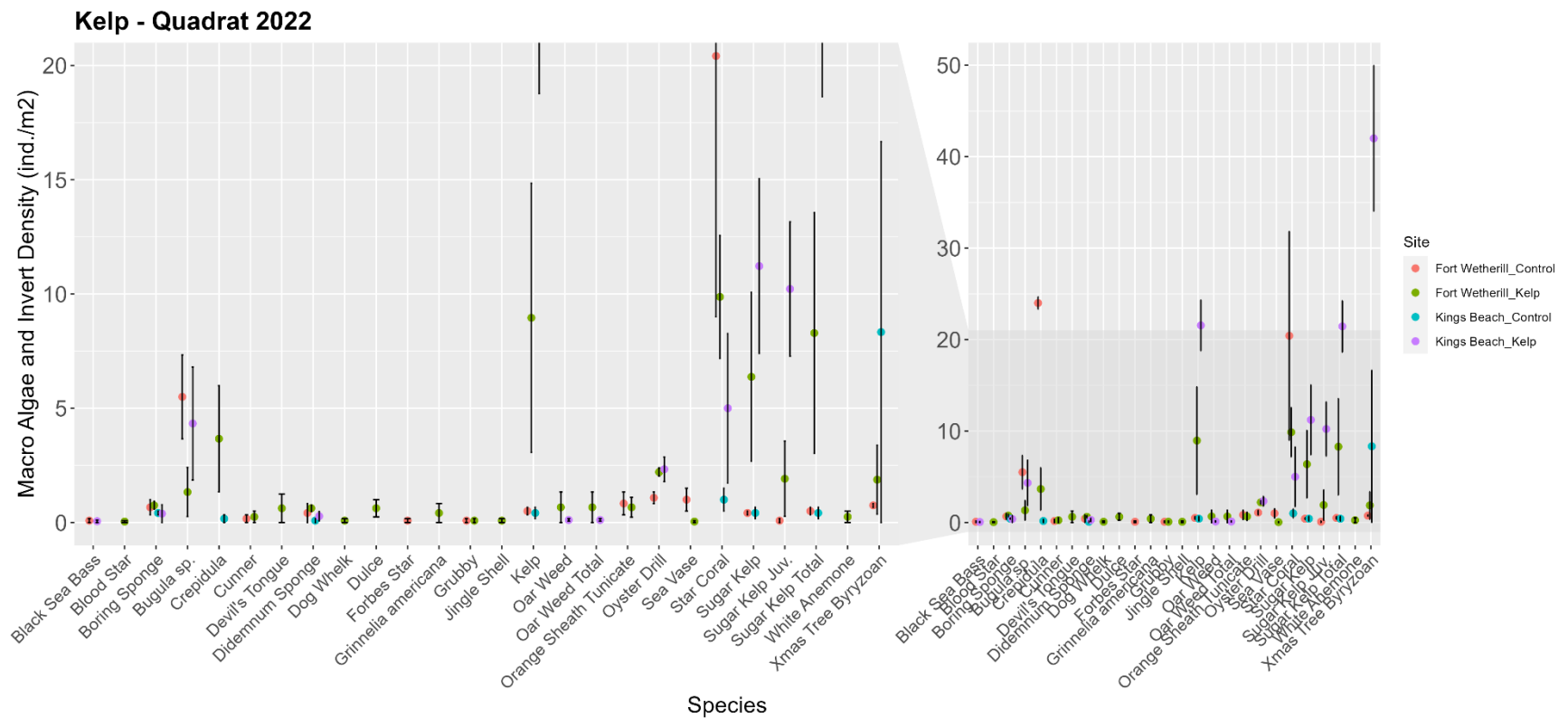


Figure 5. Mean invertebrate and macro algae density  $\pm$  SE, per habitat treatment (i.e., Kelp and Control) and site (Fort Wetherill and Kings Beach) for the quadrat transect during the 2022 surveys.

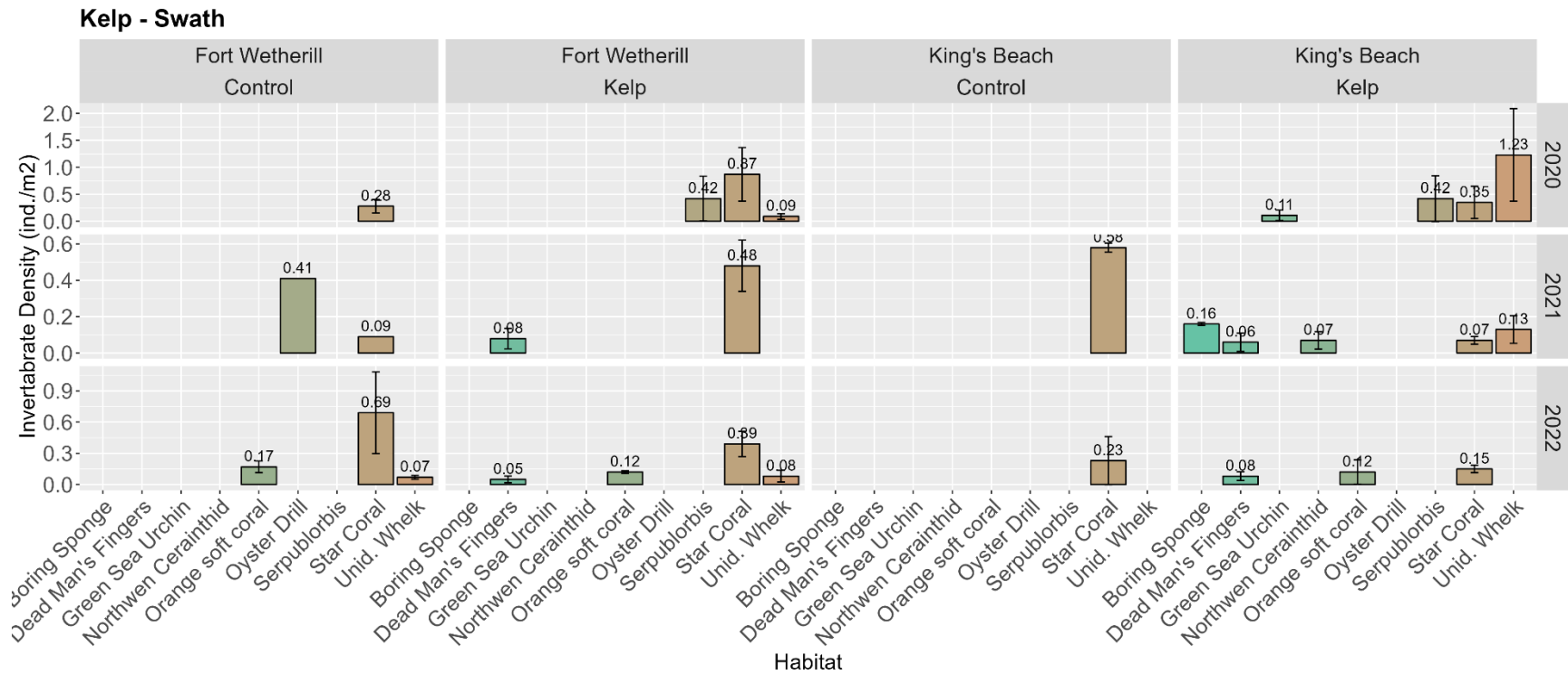


Figure 6. Mean invertebrate density  $\pm$  SE, per habitat treatment (i.e., Kelp and Control) and Site (Fort Wetherill and King's Beach) for 2020-2022 transect surveys.



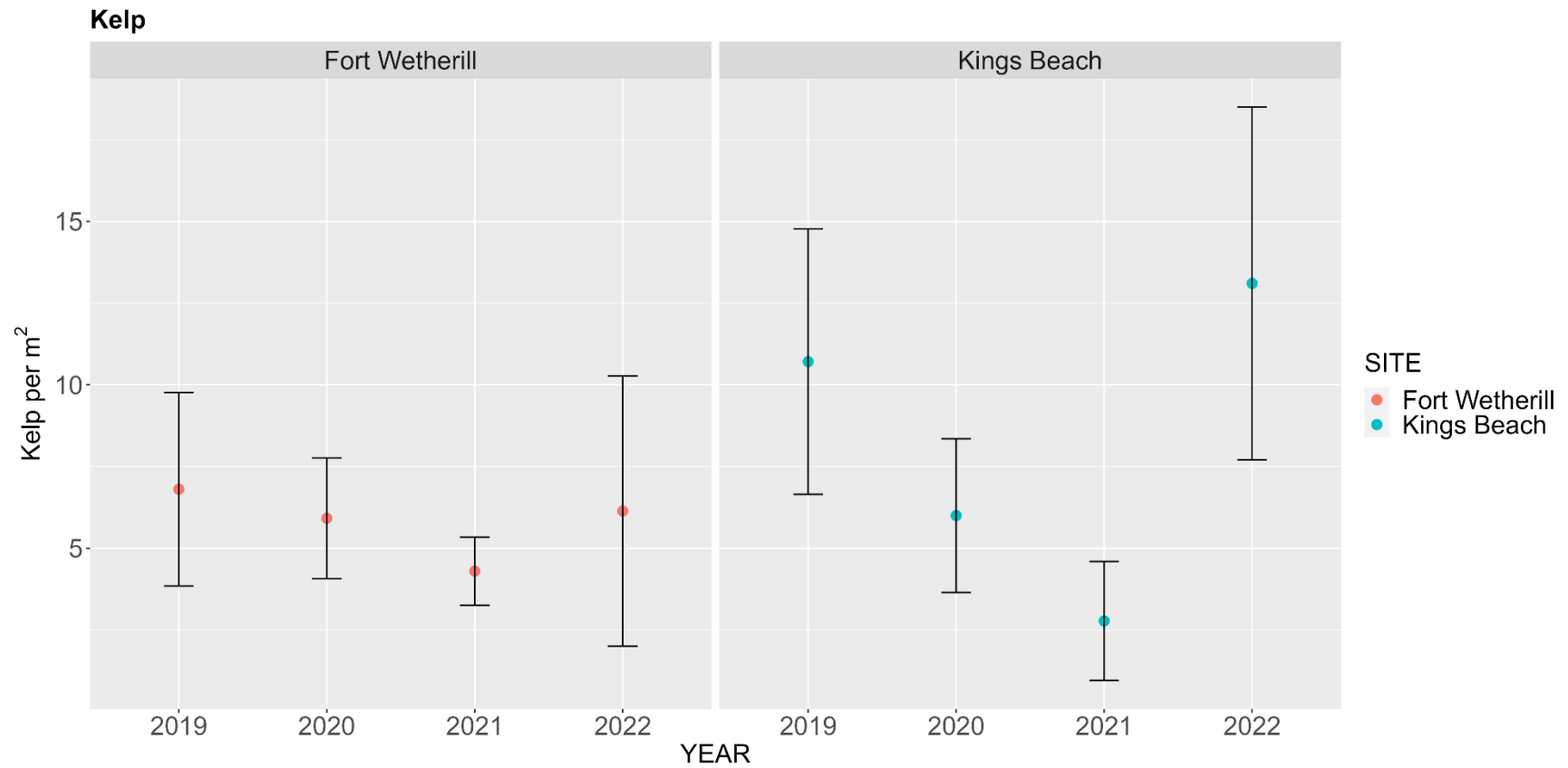


Figure 7: Average kelp density (mean  $\pm$  SE) from 2019 – 2022 in the Narragansett Bay Region grouped by site (Fort Wetherill = Red, King’s Beach = blue). Total kelp (e.g. *Sacharrina latissima* plus *Laminaria digitate*) density per meter squared for each year of the long-term Kelp monitoring survey.

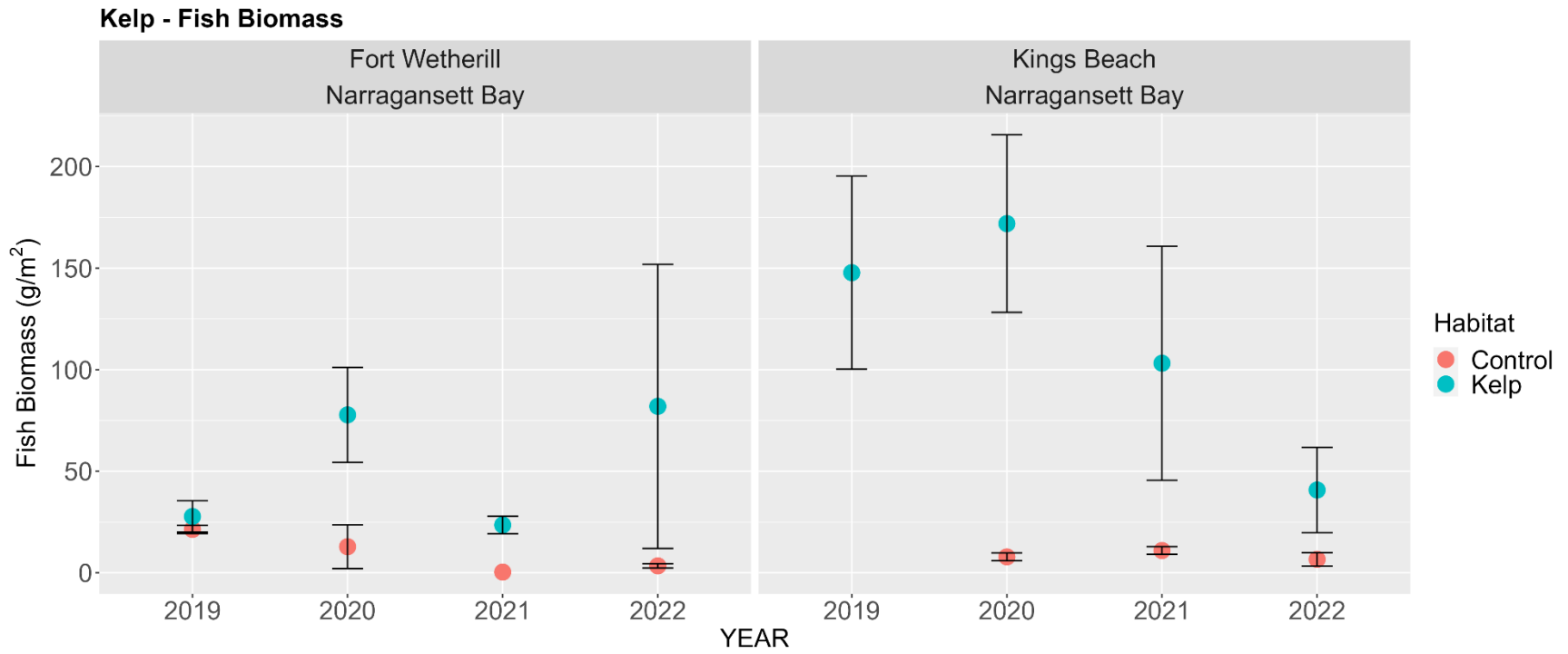


Figure 8. Mean fish biomass (g/m<sup>2</sup>) for 2019 - 2022 kelp productivity fish count surveys. Fish biomass is standardized per meter squared and presented as the average biomass  $\pm$  SE, for each habitat treatment (Kelp = blue, Control = red)

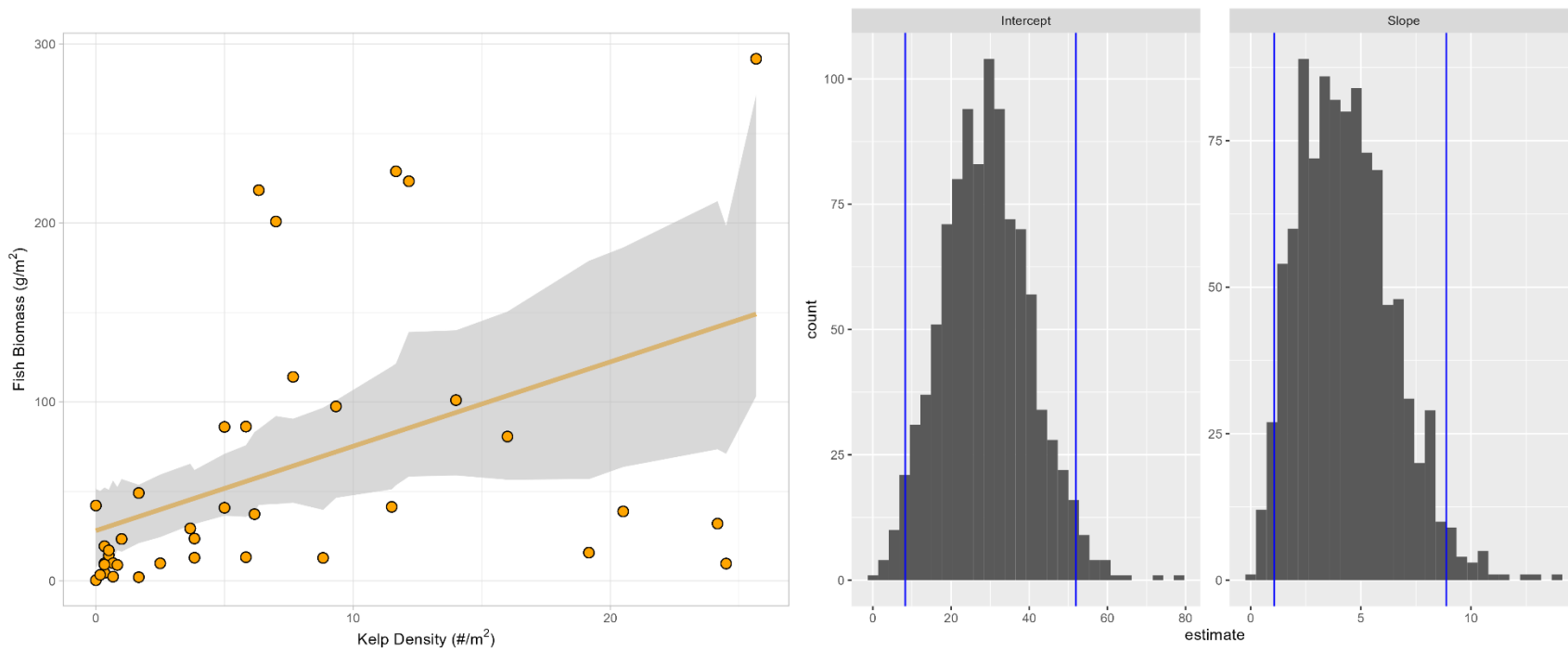


Figure 9. Linear model of observed fish biomass (grams) per meter squared of kelp habitat, as a function of observed kelp density (ind./m<sup>2</sup>). Data comes from the collective 2019-2022 kelp monitoring dataset. Grey line indicated 95% CI interval estimated via bootstrap method.

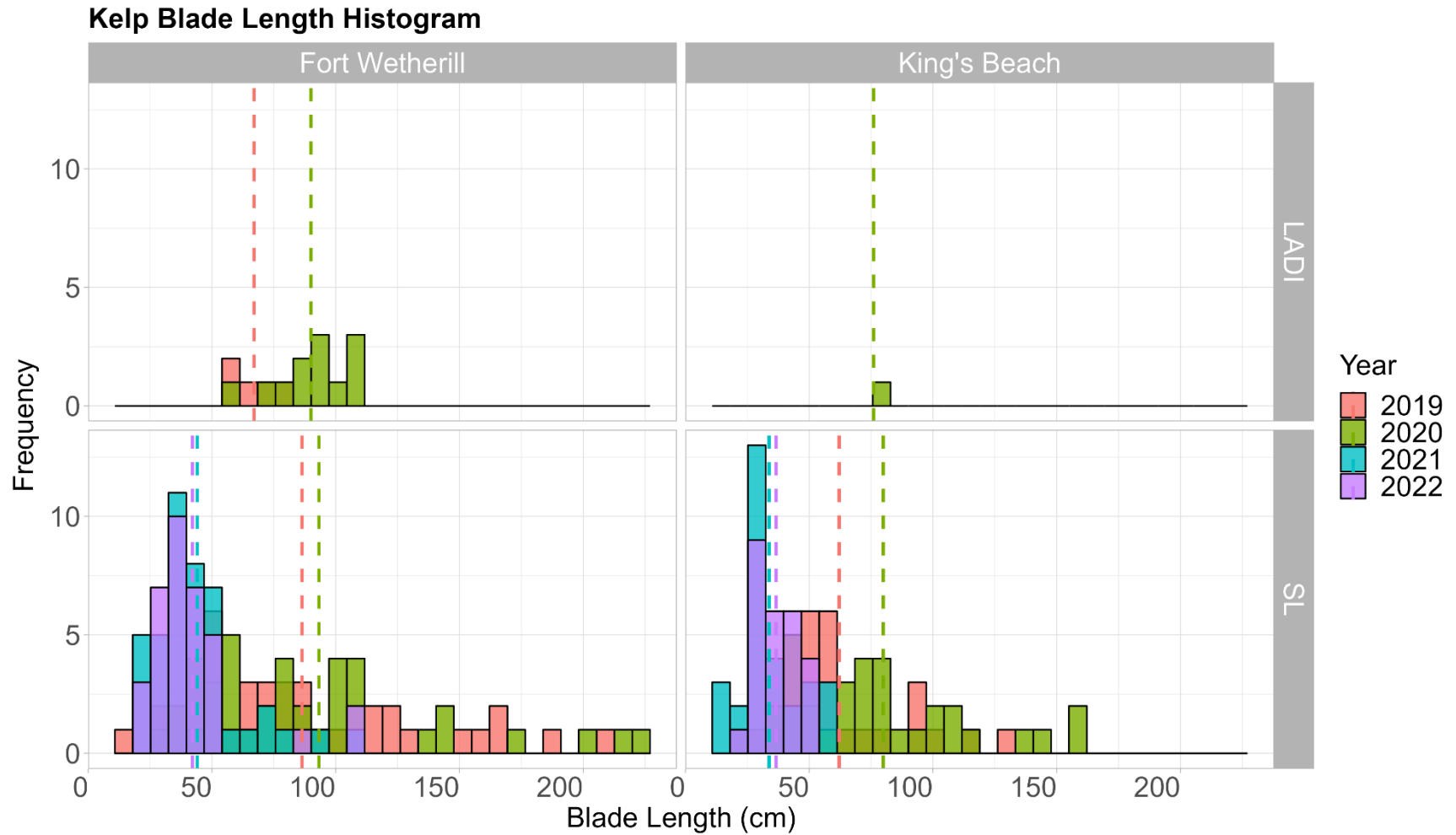


Figure 10. Histogram of blade length (cm) from 2019 – 2022 for each kelp species (LADI = *Lammaniria digitia*, SL = *Sacharina latissimi*) group by year (2019 = red, 2020 = green, 2021 = blue, 2022 = purple). Dashed lines represent the mean blade length from the transect sub samples (n=10 per transect).

The Rhode Island Chapter of The Nature Conservancy  
Annual Progress Report

Submitted to

The Rhode Island Department of Environmental Management  
Division of Fish and Wildlife

Title: Holistic Fish Habitat Assessment and Fish Productivity Estimations of Artificial Reefs

Cooperative Agreement Award Number: 3374051

Award Term: 1/15/2020 – 12/31/2024

Reporting Period: 1/15/2022 to 12/31/2022

Prepared By

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Sarah Paulson (Coastal Restoration Science Technician), and  
Patrick Barrett (DEM –Principal Biologist)

Approved By

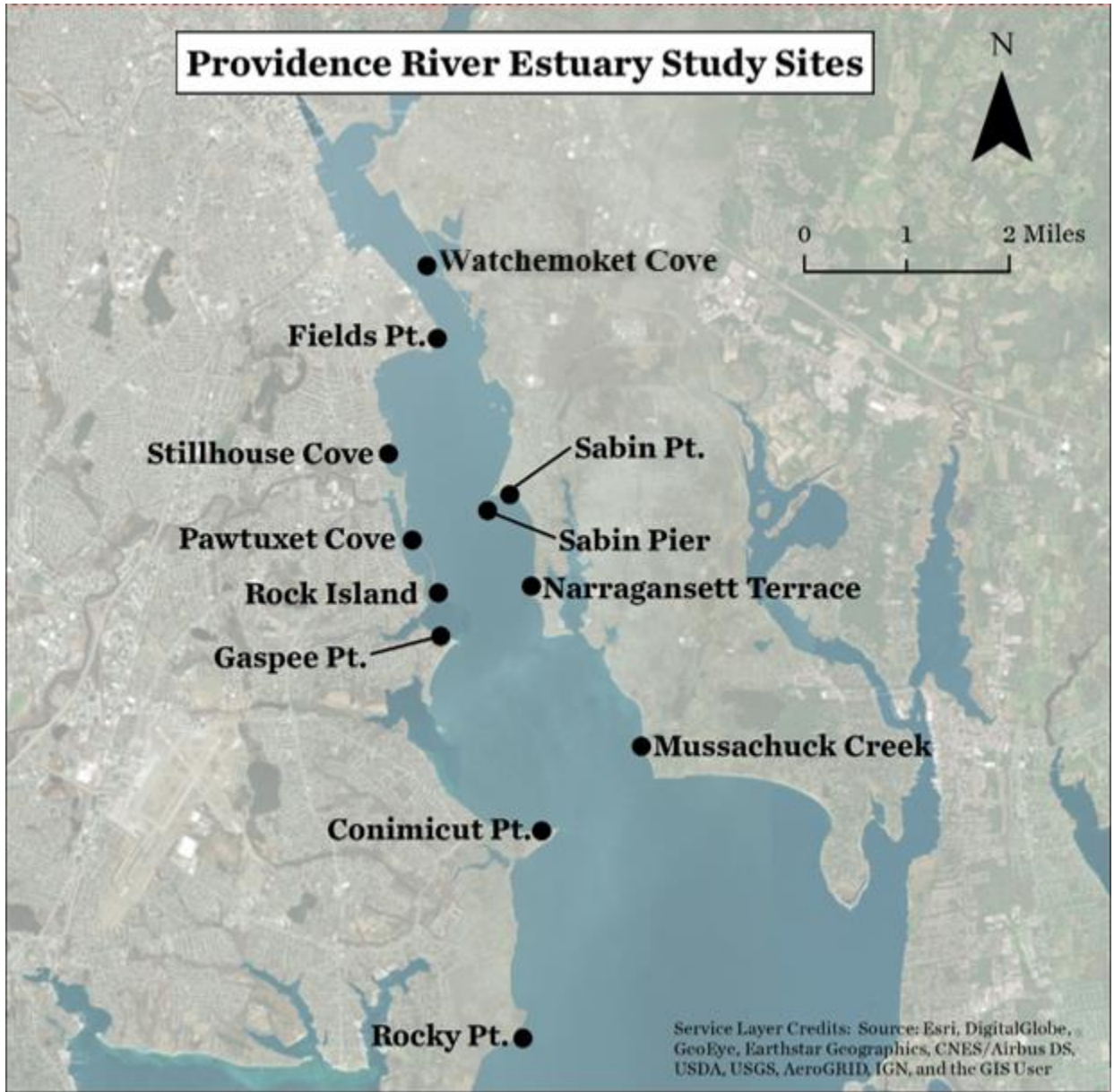
Scott Comings, Associate State Director

The Nature Conservancy Rhode Island Chapter  
159 Waterman Street  
Providence, RI 02906



Protecting nature. Preserving life.

Map of study area and sampling locations. (see Table 1 for descriptions of sampling method by site and Table A in the Appendix for coordinates).



## SUMMARY

In 2022, there were 14 species caught in the fish traps including 321 finfish (8 species) and 604 invertebrates (6 species). All target species were caught with the exception of winter flounder. Eel pots placed at the artificial reef site and three control sites caught a total of 17 species including 417 finfish (9 species) and 63 invertebrates (8 species) All five target species were caught in the eel traps.

Water quality monitoring, including temperature, salinity, and dissolved oxygen, was conducted with HOBO Data Loggers placed within fish traps during each sampling period. In addition, a YSI ProPlus was used to record the same parameters during fish trap deployment and retrieval, allowing for data quality control. During the 2022 season, the mean temperature per month ranged from  $17.37 \pm 0.02^{\circ}\text{C}$  to  $26.87 \pm 0.03^{\circ}\text{C}$ , and the mean salinity per site ranged from  $26.41 \pm 0.05$  ppt to  $29.9 \pm 0.02$  ppt. The greatest percentage of hypoxic instances per site was 8.6% at Narragansett Terrace.

Investigators successfully conducted the third year of the post-enhancement productivity dive surveys on the Sabin Point Artificial Reef (SPAR) and paired control sites. Investigators collected video and photo evidence of the reefs' colonization and succession as well as the annual productivity dive surveys completed on October 11<sup>th</sup> and 12<sup>th</sup> 2022. Despite the slight decrease in average richness and diversity across all sites compared to the previous year, species diversity was highest at the SPAR (Sabin Point Artificial Reef). Investigators found invertebrate densities to vary depending on the species and survey location. At the SPAR, investigators found the high abundance of blue mussels ( $\sim 54.6$  ind./m<sup>2</sup>) in 2021 had declined to zero in 2022. The control sites were dominated by eastern mud snails at densities as high as 84 ind./m<sup>2</sup> and hermit crabs at 10 ind./m<sup>2</sup>. After installation and initial colonization by benthic organisms, an increase in total fish biomass ( $< 1$  g/m<sup>2</sup> to over 30g/m<sup>2</sup> in two years) and greater abundances relative to both the unstructured controls as well as the natural control site each year post reef construction.

**TARGET DATE:** 12/31/2021

## NEXT STEPS

### *Sabin Pier Artificial Reef Study*

Investigators will continue to study the SPAR site and surrounding control sites to determine how artificial reefs can be used as a fisheries resource and fish habitat enhancement tool within the study area. This includes fish trap and eel pot sampling, HOBO Dataloggers, and dive surveys. This work will attempt to address the following research questions:

- 1) How do reef balls affect the area's fish assemblage and abundance?
- 2) What is the primary succession of colonizing organisms on reef balls at the Sabin Point location?
- 3) How does fish biomass change over time?
- 4) Compared to the unstructured and natural controls, how does the artificial reef site compare post-enhancement in terms of fish biomass and production

## *Evaluation and Determination of Future Artificial Reef Installations*

Investigators will utilize the growing datasets to evaluate additional locations in the Upper Bay for artificial reef installations. Considerations of habitat quality, fish assemblage, fishing opportunities and access, logistics and water quality will be considered. Investigators plan to continue looking into proposed sites (see Objective 2 in Discussion section) as well as other potential areas and may conduct dive surveys to assess pre-enhancement habitat quality.

### **INTRODUCTION**

It is well known that fish habitat supporting spawning, breeding, feeding, and/or growth of the species is critically important to the sustainability of healthy commercial and recreational fisheries (SFA 1996). In Rhode Island, recreationally significant marine finfish are supported by a variety of naturally occurring habitat types including but not limited to, rocky outcroppings, oyster reefs, kelp, and eelgrass beds that typically exist along shorelines and in estuarine rivers. Effectively preserving and enhancing these habitats helps to sustain important finfish populations and associated recreational opportunities. In areas where habitats have been historically degraded by anthropogenic stressors, artificial means of enhancement are necessary to help rectify the damage caused by coastal urbanization and to help provide additional support to help reinvigorate functional ecosystems.

Since 2016, the Rhode Island Department of Environmental Management's Division of Marine Fisheries (RI DEM) and the Rhode Island chapter of The Nature Conservancy (TNC) have conducted benthic habitat and finfish surveys at selected sites in the Providence-Seekonk tidal rivers (Head of Narragansett Bay) to assess their suitability for various habitat enhancement techniques. These assessments have provided insight into the current habitat condition and fish assemblage in these areas and the ability to prioritize locations where such fish habitat enhancement work would be most successful.

In 2019, an artificial reef was constructed off the southern shore of Sabin Point to provide enhancement to this important estuarine area. Investigators deployed 64 Reef Balls™, creating 4 distinct patch reefs (4 x 4 clusters) that range from 120 to 225 feet from the end of the fishing pier at Sabin Point Park in East Providence. The Sabin Point artificial reef is divided into two nearshore and two bayside patch reefs designed to provide equal access to both shore and boat anglers. The permitted reef area can be found on the updated NOAA Nautical Chart 13224 (Providence River and Head of Narragansett Bay) denoted as the Fish Haven on the south side of Sabin Point Park. Divers from RIDEM DMF and TNC continue to monitor the succession of the reef on a yearly basis.

Artificial reefs were selected as the enhancement habitat type because they create complex benthic habitats and increase fish production in southern Atlantic estuaries and can be versatile for enhancing fish habitat (Powers et. al. 2003). In addition, manmade structures like artificial reefs, jetties, and shipwrecks that provide similar services to naturally occurring structures for managed species are recognized by NMFS as valuable habitat (MSA 67 FR 2343). Limited information exists on the benefits of artificial reef enhancement in Rhode Island let alone New



England. Therefore, an additional facet of this study will help determine how artificial reefs can be used as a fisheries resource and fish habitat enhancement tool in Rhode Island waters. Finally, there are varying ways to monitor the different important fish habitats around the state, making it challenging to create meaningful comparisons. In order to address this challenge, standardized survey methods and innovative analytical approaches are being used to help investigators gain insight into the relative differences in habitat type success in sustaining local fish populations. Outcomes from this study will provide guidance on future priorities for preserving and restoring these valued habitat types.

## **APPROACH**

This report covers Objective 1 and 2 of Job V, Part B (Artificial Reef Installations). Planning for accomplishing Objective 2 is underway for the 2023 season. This work is conducted under a multi-year cooperative agreement with TNC and RI DEM. The agreement addresses the following tasks:

### *Objective 1 – Overview*

The purpose and scope of this objective is to monitor the SPAR site constructed in October 2019 and compare it to adjacent sites in the Upper Narragansett Bay and Providence River. The differences in structural complexity and successional stage of these sites will be evaluated with respect to their influence on recreational finfish species. In addition, the artificial reef site will be more easily compared to other essential habitat types within Narragansett Bay. This will help determine how artificial reefs can be used as a fisheries resource and fish habitat enhancement tool in Rhode Island waters.

- a. Conduct monthly fish trap and eel pot survey (May – October)
- b. Manage and QA/QC collected fish trap and eel pot data
- c. Conduct annual dive survey at artificial reef study sites
- d. Submit annual report to RIDEM
- e. Attend team meetings

### *Objective 2 – Overview*

The purpose and scope of this objective is to assess the success of the SPAR site, and identify and design plans to construct artificial reef habitat in different areas of Rhode Island (e.g., Narragansett Bay, Rhode Island Sound, South County Coastal Ponds) to assess the feasibility of artificial reefs as a cost-effective management strategy to increase the stock of important recreational finfish species

- f. Draft and submit necessary permit applications for an artificial reef project
- g. Attend permit-related meetings
- h. Conduct site assessments for potential artificial reefs
- i. Conduct any necessary stakeholder/community engagement

## **METHODS**

### *Objective 1*

#### Water Quality Data Loggers

HOBO Saltwater Conductivity/Salinity Data Loggers (Part # U24-002-C) and Dissolved Oxygen Data Loggers (Part # U25-001) were placed within one of the fish traps at each deployment from June - October. They were attached to the tops of the traps so that they hung ~ 0.5m from the bottom. The data loggers recorded temperature (°C), conductivity (uS/cm), and dissolved oxygen (mg/L) every 30 minutes. Data from the data loggers were uploaded monthly by connecting to a HOBO Waterproof Shuttle (Part # U-DTW-1) to upload information and resyncing the internal clock. Any fouling to the loggers was gently removed and the loggers were prepared to be redeployed during the following months sampling.

#### Fish Traps and Eel Pots

Black sea bass traps (43.5" x 23" x 16" (L x W x H) and 1.5" x 1.5" coated wire mesh) were deployed at 12 sites throughout the season (May – October). The traps contained a single mesh entry head and single mesh inverted parlor nozzle consistent with the black sea bass traps used in the Narragansett Bay Ventless Pot, Multispecies Monitoring and Assessment Program (conducted as part of F-61-R-23, Job #12). At each site, two traps were deployed by boat approximately 20 meters apart and were left to soak for ~96 hours, unbaited. The traps were then hauled, all animals were identified to genus or species, measured to the nearest millimeter by fork length, enumerated, then returned the water. Water salinity (ppt), temperature (°C), and dissolved oxygen (mg/L) were taken at the trap depth at the time of deployment and retrieval with a YSI handheld multiparameter. In addition, HOBO Saltwater Conductivity/Salinity Data Loggers (Part # U24-002-C) and Dissolved Oxygen Data Loggers (Part # U25-001) were placed within one trap at each site (see Water Quality Data Loggers section).

Eel traps (23" x 12" x 12" (L x W x H) and 0.5"x 0.5" coated wire mesh) were deployed at four sites (Sabin Pier, Sabin Point, Rock Island, and Gaspee Point) from May – October. The traps contained a single wire mesh entry funnel and were consistent with the eel traps used in the Assessment of Recreationally Important Finfish Stocks in Rhode Island Coastal Waters (conducted as part of F-61-R-21, Job #5 Part B). Two eel traps were deployed by boat approximately five meters from each black sea bass trap at each site and left to soak for ~96 hours, unbaited. The traps were then hauled, all animals were identified to genus or species, measured to the nearest millimeter by fork length, enumerated, then returned to the water.

#### Dive Survey

A survey of the floral and faunal communities was conducted by SCUBA at the Sabin Pier Artificial Reef (SPAR) site and three comparison sites (Sabin Point, Rock Island, and Gaspee Point) on October 11<sup>th</sup> & 12<sup>th</sup>. Data gathered before and after reef ball installation will be used to compare community composition pre- and post- enhancement. Data gathered from reference

sites will allow comparison with relatively featureless habitats (Sabin Point and Gaspee Point) and a naturally rocky habitat (Rock Island).

#### *Quadrat Sampling*

Quadrat sampling was used to determine the abundance of common invertebrates, algae, and small cryptic fish. Along each transect an 1m<sup>2</sup> quadrat was placed every 8m, alternating between onshore and offshore sides of the transect, totaling six quadrats per transect. At each quadrat, all organisms and algae were identified to the lowest possible taxonomic level and enumerated.

#### *Uniform Point Count*

Uniform point count sampling was used to determine the percent cover of algae and sessile invertebrates. Along each transect a sample was taken every meter both one meter onshore and offshore of the transect. At each sample, the substrate composition and all species found within the point (a 2cm estimated diameter) were recorded.

#### *Swath Sampling*

Swath sampling was used to determine the abundance of common algae, invertebrates, and demersal cryptic fish that could be easily counted. Along each transect a swath was performed in a 1m wide area on each side of the transect. The abundance of all target species was recorded and binned within four 20m subsections (two on each side) along the transect.

#### *Fish Count*

A fish count was used to determine the abundance of common fish along the transect. A diver slowly swam long each transect while recording the abundance and estimated size of all fish encountered within a predefined “cube” based on depth and visibility.

#### *YSI Sampling*

During the dive survey at each site, a YSI Handheld multiparameter water quality meter was used to record temperature (°C), salinity (ppt), and dissolved oxygen (mg/L) at the surface and bottom of the water column.

#### Data Analysis

Fish trap and eel pot data summaries for 2022 include all water hauls and evaluate each trap as its own data point. The catch rate (CPUE) was calculated using the following equation (see Table 1 for a description of effort at each station and month in 2022):

$$CPUE = \frac{\text{Total catch at site}}{\text{Length of soak (days)} \times \text{Total number of samples}}$$

The minimum account for a positive species presence was one individual found in the fish traps/eel pots at each site, every month. The total abundance and total abundance by station was calculated by removing all water hauls and bivalve data, then adding all remaining enumerated fish and invertebrates. Length frequency distributions for target species were also calculated and provided as histograms comparing trap type and sex when relevant. Finfish and invertebrate CPUE was calculated separately for both fish traps and eel pots. Species specific CPUE was also

calculated for the target species by month and site using the same equation above. Length-weight relationships for available species were calculated using coefficients provided by DEM and FishBase using the following equation (Froese and Pauly 2020):

$$Weight = \alpha Length^{\beta}$$

Average trap depth is determined by calculating the mean depth of the trap when it is deployed and hauled to account for any tidal variation.

#### *Statistical Approaches for dive survey*

Benthic habitat characteristics were summarized for each transect by using the uniform point count data to derive both a geological and biological percent cover for each dive transect. The total number of observations were summarized for each species or substrate and then divided by the total number of uniform point counts collected along the length of each transect. Additionally, species richness and Shannon's Index of diversity were used to calculate the total number of unique species as well as at the weighted average, or diversity, of colonization algae and sessile invertebrate species at the SPAR and control locations. Algae and Invertebrate densities were summarized using the quadrat, and swath data sets when applicable, by averaging the total number of observations across all quadrats (n=4-6) within each transect. To evaluate how the artificial reef habitat compares to the unstructured and natural controls, the mean density of individuals per meter squared  $\pm$  SE is calculated and grouped by habitat type and the corresponding controls, then faceted by survey method.

Using the fish count survey data, abundance at length was converted to total fish mass per transect by leveraging the DMF age and growth lab data to convert fish length in cm to weight in grams for our target species, using RI specific allometric growth models (see above equation). For species not currently dissected in the growth lab, the geometric mean a and B values estimated on Fishbase.org were used. To compare total fish biomass between the artificial reef, control, and natural control sites, the total fish mass was standardized by dividing the total area surveyed, to get grams per meter squared. The average fish biomass per meter squared is presented with mean  $\pm$  S.E.

## **RESULTS**

### *Objective 1:*

#### *Physical Data Summary*

Achieving a consistent trap depth between sites can be challenging due to competing factors of desired site location, proximity to fishing areas, and bathymetric variation between each site. Trap depth can impact species composition, abundance, and size since adults from certain species may be less likely to venture into shallower waters (e.g., scup (Bigelow and Schroeder 2002)). Investigators attempt to maintain an intra-site variation less than or equal to an expected tidal range of 1-2m and attempt to minimize the average variation in depth between sites as much as possible. This year, the greatest difference in average depth was 9' between Fields Point (6.2') and Rocky Point (15.1'). The greatest within site variation was 4.5' at Sabin Pier (Figure 1).

All data loggers were deployed within one trap from each sampling event starting in May. A total of 9,534 instances were recorded with dissolved oxygen data loggers and 13,774 instances with the conductivity loggers across all sites. Similar to previous seasons, using the loggers only during the four day soak period helped significantly reduce the equipment failure and unreliable data that has occurred in the past. Some equipment failure led to some incomplete data sets this season. For this report, investigators only summarized data that appeared to fall within expected values comparable to water quality information taken from the handheld YSI during other sampling.

Temperature ranges were fairly consistent across sites (Figure 2). Mean temperature values by site ranged from  $20.90 \pm 0.12$  SE°C at Narragansett Terrace to  $21.97 \pm 0.12$ °C at Sabin Point during the sampled time period. Mean temperature across sites was highest in July at  $26.87 \pm 0.02$ °C and lowest in October at  $17.37 \pm 0.02$ °C (Figure 3).

Mean salinity values by site ranged from  $26.4 \pm 0.05$  ppt at Watchemocket Cove to  $29.9 \pm 0.02$  ppt at Rocky Point. However, the majority of sites had a mean salinity of ~27 ppt (Figure 4). Mean salinity across sites was highest in August at  $28.83 \pm 0.03$  ppt and lowest in May at  $27.2 \pm 0.03$  ppt (Figure 5).

Dissolved Oxygen (DO) results appeared to be reasonably consistent with YSI recorded values. There were occasions where DO dropped to values less than 2 mg/L at some sites, suggesting hypoxia (Figure 6). By month, the most frequent and intense hypoxia occurred during July which contained 80% of all the hypoxia instances during the study period (Figure 7). In contrast, June had the least hypoxic instances, representing 2% of the total. Within each site, the percentage of readings which indicated hypoxia (<2mg/L) ranged from 0% at Rocky Point, Conimicut Point, and Mussachuck Creek to 8.6% at Narragansett Terrace.

#### *Fish Trap Summary*

There were 14 species caught in the fish traps including 321 finfish (8 species) and 604 invertebrates (6 species). All target species were caught with the exception of winter flounder (Table 2). The three most abundant finfish species were scup (223), black sea bass (37) and tautog (24). The most abundant invertebrate species were spider crabs (426). The greatest number of finfish were caught in June (CPUE =  $1.65 \pm 0.54$  SE) and the least in October ( $0.19 \pm 0.09$  SE) (Table 3). Rocky Point, Watchemocket Cove, and Mussachuck Creek had the highest catch rates overall ( $2.33 \pm 0.96$  SE,  $2.29 \pm 0.90$  SE,  $2.08 \pm 0.91$  SE) and Fields Point had the lowest ( $0.13 \pm 0.09$  SE) (Figure 8). Total finfish catch rate in the fish traps this season was the higher than the previous two years for many of the sites (Figure 9).

#### *Eel Pot Summary*

Eel pots were used at Gaspee Point, Rock Island, Sabin Pier (SPAR site), and Sabin Point. A total of 17 species were caught, including 417 finfish (9 species) and 63 invertebrates (8 species). The top three most abundant finfish species in the eel pots were black sea bass (310), oyster toadfish (45), and cunner (27). The top three most abundant invertebrate species were spider crabs (22), mud crabs (16), and blue crabs (15) (Table 2). All five target species were caught in the eel pots. The highest catch rate in the eel pots was during the month of August ( $10.25 \pm 2.05$ )

SE and Gaspee Point had the highest average catch rate ( $6.42 \pm 2.22$ ) compared to the other three sites (Table 4, Figure 10).

#### *SPAR Summary*

There were 15 species caught at the artificial reef site (8 finfish species). The most abundant species were black sea bass (85), oyster toadfish (21) and spider crab (15). Black sea bass were also the most abundant species at the three control sites, making up the majority of the catch in 2022 (Figure 12). About 86% of the total fish caught (by abundance) this season were found in the eel pots and 52% of the invertebrates were from the fish traps. At the SPAR site, finfish CPUE in the fish traps was  $0.75 \pm 0.30$  SE and  $4.8 \pm 2.18$  SE (Figure 11). The SPAR site also displayed higher species richness than the control sites and was similar in diversity to all sites except Gaspee point (Table 5).

#### *Target Species Summary*

Scup were the most abundant finfish species caught in the traps with a peak catch rate in June ( $1.31 \pm 0.48$  SE) (Table 6). Similar to previous years, scup accounted for any considerable variations in finfish catch rate between sites. Scup were caught at eleven of the twelve sites (Table 7). Their sizes ranged from 12.5 – 33.0cm (FL) and had an estimated mean weight of 0.41 lbs (Figure 13). The highest catch rate was at Watchemocket Cove. Scup made up the largest percentage of fish catch by number (69.5%) and by weight (47.0%). Scup were also found at all four eel trap sites and had an average catch rate of  $0.09 \pm 0.05$  SE (Table 8). The sites with the greatest number of scup caught in the eel pots was Rock Island (CPUE =  $0.25 \pm 0.17$  SE). Scup size in the eel pots ranged from 6.3-10.0cm (Figure 13)(Avg biomass: 0.01lbs and 1.3% of the catch by weight).

Tautog were the third most abundant finfish species caught with a peak catch rate in May ( $0.31 \pm 0.12$  SE) with sizes ranging from 18.0-49.0cm (FL) (Table 6 and Figure 14). Though they were third in catch rate, tautog had the greatest weight per fish of the target species at an average of 2.3lbs. Tautog were caught at nine of the twelve sites and had the highest catch rate at Stillhouse Cove (Table 7). Tautog made up about 7.5% of the total fish catch by number which was the third highest percentage after scup and black sea bass. Tautog had the second highest percentage of all fish species by weight (28.1%). Tautog were found at three of the four eel trap sites with an average catch rate of  $0.08 \pm 0.03$  SE (Table 6). Tautog size in the eel pots ranged from 5.2-15.0cm (Figure 14)(Avg biomass: 0.05lbs and 1.9% of the catch by weight).

Summer flounder were the fifth most abundant finfish species caught ranging in size from 21.0-47.0cm (Figure 15). Summer Flounder were second in weight out of the target species at an average of 1.4lbs, had a peak catch rate in June ( $0.13 \pm 0.05$  SE) and were caught at six of the twelve sites (Table 5 and 7). The highest catch was at Mussachuck Creek. Summer flounder made up the fourth highest percentage of total fish catch by number and third by weight (3.7% and 9.4% respectively). There was one summer flounder caught in the eel pots at Sabin Pier (8.7mm FL).

Black sea bass were the second most abundant finfish species caught in the fish traps, ranging in size from 18.5-35.0cm and averaging at 0.48lbs (Figure 16). Black Sea Bass had a peak catch rate in September ( $0.19 \pm 0.09$  SE) and were caught at six of the twelve sites (Table 7). The

highest catch rate was at Mussachuck Creek. Black sea bass were the third highest percent of total finfish catch by number and had the fourth highest percentage by weight (8.4% and 6.7% respectively). Black sea bass were the most abundant species caught in the eel pots with a higher average catch rate than all other species (CPUE =  $3.23 \pm 0.85$  SE) and were caught at all four eel trap sampling sites (Table 8). The black sea bass caught in the eel pots ranged in size from 6.1-21.0cm (Figure 16) (Avg biomass: 0.04lbs and 53.9% of the catch by weight). The greatest number of eel pot black sea bass were caught at Gaspee Point (CPUE =  $5.42 \pm 2.12$  SE).

Blue crabs were the second most abundant invertebrate species caught in 2022 with a peak catch rate in June ( $1.02 \pm 0.19$  SE) and the highest rate by site at Fields Point ( $1.21 \pm 0.29$ ). Blue crabs were also sexed when possible and there was a higher ratio of males to females caught in the traps throughout the entire season. Blue crabs ranged in size from 2.5-23.0cm with the females making up the smaller range of sizes (Figure 17). The average male blue crab size was  $12.8 \pm 0.2$ cm while the average female was  $12.0 \pm 0.4$ cm. Blue crabs were the second most abundant invertebrate species caught in the fish traps and third most abundant in the eel pots (Table 1). Blue crabs were found at all four eel pot sites and ranged in size from 3.0-15.0cm.

### Dive Survey

During October 2022, dive surveys were conducted to determine the baseline floral and faunal communities for use in productivity estimation at four locations near the mouth of the Providence River. The four sites included, Sabin Point Pier (artificial reef site, post enhancement), Sabin Point (unstructured control - east), Rock Island (natural rocky subtidal control - west), and Gaspee Point. (unstructured control – west). Using a multitude of dive transect methods, investigators were able to determine the substrate percent cover, mean proportion flora and fauna inhabiting the landscape, and the biomass of finfish utilizing these different habitats.

Investigators successfully conducted the third year of the post enhancement productivity dive surveys on the Sabin Point Artificial Reef (SPAR) and paired control sites. During each dive, staff removed gear from the reef, collected video and photo evidence of the reefs' colonization and succession, and the annual productivity dive surveys completed on October 10 and 11, 2022.

Percent cover at the two Providence River control sites, Gaspee Point and Sabin Point Control, were similar with respect to the substrate condition. Both sites were composed of primarily sand and fine sediment, with intermixed cobble and *Crepidula* and quahog shells. The proportion, or percent cover, of sand and shell at the control sites ranged from 47.5 to 100% (Figure 18; GASP and SPCTR). Post deployment of the SPAR, the Reef Balls have taken up a 20-50 percent cover of the uniform point count transects. During each of the seven dives completed since 2020, no evidence of scouring or damage to the reef balls were observed. Compared the natural control, or Rock Island site, the percent cover of boulder substrate (5-50 percent boulder) was similar to that of the proportion of Reef Ball cover at the SPAR (5-55% reef ball). Both the SPAR and Rock Island sites have a higher proportion of more complex structure compared to the relatively sandy and flat control sites of Sabin Point Control and Gaspee Point. During the 2022 dive survey, investigators found that the Sabin Point reef site had 26.6% cover of blue mussels in 2021 but in 2022 the blue mussels had been eaten off the reef and shell was distrusted throughout the reef

area (Figure 19). Aside for the reef balls, the SPAR site remains to be a sand dominated habitat with dramatic increase in blue mussel shell, increasing to 32% percent shell cover this past survey (Figure 19).

In 2022, the overall species richness and diversity, with respect to the algae and sessile invertebrate species, were greater at the reference and Artificial Reef sites, relative to the controls (Table 9). The biggest difference between the rocky substrate locations and sand/mud flat controls is the abundance of branching and filamentous algae that are able to adhere to the firmer substrate as well as shellfish that have recruited to the artificial reef. Most notably *Fucus visiculosus*, *Argardehlia subulate*, and blue mussels (Figure 19 and 20). Three years after deployment, the algae and invertebrate community at Sabin Point AR has begun to look more similar to the rock island natural control site. With decreasing *ulva lactuca* and increasing boring sponge, red beard sponge, blue mussels, eastern oysters, and *Argardehlia subulate* (Figure 20). Investigators found invertebrate densities to vary depending on the species and survey location. The control sites were dominated by eastern mud snails (35 - 86 ind./m<sup>2</sup>) and long clawed hermit crabs (2-10 ind./m<sup>2</sup>) (Figure 22). When comparing swath and quadrat survey techniques, it seems the swath method provides a higher estimate of shellfish densities across all locations, as was the case for the Northern Quahog densities (Figure 21 and 22). Greater abundance of rare or less occurring species like red beard sponge or the orange sheath tunicate was also more effectively documented with the swath method, whereas the quadrats were most helpful for species occurring in abundances so large that counting along the entire swath of the transect would be not worthwhile, for example eastern mud snails and crepidula (Figure 22).

In 2019, during the pre-enhancement survey, total fish biomass at the SPAR ( $0.27 \pm 0.03$  g/m<sup>2</sup>) was equal to the two control sites (GASP  $2.23 \pm 2.15$  and SPCTR  $0.76 \pm 0.68$ ). After installation and initial colonization by benthic organisms, and subsequent blue mussel set, an increase in fish biomass relative to both the unstructured controls as well as the natural control sites was observed (Figure 23). Fish biomass at the SPAR experienced a 3-fold increase from  $10.58 \pm 5.6$  g/m<sup>2</sup> to  $31.31 \pm 15.52$  from the first to second year after reef construction (Figure 23). In 2022 fish biomass declined to  $15.53 \pm 9.85$  g/m<sup>2</sup> but still remained greater than the control sites. When comparing the effect of the artificial reef on fish biomass relative to the controls, Sabin Point AR has had positive effect relative to the unstructured controls each year since the deployment of the artificial reef (Figure 24).

## **DISCUSSION:**

### *Objective 1*

#### Water Quality Data Loggers

Mean temperature, salinity, and dissolved oxygen fell within typical ranges associated with Upper Narragansett Bay (NBFSMN 2016; Reed and Oviatt 2006-2019). The periodic instances of hypoxia (<2mg/L) at various sites in 2022 are typical of the area, especially within the upper reaches of the PRE (Hale et al 2018). However, this year, the hypoxia rate was less widespread across sites, with 3 sites showing no evidence of hypoxia during the study period. Similar to previous years, the use of the HOB0 data loggers at shorter (four day) intervals was more successful than the previous fixed site (30 day) approach.



## Fish and Eel Traps

Similar to previous years, data collected from the fish and eel traps were consistent with documented scup life history patterns described in the “Essential Fish Habitat Source Document: Scup, *Stenotomous chrysops*, Life History and Habitat Characteristics” by Steimle et al. 1999. However, this year trends showed two peaks in June and August, and were more consistent through the summer months. Scup are schooling fish and have been caught in high numbers at a time in the traps compared to other species. More scup were caught in May than in previous years but the larger adult scup were first documented at most sites in June. By October, individuals from this larger cohort were caught up to the northernmost fish trap site (Watchemoket Cove). In August, YOY scup were caught in the eel traps at all four eel trap sites.

Similar to previous years, the majority of tautog were caught in May and were composed of mostly adult fish (>25cm). Mature tautog have been reported in the upper estuary of Narragansett Bay spawning from May – July (Steimle and Shaheen 1999; Dorf and Powell 1997). This year, a few juvenile and YOY tautog were caught in the eel pots in May and August - October. The lack of larger tautog in the summer months could be due to warmer temperatures as tautog are known to relocate when suboptimal conditions present themselves (Steimle and Shaheen 1999). This was especially true during July – September this year when DO values were hitting hypoxic levels. Tautog are strongly associated with complex and structured habitats and were seen utilizing the SPAR reef structures during the dive transects. This could explain a reduction in tautog, and other structure-seeking species like cunner in the fish traps and eel pots. Though the sample size is small, YOY tautog were caught at three of the eel trap sites. Investigators should continue document any differences in size class and abundance of this structure seeking target species as the artificial reef matures.

There continue to be few summer flounder and winter flounder caught in the fish and eel traps. This could be due to the trap’s inefficiency in catching flatfish species as the trap openings are not particularly wide, limiting the size class that can fit in the eel and fish traps. In addition, although summer flounder do occasionally seek structure habitat for refuge, they tend to prefer sandy flat bottom habitat and therefore may not seek out the traps like structure associated fish (Packer et al. 1999). This has been a consistent finding over the course of this project thus far.

Black sea bass were first caught in the fish traps in June at the two southernmost sites. Based on the size class (20-30cm) these individuals were most likely spawning adults (Northeast Fisheries Service Center 2017). Winter juveniles (7-11cm) were documented in the eel pots in May at Gaspee Point in low numbers (southernmost eel pot site) and reached relatively high numbers by August through October. Few black sea bass were caught in the fish traps but had a wider distribution across sites than in previous years. At the sites where the eel traps were used, there was an abundance of year-1 and YOY black sea bass captured while none were caught in the fish traps. Larger black sea bass (>19cm) tend to stay in deeper water especially when there is limited structure available (Northeast Fisheries Service Center 2017), so this could be why there were more caught in the deeper southern sites, and none caught at the sites which had an abundance of smaller fish. The smaller black sea bass are likely able to escape the larger traps as well. This is consistent with the previous years’ catches. As the fish trap time series becomes more developed

it will be important to keep track of differences in where the various size, or age, classes are found especially across the AR study sites as well as how this compares with the dive survey data.

### Dive Survey and Sabin Point Artificial Reef Deployment

The artificial reef structures will continue to undergo successional changes and colonized by different algae and invertebrate species, further promoting the base of the food web that will ultimately support more mid-trophic level sportfish. Research on Reef Balls™ have been shown to create a more robust benthic habitats, ultimately attracting more fish to the reef (Bohnsack 1994, Lindberg 2006, Jordan 2005, Rosemond 2018). The reef will also provide shelter and food resources for sub-legal size sportfish and aggregating forage fish, promoting both the growth and survival of these individuals (Powers 2003, Caddy 2011). The Sabin Point project has begun to enhance fishing in the nearby Sabin Point waters, which currently provides fishing access and until recently, little structure for demersal reef fish like tautog and black sea bass. Through this work we have increased complex structure of the Sabin Point Pier benthos by an average of 15-50 percent on average. The species richness and diversity at Sabin Point continues to remain higher than the control sites, and has received a massive set of blue mussels in 2021, averaging over 59 ind./m<sup>2</sup> with individual recordings up to 2,500 per meter squared. Fish biomass continues to be greatest at the new reef location as well, with increased juvenile and adult abundance of sportfish like cunner, tautog, and black sea bass. Our results support the findings from a recent meta-analysis of 39 artificial reef studies conducted around the globe, that found the effect size of artificial reefs on fish density to be greatest in the Atlantic Ocean and artificial reefs made with concrete materials (Paxton et al 2020). In addition to the ocean and material used, the effect size of artificial reefs relative to natural reefs increased with increasing latitude, with positive effects for reefs in temperate regions (Paxton et al 2020). Our results also suggest that effect of artificial reefs on total fish biomass was positive relative to both the unstructured and natural rocky reefs.

### *Objective 2*

Staff from TNC and DEM attended meetings with the Narragansett Bay Commission to discuss three potential locations for future artificial reef installations and to provide guidance on a draft permit application (Appendix- Figure A). The permit application was put on hold because of limited capacity and will be revisited in the coming years. Investigators plan to continue looking into these proposed sites as well as other potential areas and may conduct dive surveys to assess pre-enhancement habitat quality.

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**FIGURES:**

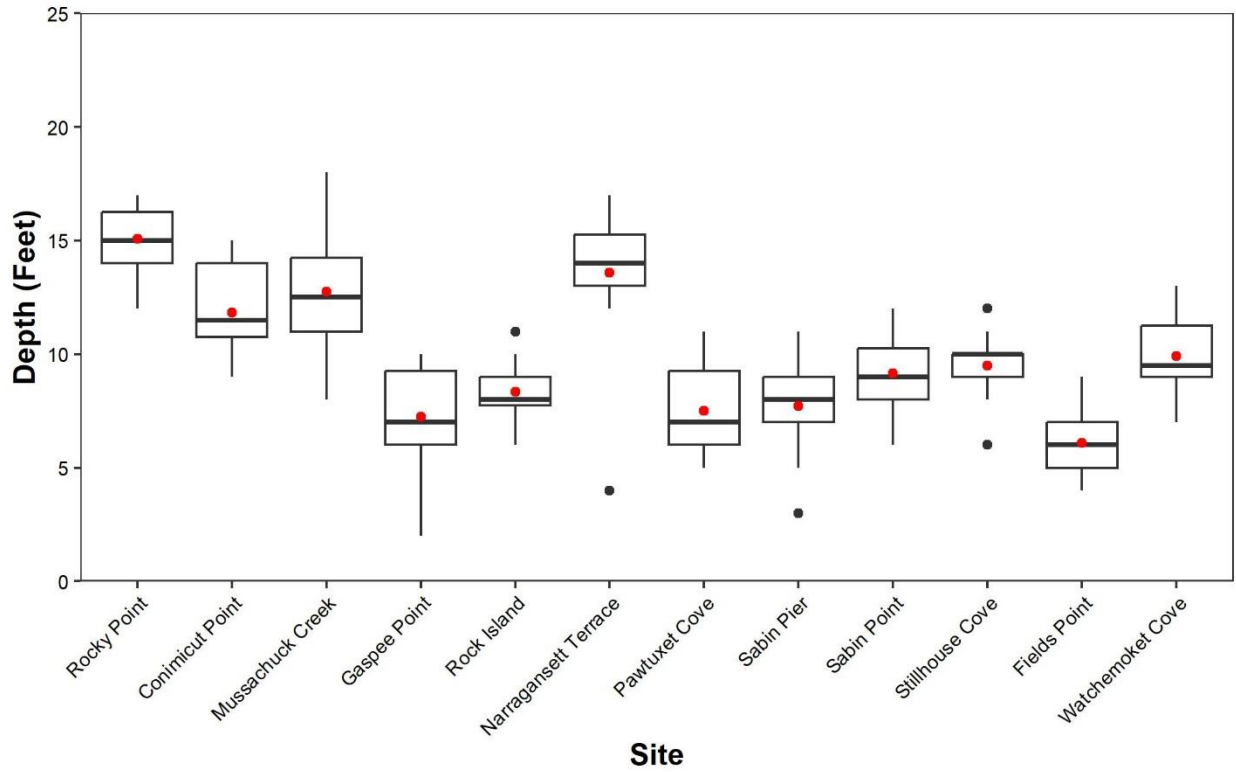


Figure 1. Boxplot of depth (ft) fish traps and eel pots were set at each site. Depth was recorded at the set and pull dates with red center points representing mean values.

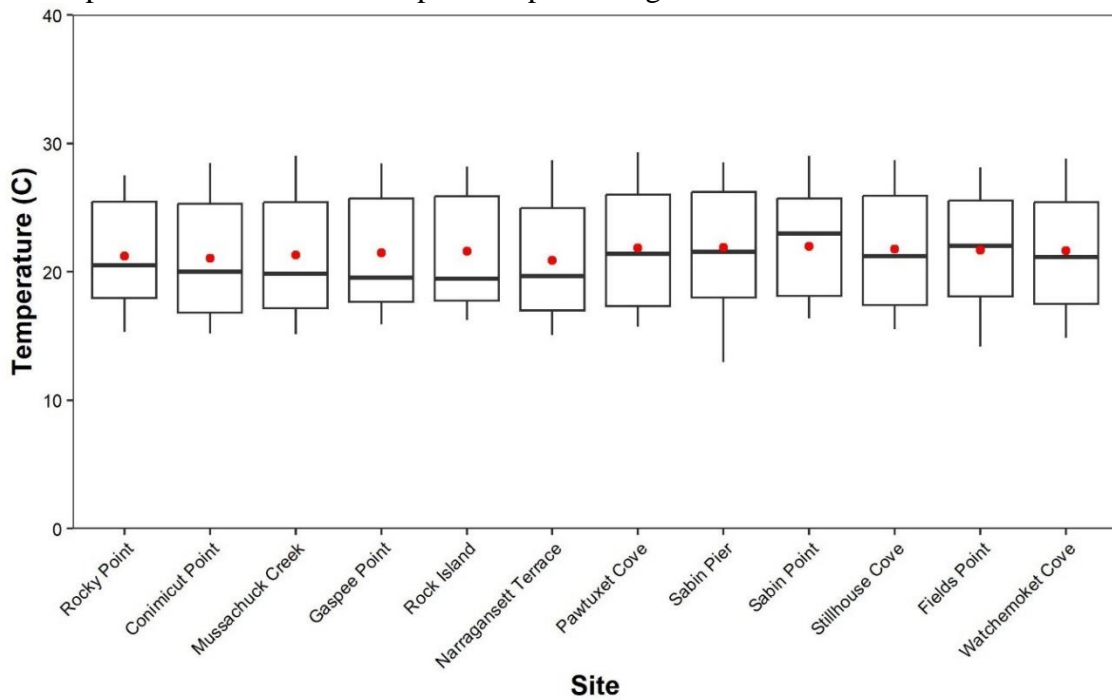


Figure 2. Boxplots of temperature (°C) recorded by the data loggers at sites during 2022 with red center points representing mean values.

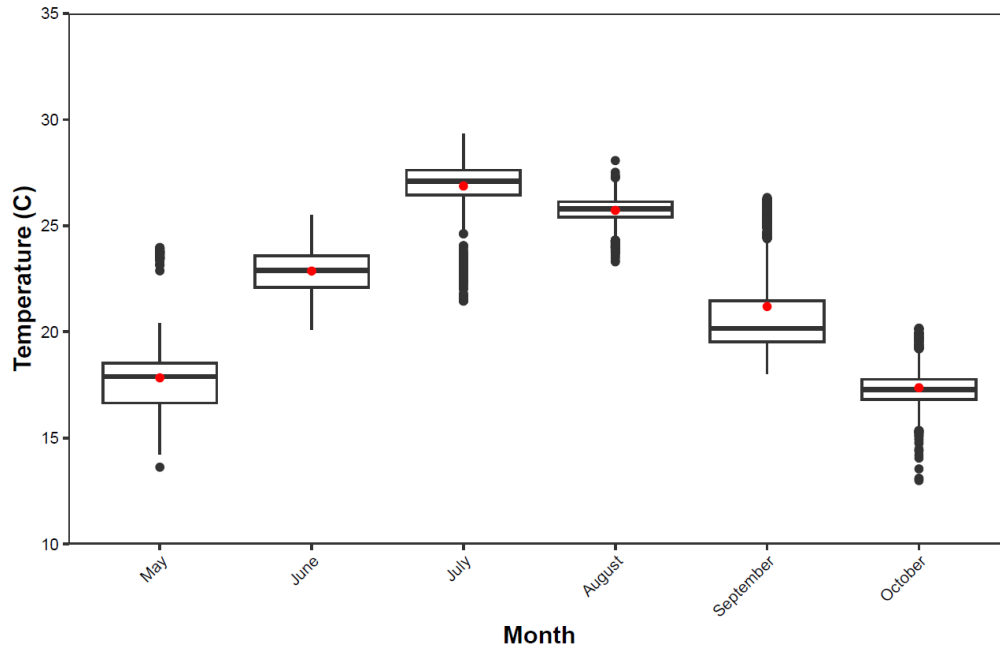


Figure 3. Boxplots of temperature (°C) recorded by the data loggers each month during 2022 with red center points representing mean values.

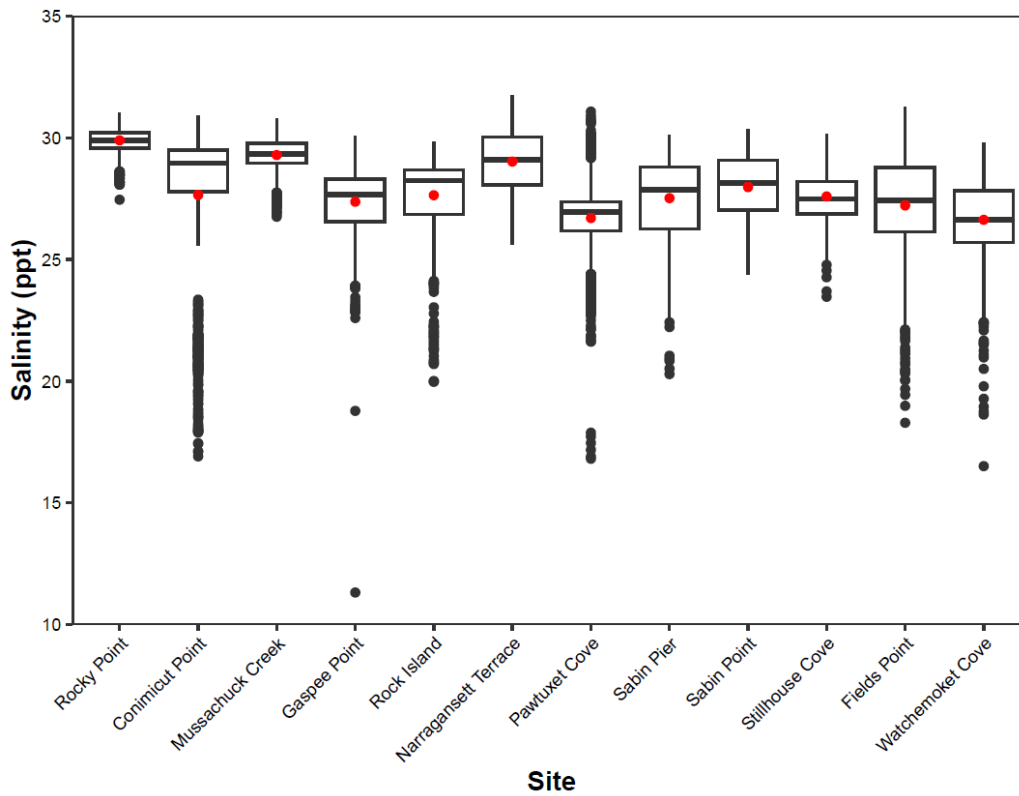


Figure 4. Boxplots of salinity (ppt) recorded by the data loggers at sites during 2022 with red center points representing mean values.

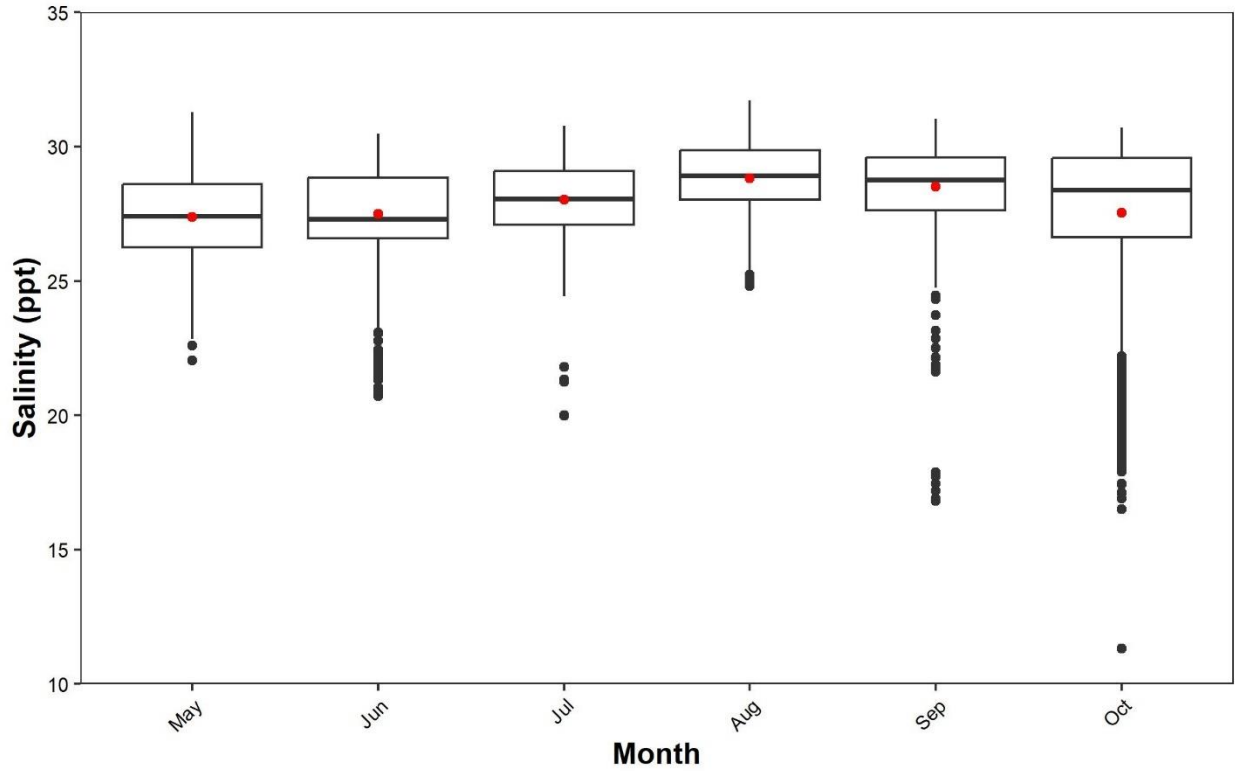


Figure 5. Boxplots of salinity (ppt) recorded by the data loggers across months during 2022 with red center points representing mean values.

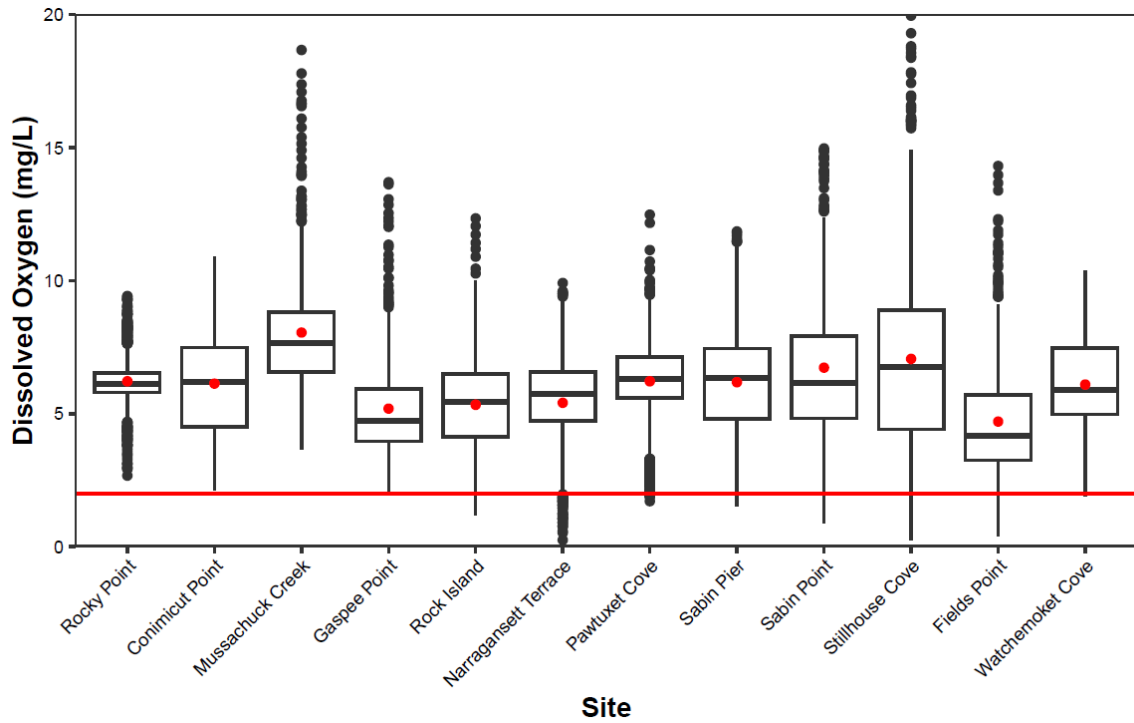


Figure 6. Boxplots of dissolved oxygen (mg/L) recorded by the data loggers at sites during 2022 with red center points representing mean values.

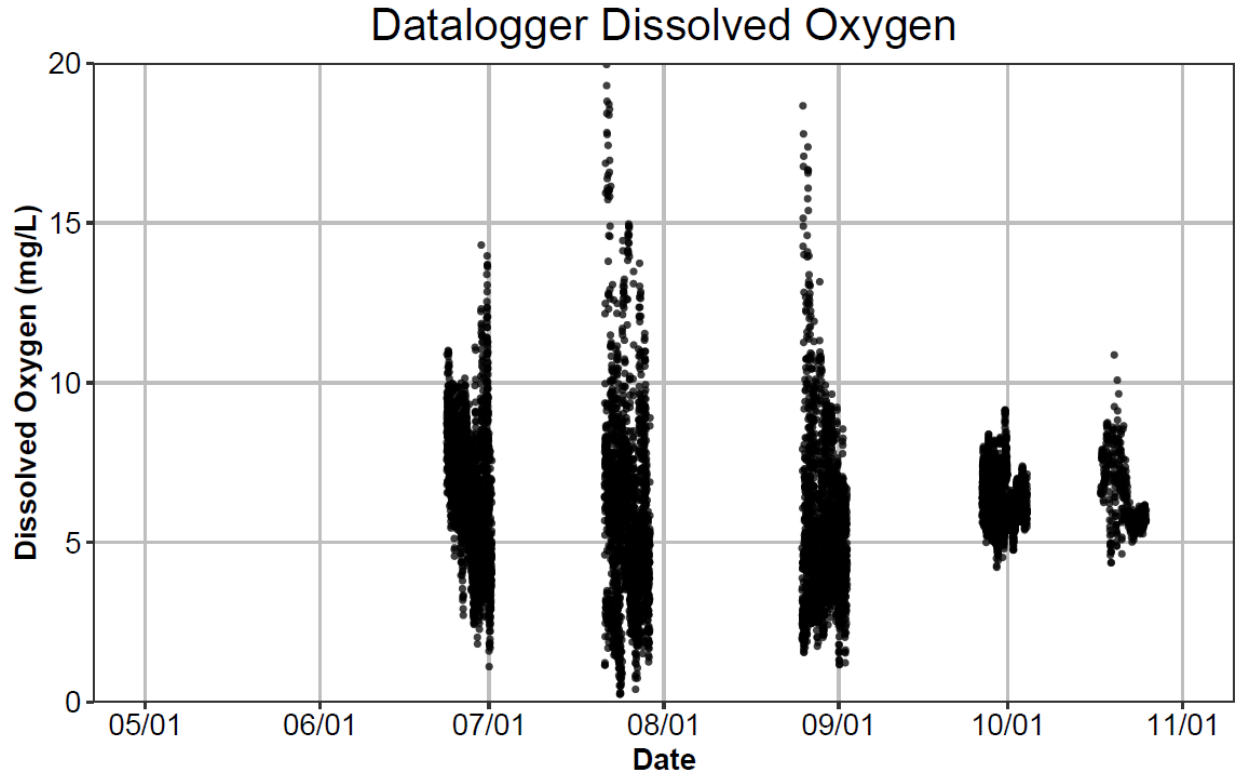


Figure 7. Dissolved oxygen (mg/L) values recorded by the data loggers each month during 2022.

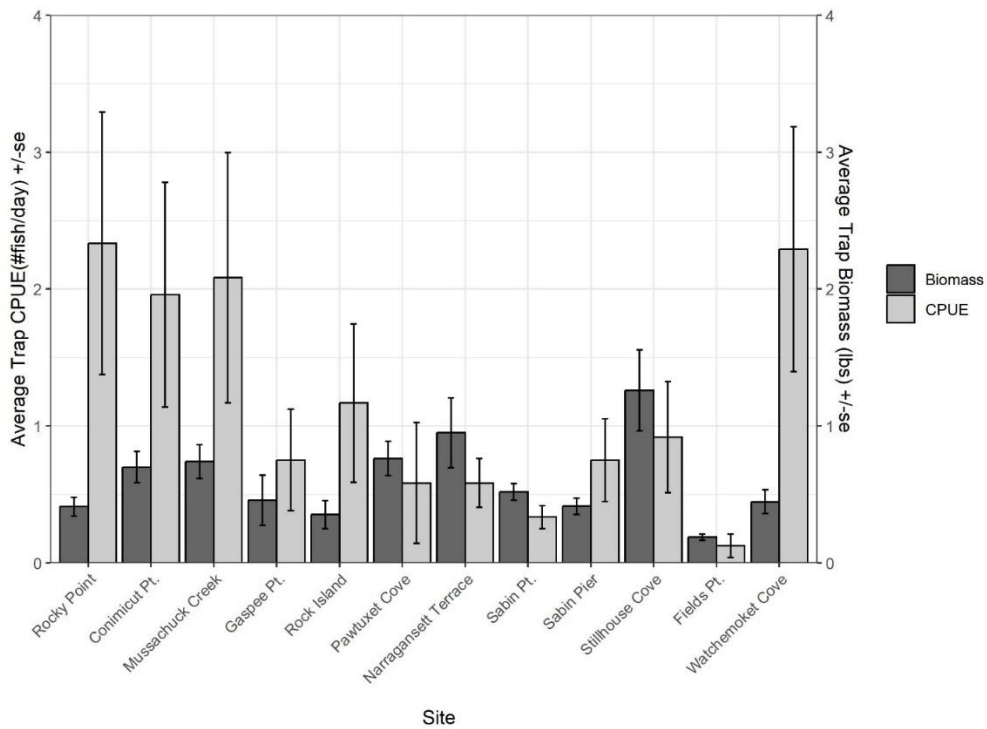


Figure 8. Average fish trap CPUE and biomass in 2022 across all sites. Error bars represent standard error.



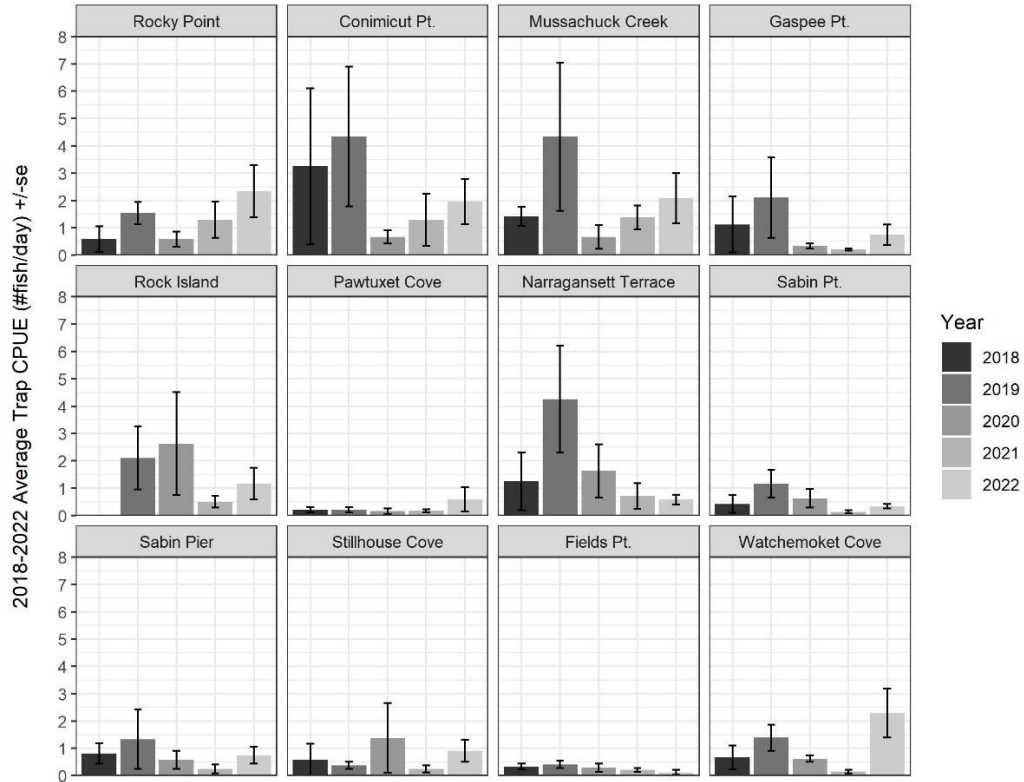


Figure 9. Average fish trap CPUE across all sites each year (2018-2022). Error bars represent standard error.

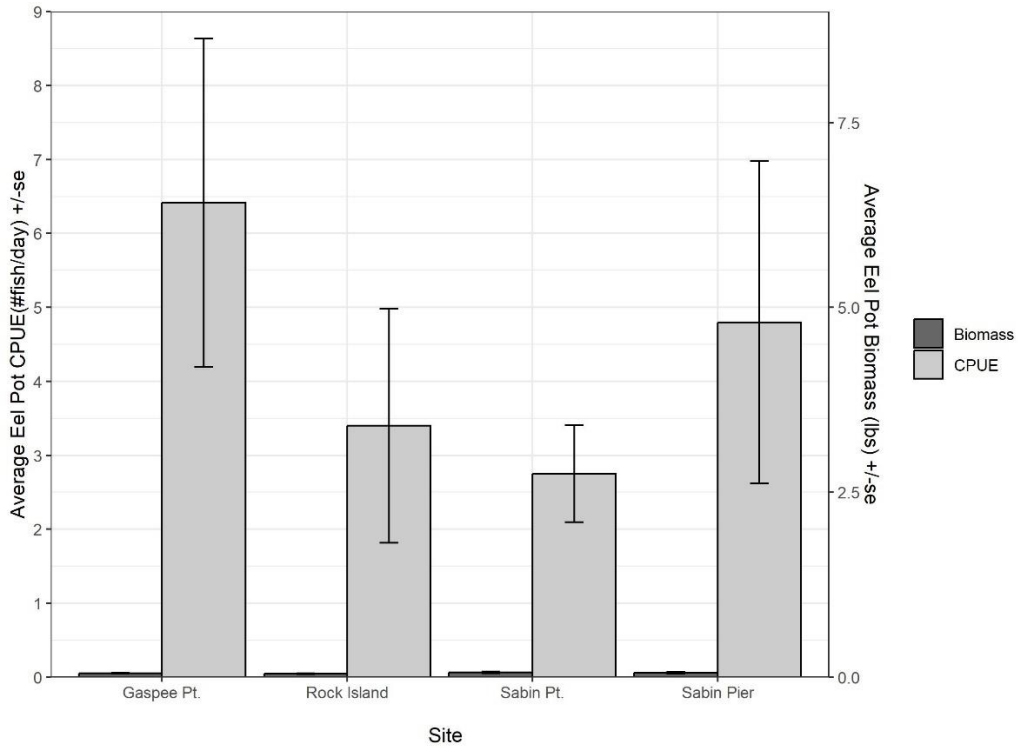


Figure 10. Average eel pot CPUE and biomass in 2022 across all stations. Error bars represent standard error.

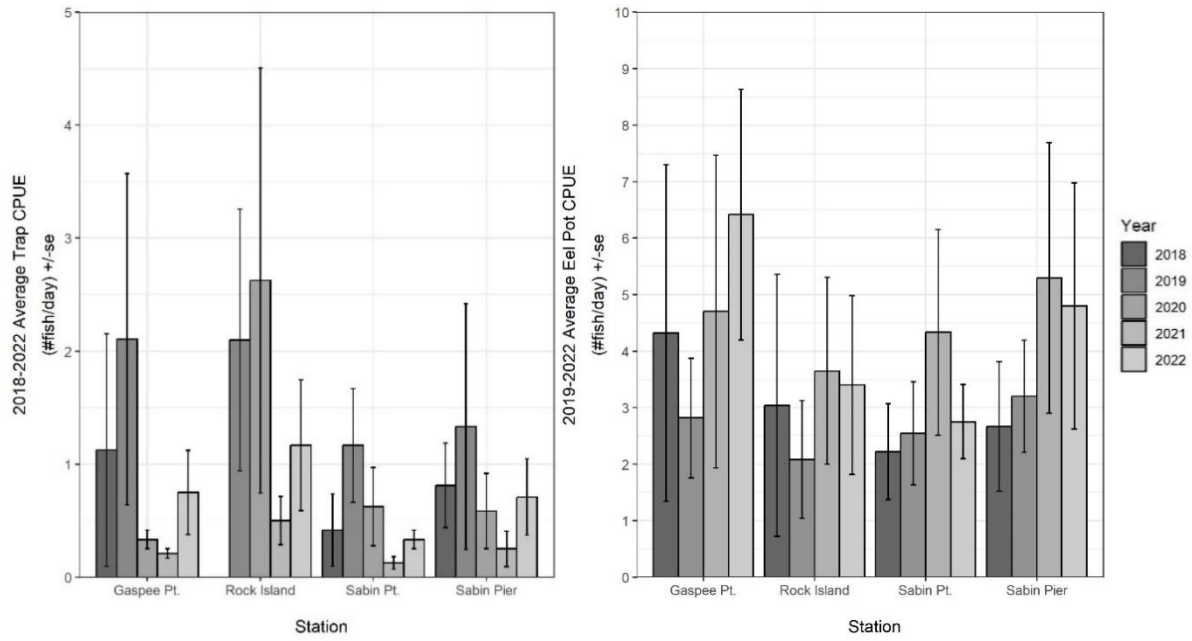


Figure 11. Average eel pot CPUE (left) and fish trap (right) across the four AR monitoring sites each year (2018-2022). Error bars represent standard error.

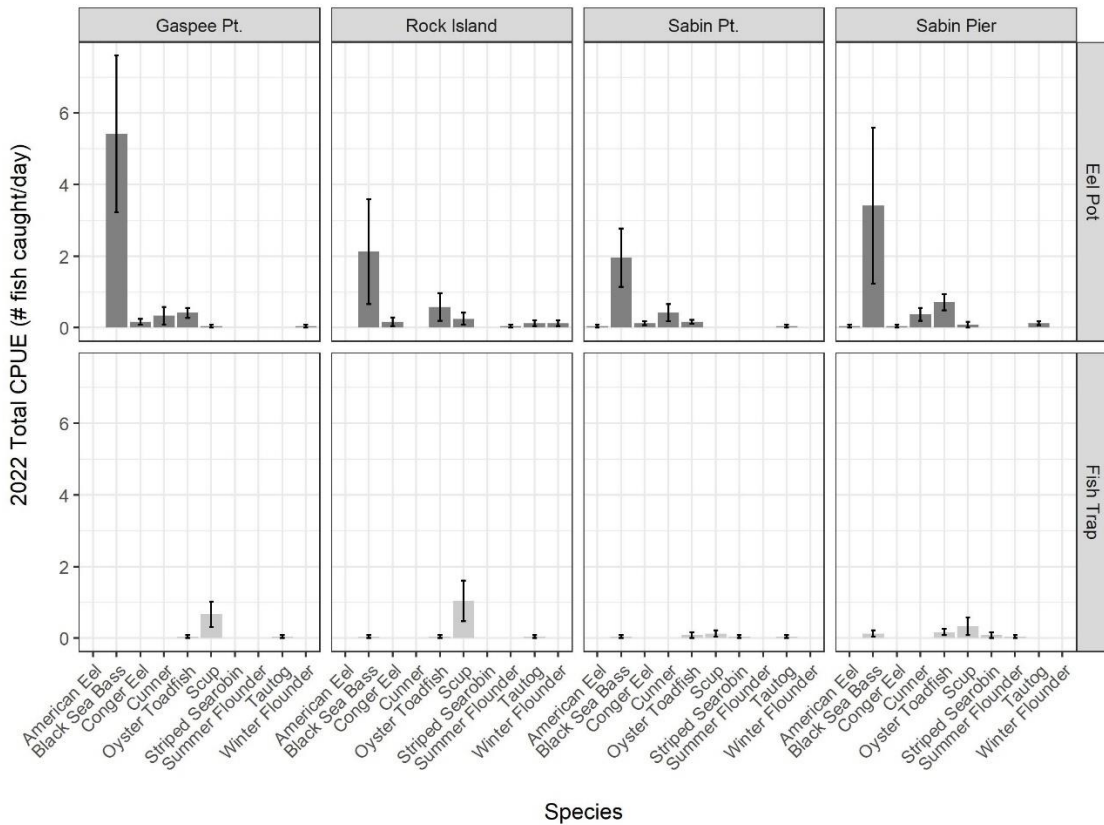


Figure 12. Average CPUE (# of fish/day) by species across all AR monitoring sites in 2022.

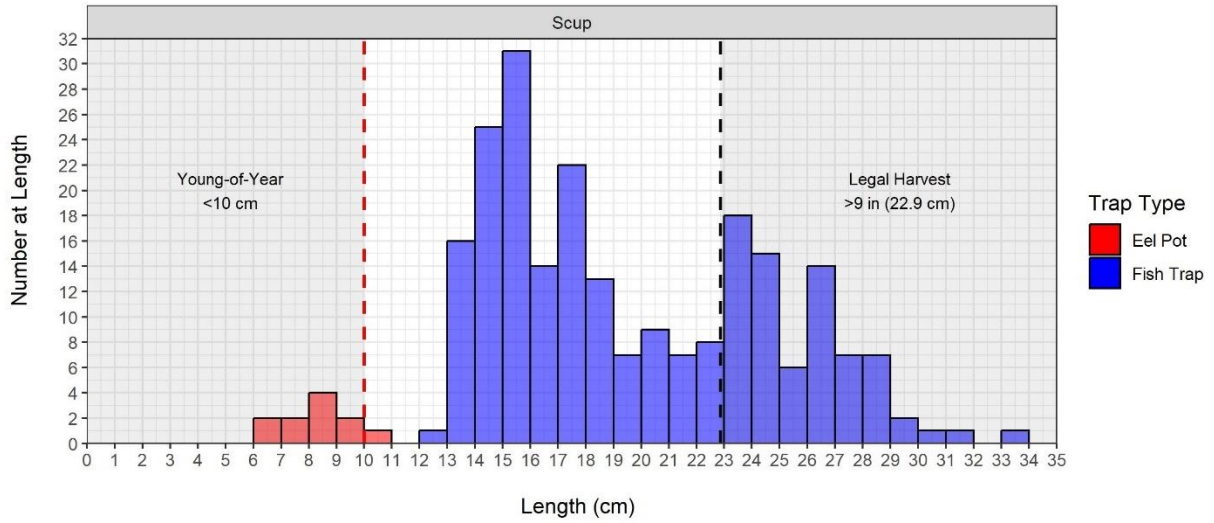


Figure 13. Histogram showing the size frequency at length of scup species caught in eel traps and fish traps.

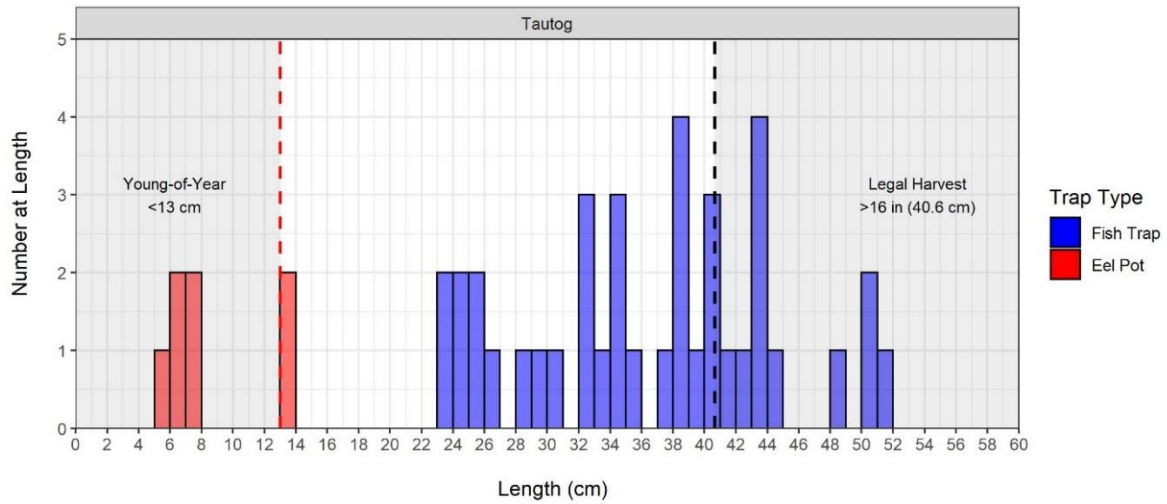


Figure 14. Histogram showing the size frequency at length of tautog species caught in eel traps and fish traps.

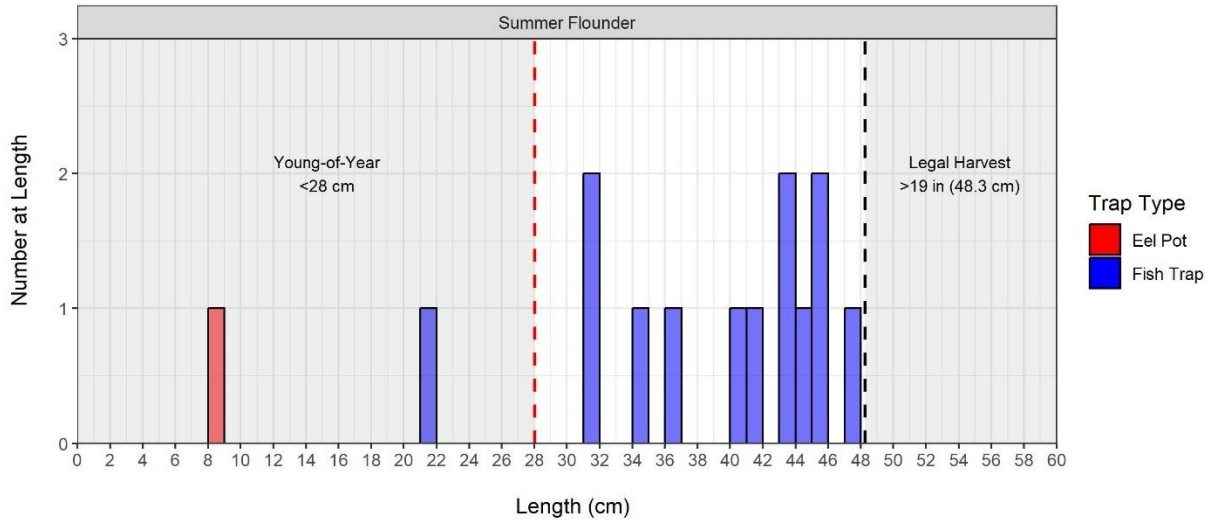


Figure 15. Histogram showing the size frequency at length of summer flounder species caught in eel traps and fish traps.

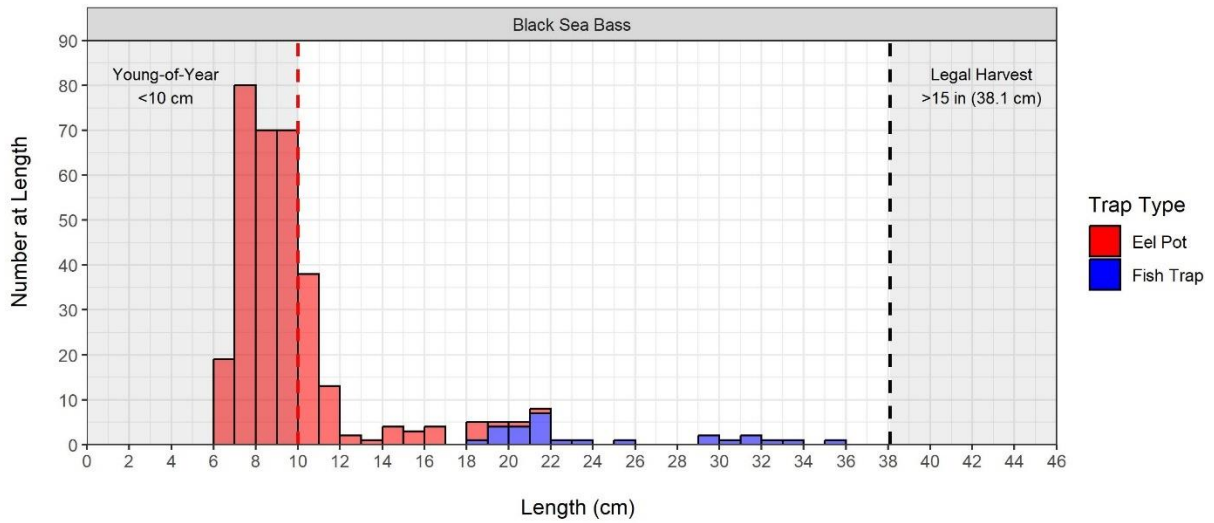


Figure 16. Histogram showing the size frequency at length of black sea bass species caught in eel traps and fish traps.

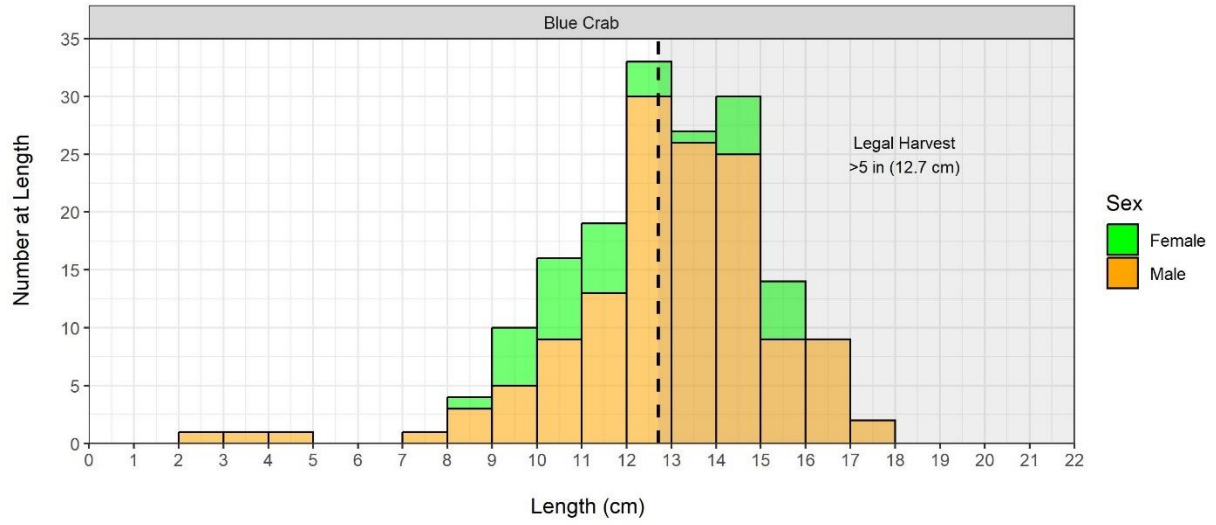


Figure 17. Histogram showing the size frequency at length of blue crabs caught in fish traps separated by sex.



Figure 18. Percent cover of substrate along the y-axis plotted for each transect along the x-axis, for each 2020-2022 fish productivity survey. Percent cover is grouped by substrate type (BL = boulder large, BM = boulder medium, BS = boulder small, M = mud/fines, M\_S = sandy mud mix, S = Sand, RB = Reef Ball) and faceted by Site (GASP = Gaspee Point (Control), ROCK = Rock Island (Natural Control), SPAR = Sabin Point Artificial Reef (Reef), SPCTR = Sabin Point Control (Control)).

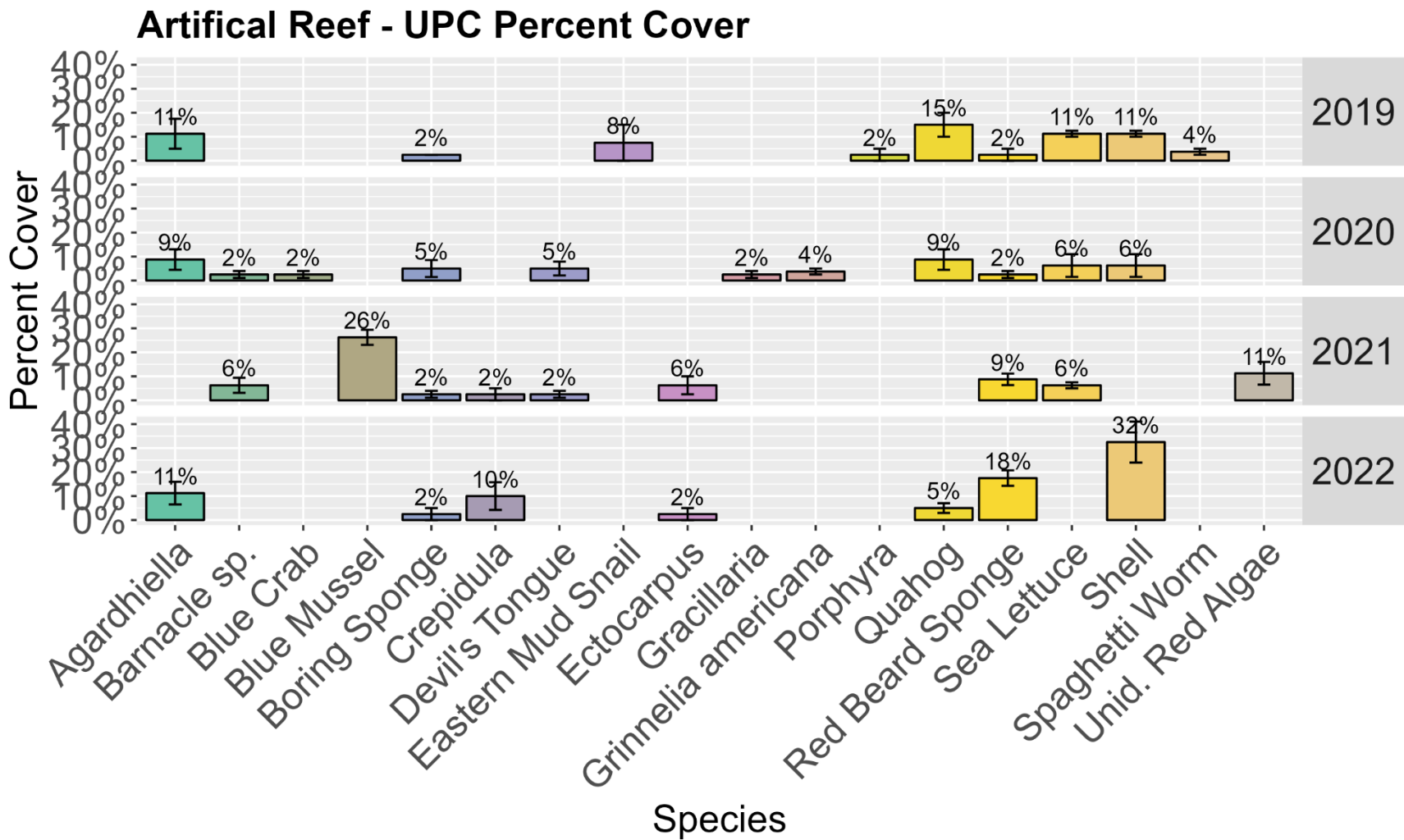


Figure 19. Mean algal and sessile invertebrate cover  $\pm$  SE, greater than 2.5% cover, for all years of the study at the Sabin Point Artificial Reef Sites (SPAR) Reef Balls were deployed after the 2019 dive survey.

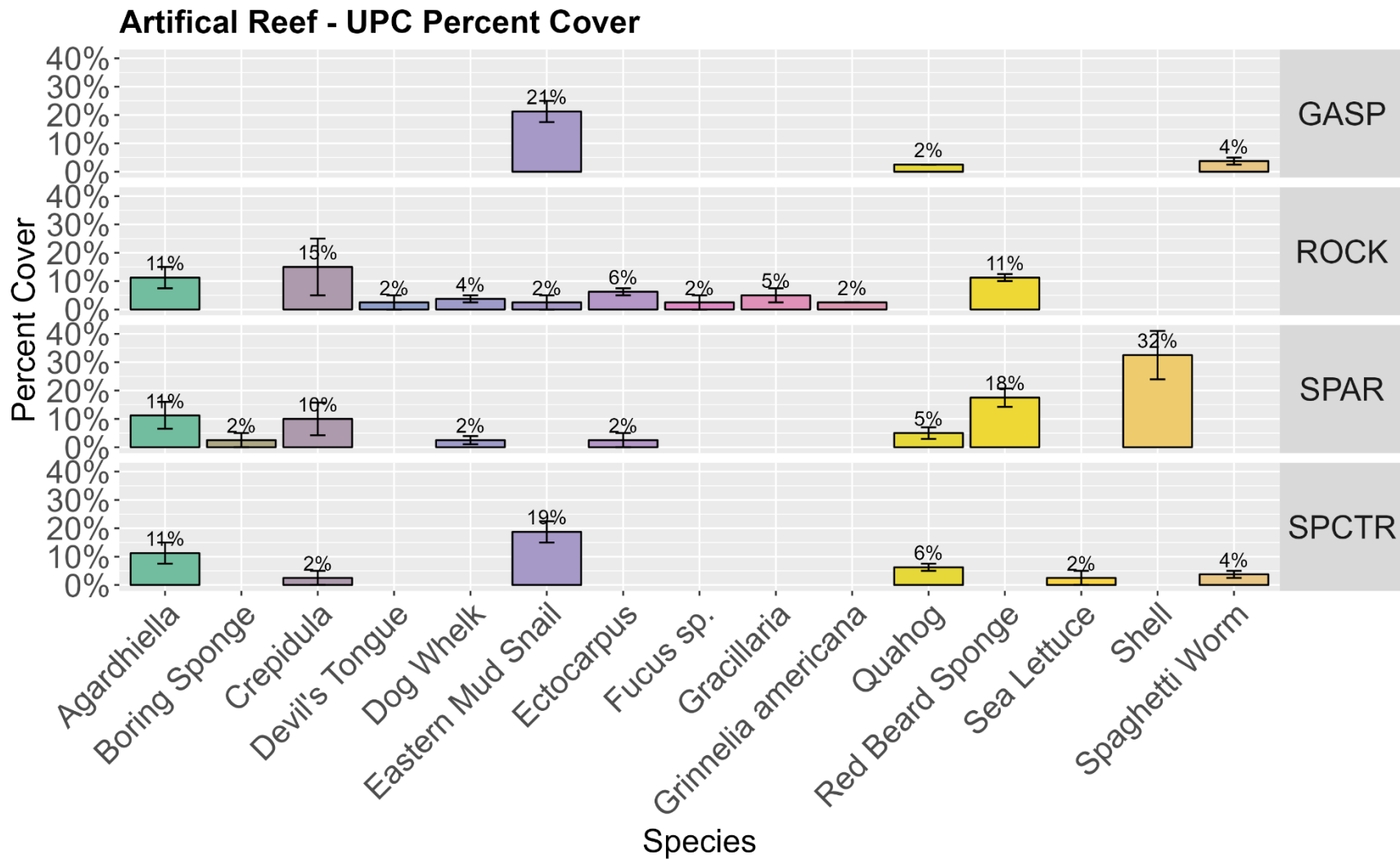


Figure 20. Mean algal and sessile invertebrate cover  $\pm$  SE, greater than 2% cover, for all years of the study at the Sabin Point Artificial Reef Sites (SPAR) Reef Balls were deployed after the 2019 dive survey.



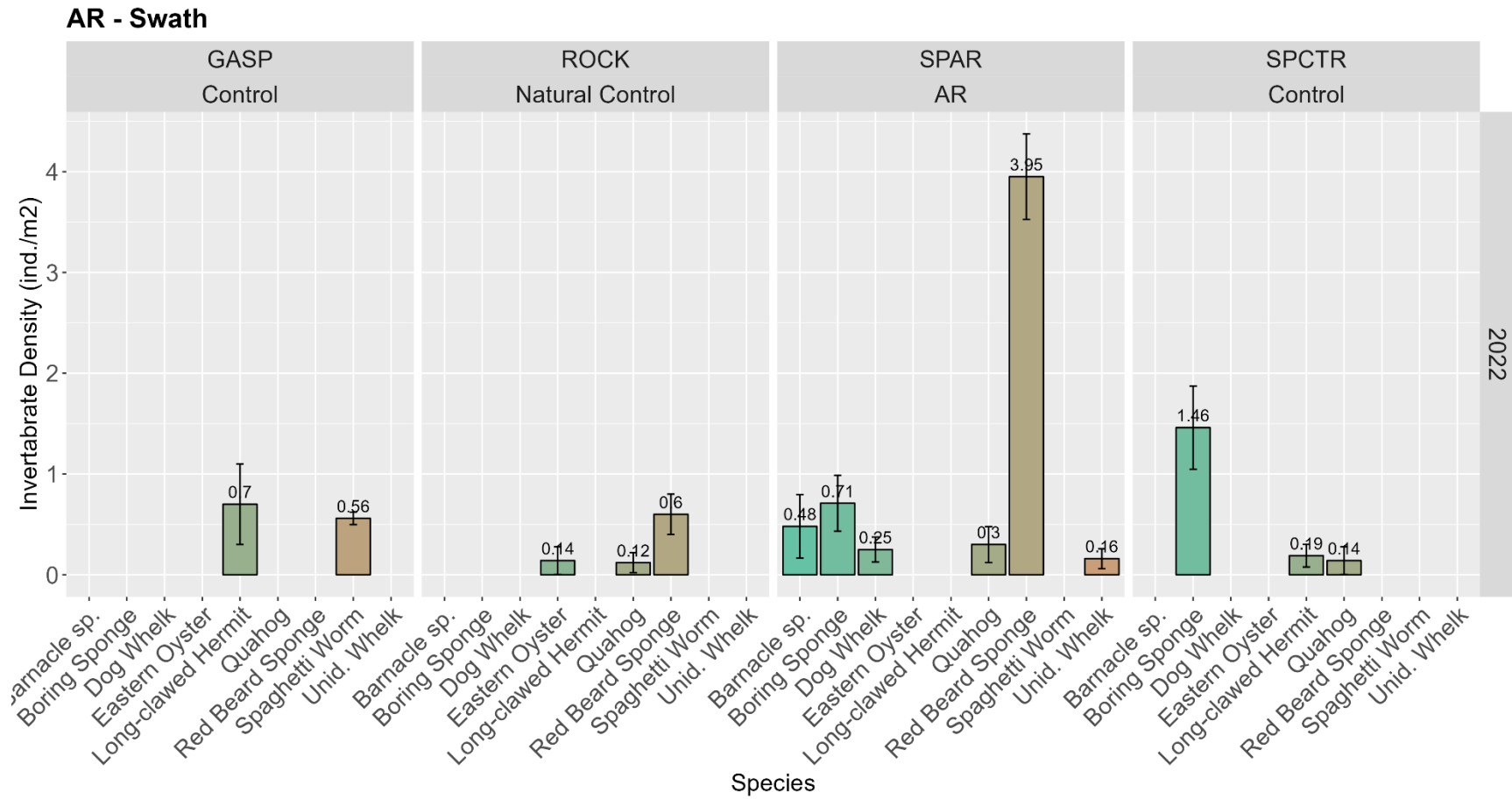


Figure 21. Mean algal and sessile invertebrate cover  $\pm$  SE, for all sites surveyed in 2022.

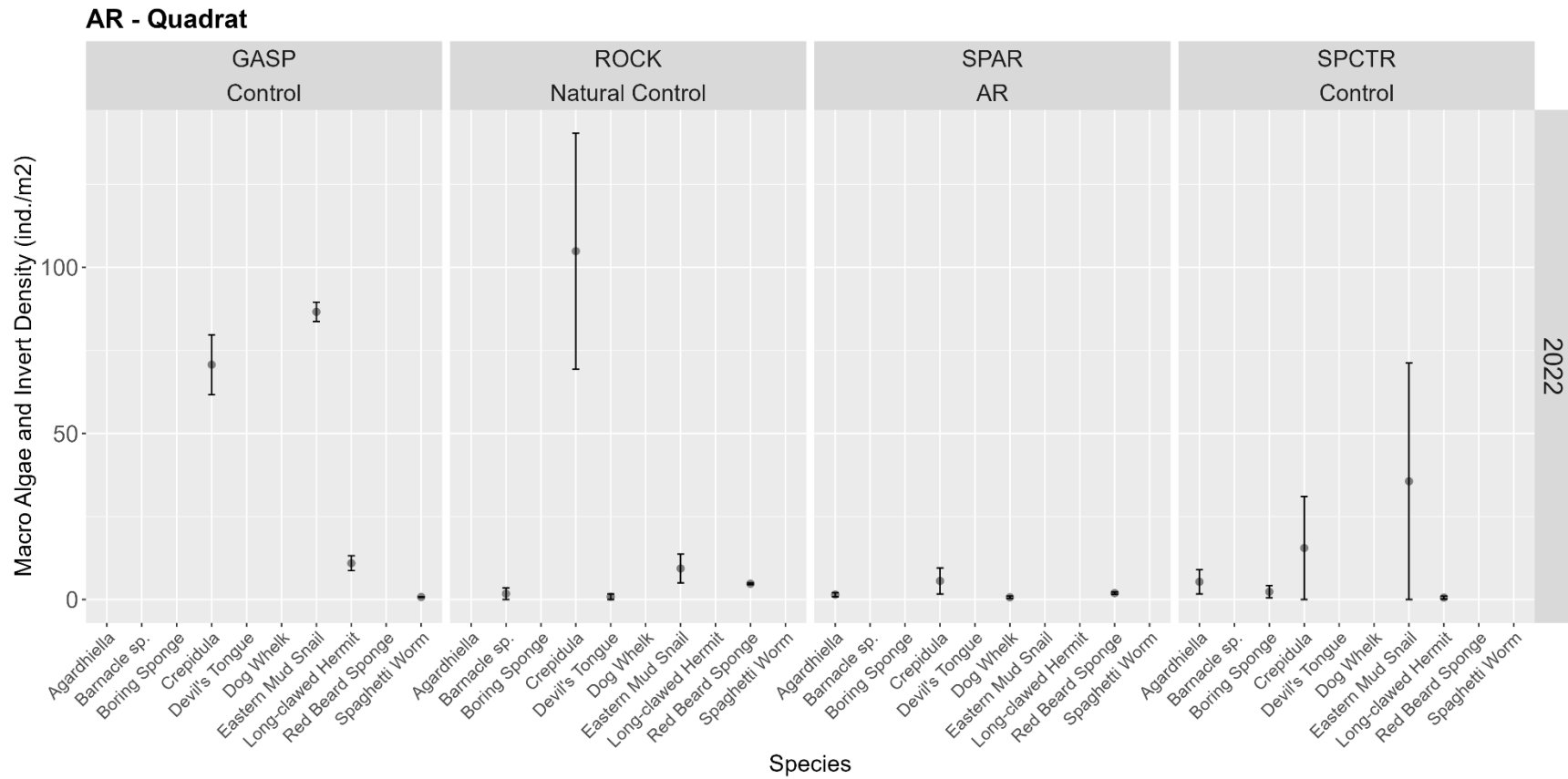


Figure 22. Mean invertebrate density  $\pm$  SE, per habitat treatment (GASP = Gaspee Point (Control), ROCK = Rock Island (Natural Control), SPAR = Sabin Point Artificial Reef (Reef), SPCTR = Sabin Point Control (Control)), grouped by site (AR, Control, Natural Control) and year (2019-2022) for the swath survey method.

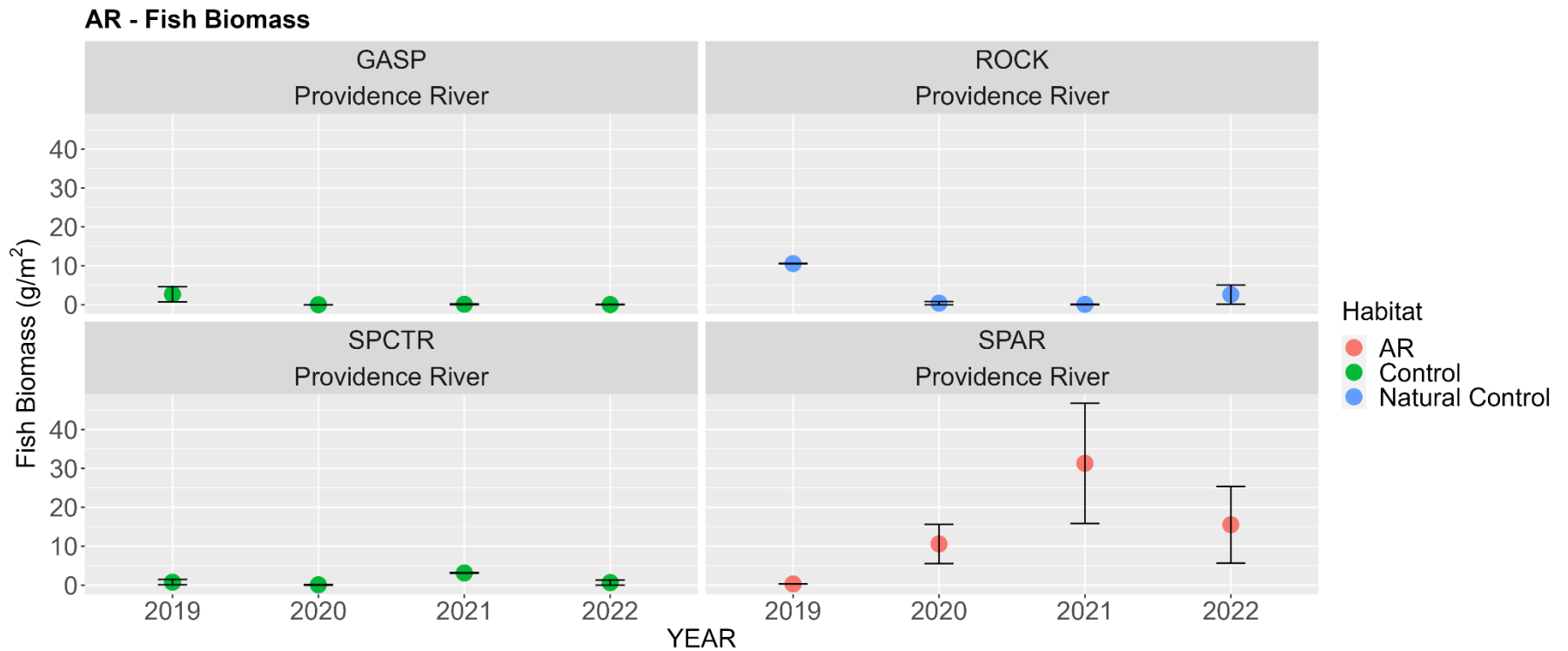


Figure 23. Mean fish biomass (g/m<sup>2</sup>) before (2019) and after (2020,2021,2021) the construction of the Sabin Point Artificial Reef. Fish biomass is standardized per meter squared and presented as the average biomass  $\pm$  SE, for each habitat treatment (AR = red, Control = green, Natural Control = blue)

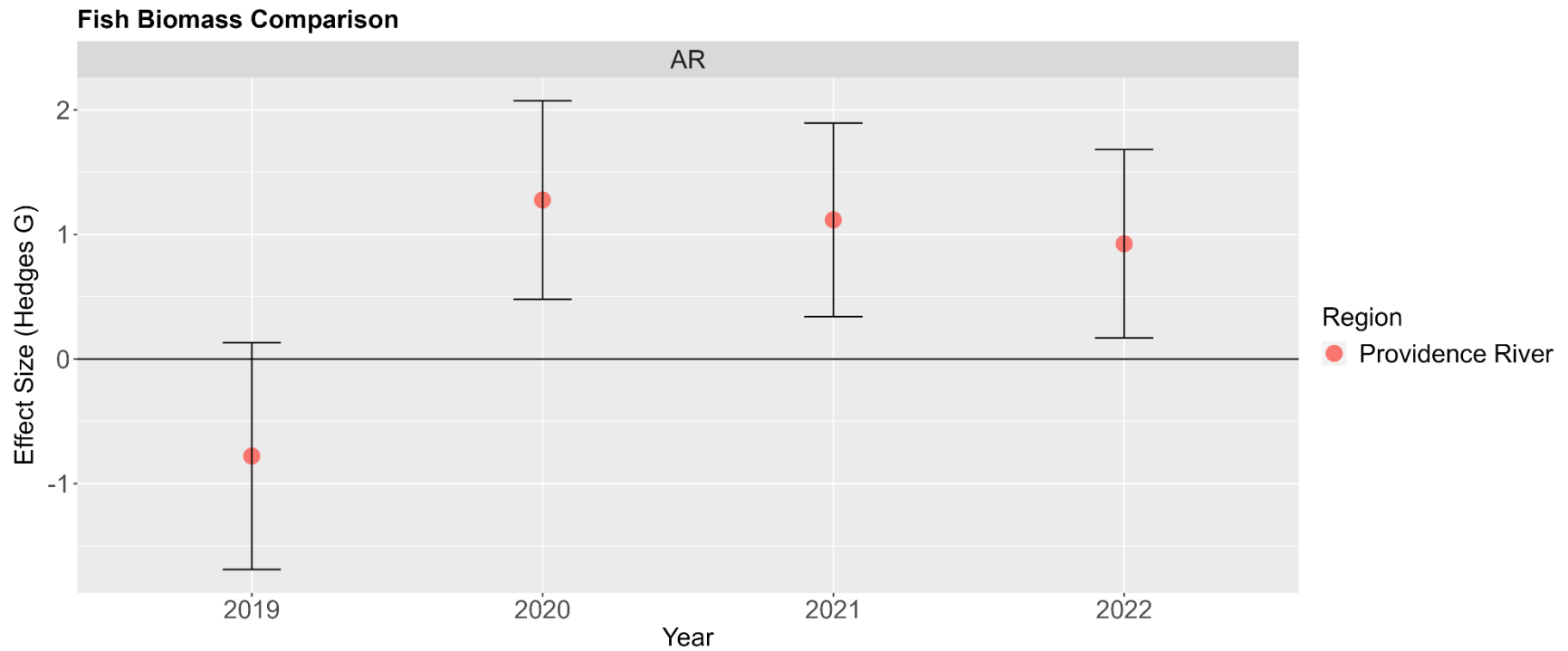


Figure 24. The effect size  $\pm$  SE (Hedge's G) of fish biomass at Sabin Point Artificial Reef relative to the Sabin Control Site each year. 2019 represents the pre reef construction, and 2020-2022 were all conducted post construction of the Sabin Point Artificial Reef. Fish biomass is standardized per meter squared.

**TABLES:**

Table 1. Summary of fishing effort in 2022. X = two ventless un-baited black sea bass traps set ~20m apart and left to soak for 4 days (96 hours). XX = months where eel pots and fish traps were both used. \* = indicates lost trap

2021	May	June	July	Aug	Sept	Oct	Total fish trap samples by site	Total eel pot samples by site
Watchemoket Cove	X	X	X	X	X	X	6	0
Fields Point	X	X	X	X	X	X	6	0
Stillhouse	X	X	X	X	X	X	6	0
Sabin Point	XX	XX	XX	XX	XX	XX	6	6
Sabin Pier	XX	XX	XX	XX	XX	XX	6	6
Pawtuxet Cove	X	X	X	X	X	X	6	0
Narragansett Terrace	X	X	X	X	X	X	6	0
Rock Island	XX	XX	XX	XX	XX	XX	6	6
Gaspee Point	XX	XX	XX	XX	XX	XX	6	6
Conimicut	X	X	X	X	X	X	6	0
Mussachuck	X	X	X	X	X	X	6	0
Rocky Point	X	X	X	X	X	X	6	0
Total fish trap samples per month	12	11	12	12	12	12	<b>Total Trap Samples: 72</b>	-
Total eel pot samples per month	4	4	3.5	4	4	4	-	<b>Total Eel Pot Samples: 24</b>

Table 2. Total number of each species caught at all sites in eel pots (four sites) and fish traps (12 sites) in 2022.

Common Name	Scientific Name	Eel Pot	Fish Trap
American Eel	<i>Anguilla rostrata</i>	2	0
Black Sea Bass	<i>Centropristus striata</i>	310	27
Conger Eel	<i>Conger Oceanicus</i>	12	0
Cunner	<i>Tautogolabrus adspersus</i>	27	0
Oyster Toadfish	<i>Opsanus tau</i>	45	23
Scup	<i>Stenotomus chrysops</i>	9	223
Summer Flounder	<i>Paralichthys dentatus</i>	1	12
Tautog	<i>Tautoga onitis</i>	7	24
Winter Flounder	<i>Pseudopleuronectes americanus</i>	4	0
Blue Crab	<i>Calinectes sapidus</i>	15	166
Channelled Whelk	<i>Busycotypus canaliculatus</i>	1	1
Green Crab	<i>Carcinus maenus</i>	4	7
Japanese Shore Crab	<i>Hemigrapsus sanguineus</i>	1	0
Mantis Shrimp	<i>Squilla empusa</i>	3	0
Moon Snail	<i>Lunatia heros</i>	1	0
Mud Crab	<i>Panopeus spp</i>	16	0
Spider Crab	<i>Libinia emarginata</i>	22	426
Northern Puffer	<i>Sphoeroides maculatus</i>	0	1
Smooth Dogfish	<i>Mustelus Canis</i>	0	1
Striped Searobin	<i>Prionotus evolans</i>	0	10
Horseshoe Crab	<i>Limulus polyphemus</i>	0	5
Quahog	<i>Mercenaria mercenaria</i>	0	1
Rock Crab	<i>Cancer irroratus</i>	0	2
Water Haul	-	14	0
Total Fish	-	417	321
Total Crustaceans	-	63	608

Table 3. Fish trap CPUE (#fish/day) at all sites each month with calculated mean, standard error and standard deviations.

	Rocky Point	Conimicut Pt.	Mussachuck Creek	Gaspee Pt.	Rock Island	Pawtuxet Cove	Narragansett Terrace	Sabin Pt.	Sabin Pier	Stillhouse Cove	Fields Pt.	Watchemoket Cove	n	mean	SE	SD
May	5.8	4.8	2.3	0.3	0.3	0.5	0.5	0.3	1	1.3	0.5	0.8	12	1.50	0.51	1.77
June	1.8	0.5	6.5	0.3	1	2.8	1.3	0	0.3	2.8	0	2.8	12	1.65	0.52	1.79
July	4.8	3.8	1.3	2.3	1.8	0	0	0.5	0	0.3	0.3	0.5	12	1.27	0.44	1.52
August	1	2.5	0.5	1.5	3.8	0.3	0.8	0.5	1	0.5	0	5.8	12	1.50	0.47	1.63
September	0.8	0.3	1	0.3	0.3	0	0.8	0.3	2	0.8	0	3.8	12	0.83	0.30	1.03
October	0	0	1	0	0	0	0.3	0.5	0.3	0	0	0.3	12	0.19	0.08	0.29
n	6	6	6	6	6	6	6	6	6	6	6	5				
mean	2.33	1.30	1.37	0.17	0.48	0.13	0.70	0.10	0.23	0.25	0.18	0.12				
SE	0.88	0.95	0.44	0.03	0.22	0.04	0.47	0.04	0.16	0.14	0.07	0.04				
SD	2.14	2.33	1.08	0.08	0.53	0.10	1.15	0.11	0.39	0.33	0.18	0.11				

Table 4. Eel pot CPUE (#fish/day) at all sites each month with calculated mean, standard error and standard deviations.

	<i>Gaspee Pt.</i>	<i>Rock Island</i>	<i>Sabin Pt.</i>	<i>Sabin Pier</i>	n	mean	SE	SD
May	1	0	1	3	4	1.25	0.54	1.09
June	3.2	1	2.5	1	4	1.93	0.48	0.96
July	1	0.5	1.5	3.5	4	1.63	0.57	1.14
August	9.8	10.2	5.5	15.5	4	10.25	1.77	3.55
September	14	5.2	3.5	3.8	4	6.63	2.15	4.31
October	9.5	3.5	2.5	2	4	4.38	1.50	3.01
n	6	6	6	6				
mean	6.42	3.40	2.75	4.80				
SE	2.02	1.45	0.60	1.99				
SD	4.96	3.54	1.46	4.88				

Table 5. Calculated species richness(*S*), Shannon diversity (*H'*), Pielou's evenness (*J'*), Simpson's index ( $\lambda$ )

Name	<i>S</i>	<i>H'</i>	<i>J'</i>	$\lambda$
Gaspee Pt.	13	1.47	0.57	0.62
Rock Island	10	1.82	0.79	0.80
Sabin Pt.	11	1.80	0.75	0.77
Sabin Pier	15	1.83	0.68	0.73

Table 6. Average fish trap CPUE (#fish/day) in 2022 by month  $\pm$  standard error with overall mean and total CPUE for each target species.

Fish Traps	<i>Scup</i>	<i>Black Sea Bass</i>	<i>Summer Flounder</i>	<i>Tautog</i>	<i>Winter Flounder</i>
May	0.04 $\pm$ 0.03	0	0.04 $\pm$ 0.03	<b>0.31 <math>\pm</math> 0.12</b>	0
June	<b>1.31 <math>\pm</math> 0.48</b>	0.13 $\pm$ 0.09	<b>0.13 <math>\pm</math> 0.05</b>	0.08 $\pm$ 0.05	0
July	1.06 $\pm$ 0.45	0.04 $\pm$ 0.04	0.04 $\pm$ 0.03	0.02 $\pm$ 0.02	0
August	1.08 $\pm$ 0.49	0.13 $\pm$ 0.05	0.04 $\pm$ 0.03	0.06 $\pm$ 0.03	0
September	0.5 $\pm$ 0.23	<b>0.19 <math>\pm</math> 0.09</b>	0	0	0
October	0	0.08 $\pm$ 0.08	0	0.02 $\pm$ 0.02	0
Mean Overall	<b>0.77 <math>\pm</math> 0.18</b>	0.09 $\pm$ 0.03	0.04 $\pm$ 0.01	0.08 $\pm$ 0.03	0
2022 Total CPUE	<b>55.75</b>	6.75	3	6	0

Table 7. Total abundance of species caught in fish traps by station in 2022.

Common Name	Watchemoket Cove	Fields Pt.	Stillhouse Cove	Sabin Pier	Sabin Pt.	Pawtuxet Cove	Narragansett Terrace	Rock Island	Gaspee Pt.	Conimicut Pt.	Mussachuck Creek	Rocky Point	Total
<b>Black Sea Bass</b>	<b>1</b>	-	-	<b>3</b>	<b>1</b>	-	-	<b>1</b>	-	<b>1</b>	<b>13</b>	<b>7</b>	<b>27</b>
Oyster Toadfish	2	3	1	4	2	1	3	1	1	3	1	1	23
<b>Scup</b>	<b>45</b>	-	<b>16</b>	<b>8</b>	<b>3</b>	<b>10</b>	<b>7</b>	<b>25</b>	<b>16</b>	<b>30</b>	<b>23</b>	<b>40</b>	<b>223</b>
Striped Searobin	-	-	-	2	1	-	1	-	-	4	-	2	10
<b>Summer Flounder</b>	<b>1</b>	-	-	<b>1</b>	-	<b>3</b>	<b>2</b>	-	-	<b>1</b>	<b>4</b>	-	<b>12</b>
<b>Tautog</b>	<b>6</b>	-	<b>5</b>	-	<b>1</b>	-	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>24</b>
Northern Puffer	-	-	-	-	-	-	-	-	-	-	-	1	1
Smooth Dogfish	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	55	3	22	18	8	14	14	28	18	41	44	56	943
<b>Blue Crab</b>	<b>12</b>	<b>29</b>	<b>17</b>	<b>10</b>	<b>14</b>	<b>28</b>	<b>6</b>	<b>26</b>	<b>10</b>	<b>8</b>	<b>3</b>	<b>3</b>	<b>166</b>
Rock Crab	-	-	-	-	-	-	-	-	-	1	0	1	2
Spider Crab	6	3	6	10	16	2	46	18	15	44	165	95	426
Horseshoe Crab	-	1	-	-	-	-	-	-	-	-	-	-	1
Green Crab	-	-	-	2	-	-	-	-	3	-	2	-	7
Total	18	33	23	22	30	30	52	44	28	53	170	99	602
Water Haul	1	-	1	1	1	2	1	2	1	1	2	1	14

Table 8. Average eel pot CPUE (#fish/day) in 2022 by month ± standard error with overall mean and total CPUE for each target species.

Eel Pots	Scup	Black Sea Bass	Summer Flounder	Tautog	Winter Flounder
May	0	0.06 ± 0.06	0	<b>0.13 ± 0.07</b>	<b>0.06 ± 0.06</b>
June	0	0.38 ± 0.24	<b>0.06 ± 0.06</b>	0	<b>0.06 ± 0.06</b>
July	0	1.06 ± 0.52	0	0	0
August	<b>0.44 ± 0.21</b>	<b>9.25 ± 1.80</b>	0	0.06 ± 0.06	0
September	0.13 ± 0.13	5.63 ± 2.46	0	0.13 ± 0.13	0
October	0	3.00 ± 1.86	0	<b>0.13 ± 0.07</b>	0
Mean Overall	0.09 ± 0.05	<b>3.23 ± 0.85</b>	0.01 ± 0.01	0.07 ± 0.03	0.01 ± 0.01
2021 Total CPUE	2.25	<b>77.5</b>	0.25	1.75	1



Table 9. Species Richness (R) and Shannon H-index (H) of diversity for each Artificial Reef Dive Survey Site (SPAR – Sabin Point Artificial Reef, GASP – Gaspee Point, SPCTR – Sabin Point Control, ROCK – Rock Island) from 2019 to 2022.

YEAR	REGION	SITE	HABITAT	R	H
2019	Providence River	SPAR	AR	8 ± 1	1.87 ± 0.12
2019	Providence River	GASP	Control	9 ± 2	1.9 ± 0.25
2019	Providence River	SPCTR	Control	7.5 ± 0.5	1.49 ± 0.1
2019	Providence River	ROCK	Natural Control	10 ± 1	1.93 ± 0.03
2020	Providence River	SPAR	AR	6.75 ± 1.18	1.74 ± 0.2
2020	Providence River	GASP	Control	7.5 ± 1.5	1.66 ± 0.22
2020	Providence River	SPCTR	Control	6.5 ± 0.5	1.65 ± 0.08
2020	Providence River	ROCK	Natural Control	6.5 ± 1.5	1.56 ± 0.15
2021	Providence River	SPAR	AR	8.5 ± 1.26	1.89 ± 0.13
2021	Providence River	GASP	Control	5 ± 0	1.25 ± 0.07
2021	Providence River	SPCTR	Control	6 ± 1	1.06 ± 0.04
2021	Providence River	ROCK	Natural Control	8.5 ± 3.5	1.83 ± 0.47
2022	Providence River	SPAR	AR	6.25 ± 1.03	1.53 ± 0.12
2022	Providence River	GASP	Control	4 ± 0	0.92 ± 0.02
2022	Providence River	SPCTR	Control	6 ± 1	1.52 ± 0.21
2022	Providence River	ROCK	Natural Control	8.5 ± 1.5	1.97 ± 0.23

## APPENDIX

Table A. Fish and Eel Pot Locations in 2022. <sup>x</sup> = indicates sites where eel pots were used.

<b>Name</b>	<b>Latitude</b>	<b>Longitude</b>
Fields Point	41.7868	-71.3722
Stillhouse Cove	41.7729	-71.3855
Sabin Point <sup>x</sup>	41.7631	-71.3669
Sabin Pier <sup>x</sup>	41.7636	-71.3686
Pawtuxet Cove	41.7590	-71.3854
Narragansett Terrace	41.7522	-71.3654
Rock Island <sup>x</sup>	41.7526	-71.3793
Gaspee Point <sup>x</sup>	41.7470	-71.3740
Mussachuck Creek	41.7278	-71.3431
Conimicut Point	41.7228	-71.3622
Kettle Point	41.7978	-71.3816
Rocky Point	41.6885	-71.3639

Table B. Presence of finfish and crustaceans by month captured by the fish traps in 2022.

APPENDIX

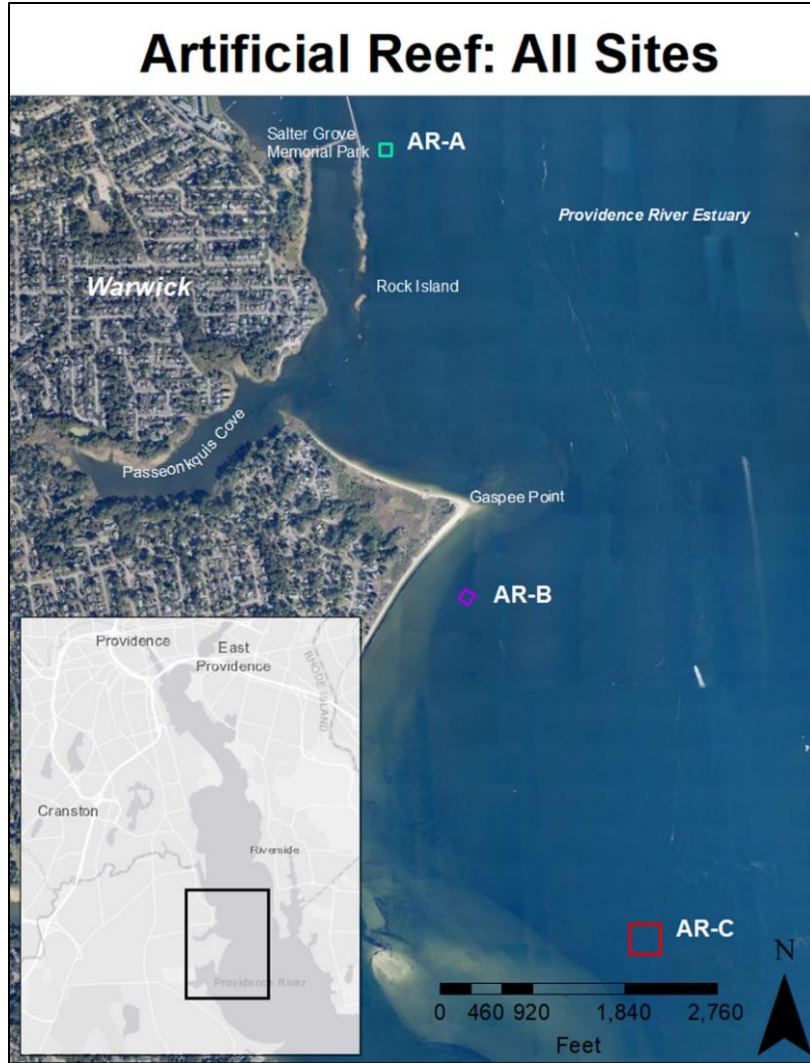


Figure A. NBC draft permit: aerial view of the three proposed artificial reef sites in the Providence River Estuary. Site AR-A (41.75394, -71.37949), Site AR-B (41.74185, -71.74185), Site AR-C (41.73268, -71.37011).

APPENDIX

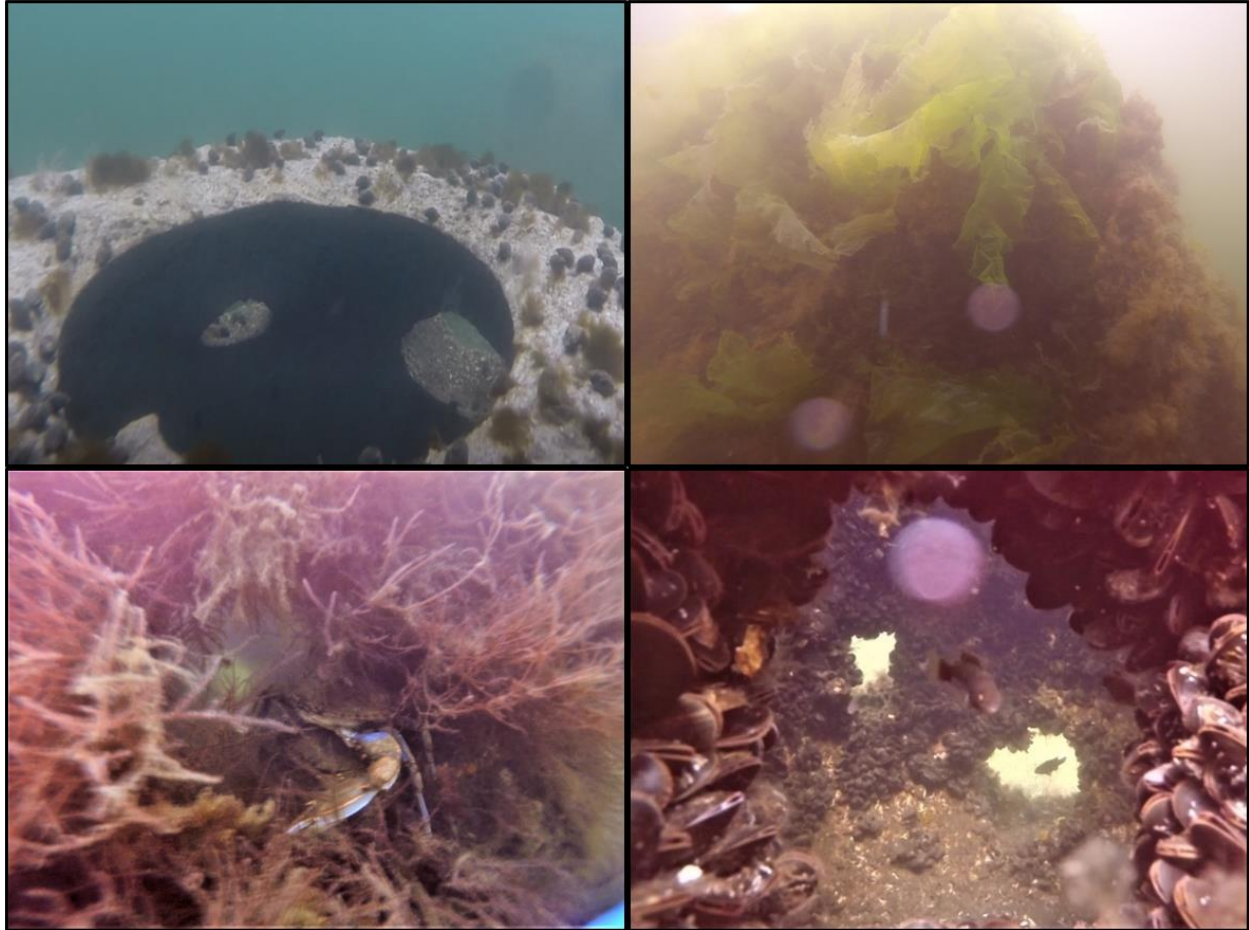


Photo: Succession of Reef Ball modules at Sabin Point Artificial Reef. (Top left – Fall 2019, Top Right – May 2020, Bottom left - September 2020, Bottom Right – September 2021)

Table A. Fish and Eel Pot Locations in 2022. <sup>x</sup> = indicates sites where eel pots were used.

Name	Latitude	Longitude
Fields Point	41.7868	-71.3722
Stillhouse Cove	41.7729	-71.3855
Sabin Point <sup>x</sup>	41.7631	-71.3669
Sabin Pier <sup>x</sup>	41.7636	-71.3686
Pawtuxet Cove	41.7590	-71.3854
Narragansett Terrace	41.7522	-71.3654
Rock Island <sup>x</sup>	41.7526	-71.3793
Gaspee Point <sup>x</sup>	41.7470	-71.3740
Mussachuck Creek	41.7278	-71.3431
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## APPENDIX

Table B. Presence of finfish and crustaceans by month captured by the fish traps in 2022.

<b>MAY</b>	<b>Site</b>												
<b>Species</b>	<b>Rocky Point</b>	<b>Conimicut Pt.</b>	<b>Mussachuck Creek</b>	<b>Gaspee Pt.</b>	<b>Rock Island</b>	<b>Pawtuxet Cove</b>	<b>Narragansett Terrace</b>	<b>Sabin Pt.</b>	<b>Sabin Pier</b>	<b>Stillhouse Cove</b>	<b>Fields Pt.</b>	<b>Watchemoket Cove</b>	<b>Total out of 12</b>
Black Sea Bass	1	1	1	0	1	0	0	1	0	0	0	0	5
Channelled Whelk	1	0	0	0	0	0	0	0	0	0	0	0	1
Oyster Toadfish	1	0	0	0	0	0	1	0	0	0	0	0	2
Smooth Dogfish	1	0	0	0	0	0	0	0	0	0	0	0	1
Spider Crab	1	1	1	1	1	0	1	1	0	0	0	1	8
Tautog	1	0	0	0	0	0	0	1	0	0	0	1	3
Blue Crab	0	1	0	1	1	1	1	1	1	1	1	1	10
Scup	0	1	1	1	1	0	1	1	1	1	0	1	9
Summer Flounder	0	0	0	0	0	1	1	0	0	0	0	0	2

<b>JUNE</b>	<b>Site</b>												
<b>Species</b>	<b>Rocky Point</b>	<b>Conimicut Pt.</b>	<b>Mussachuck Creek</b>	<b>Gaspee Pt.</b>	<b>Rock Island</b>	<b>Pawtuxet Cove</b>	<b>Narragansett Terrace</b>	<b>Sabin Pt.</b>	<b>Sabin Pier</b>	<b>Stillhouse Cove</b>	<b>Fields Pt.</b>	<b>Watchemoket Cove</b>	<b>Total out of 12</b>
Blue Crab	1	1	0	1	1	1	1	1	1	1	1	1	11
Scup	1	1	1	1	1	0	0	1	0	1	0	0	7
Spider Crab	1	1	1	0	1	0	1	1	0	1	0	0	7
Oyster Toadfish	0	1	1	1	0	0	0	0	0	1	0	0	4
Black Sea Bass	0	0	1	0	0	0	0	0	0	0	0	0	1
Green Crab	0	0	1	1	0	0	0	0	0	0	0	0	2
Summer Flounder	0	0	1	0	0	0	0	0	0	0	0	1	2
Quahog	0	0	0	0	0	0	1	0	0	0	0	0	1
Tautog	0	0	0	0	0	0	0	0	0	0	0	1	1

<b>JULY</b>	<b>Site</b>												
<b>Species</b>	<b>Rocky Point</b>	<b>Conimicut Pt.</b>	<b>Mussachuck Creek</b>	<b>Gaspee Pt.</b>	<b>Rock Island</b>	<b>Pawtuxet Cove</b>	<b>Narragansett Terrace</b>	<b>Sabin Pt.</b>	<b>Sabin Pier</b>	<b>Stillhouse Cove</b>	<b>Fields Pt.</b>	<b>Watchemoket Cove</b>	<b>Total out of 12</b>
Black Sea Bass	1	0	1	0	0	0	0	0	0	0	0	0	2
Blue Crab	1	1	1	1	1	1	1	1	1	1	1	1	12
Scup	1	0	1	1	1	1	0	0	1	0	1	0	8
Spider Crab	1	1	1	1	0	0	1	0	0	1	0	1	7
Tautog	1	1	1	0	0	0	0	0	0	0	0	0	3
Summer Flounder	0	1	1	0	0	1	1	0	1	0	0	0	5
Green Crab	0	0	0	1	0	0	0	0	1	0	0	0	2

**APPENDIX**

<b>AUGUST</b>	<b>Site</b>												
<b>Species</b>	Rocky Point	Conimicut Pt.	Mussachuck Creek	Gaspee Pt.	Rock Island	Pawtuxet Cove	Narragansett Terrace	Sabin Pt.	Sabin Pier	Stillhouse Cove	Fields Pt.	Watchemoket Cove	<b>Total out of 12</b>
Scup	1	1	0	0	0	0	0	0	0	0	0	0	<b>2</b>
Spider Crab	1	1	1	1	1	1	1	1	1	1	1	0	<b>11</b>
Striped Searobin	1	1	0	0	0	0	1	1	1	0	0	0	<b>5</b>
Tautog	1	1	1	1	1	0	1	0	0	1	0	1	<b>8</b>
Oyster Toadfish	0	1	0	0	0	1	0	0	1	0	1	0	<b>4</b>
Summer Flounder	0	0	1	0	0	1	0	0	0	0	0	0	<b>2</b>
Blue Crab	0	0	0	0	1	0	1	1	0	0	1	0	<b>4</b>
Green Crab	0	0	0	0	0	0	0	0	1	0	0	0	<b>1</b>
Horseshoe Crab	0	0	0	0	0	0	0	0	0	0	1	0	<b>1</b>

<b>SEPTEMBER</b>	<b>Site</b>												
<b>Species</b>	Rocky Point	Conimicut Pt.	Mussachuck Creek	Gaspee Pt.	Rock Island	Pawtuxet Cove	Narragansett Terrace	Sabin Pt.	Sabin Pier	Stillhouse Cove	Fields Pt.	Watchemoket Cove	<b>Total out of 12</b>
Rock Crab	1	1	0	0	0	0	0	0	0	0	0	0	<b>2</b>
Spider Crab	1	1	1	0	0	0	1	0	0	0	0	0	<b>4</b>
Black Sea Bass	0	0	1	0	0	0	0	0	0	0	0	0	<b>1</b>
Green Crab	0	0	1	0	0	0	0	0	0	0	0	0	<b>1</b>
Blue Crab	0	0	0	1	1	1	0	0	0	1	1	0	<b>5</b>
Oyster Toadfish	0	0	0	0	0	0	1	1	1	0	0	0	<b>3</b>
Tautog	0	0	0	0	0	0	0	0	0	0	0	1	<b>1</b>

<b>OCTOBER</b>	<b>Site</b>												
<b>Species</b>	Rocky Point	Conimicut Pt.	Mussachuck Creek	Gaspee Pt.	Rock Island	Pawtuxet Cove	Narragansett Terrace	Sabin Pt.	Sabin Pier	Stillhouse Cove	Fields Pt.	Watchemoket Cove	<b>Total out of 12</b>
Black Sea Bass	1	0	1	0	0	0	0	1	1	0	0	1	<b>5</b>
Northern Puffer	1	0	0	0	0	0	0	0	0	0	0	0	<b>1</b>
Spider Crab	1	1	0	1	1	0	0	0	0	1	0	0	<b>5</b>
Blue Crab	0	1	0	1	0	1	0	0	0	1	1	1	<b>6</b>
Scup	0	1	0	1	0	0	1	0	1	1	0	1	<b>6</b>
Oyster Toadfish	0	0	0	0	1	0	1	0	1	1	0	1	<b>5</b>

**PERFORMANCE REPORT**

**STATE:** Rhode Island

**PROJECT NUMBER:** F-61-R  
**SEGMENT NUMBER:** 21

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

**PERIOD COVERED:** January 1, 2022 - December 31, 2022

**JOB NUMBER AND TITLE:** V: Holistic Fish Habitat Assessment and Fish Productivity Estimations; Part D: Eelgrass Monitoring and Productivity Assessment

**STAFF:** Pat Barrett (Fisheries Specialist), Eric Schneider (Principal Biologist), and Conor Mcmanus (Deputy Chief) RI DEM, Div. of Marine Fisheries

**JOB OBJECTIVE:**

The goal of this project is to estimate production of recreationally important fish species by eelgrass habitat different areas in Rhode Island waters. We will address this goal with following objectives:

- (1) Use standardized sampling approaches to quantify attributes of eelgrass habitat and measure abundance of finfish and invertebrates at targeted sampling locations.
- (2) Use eelgrass, fisheries, and environmental data collected to produce estimates of production for recreationally important finfish at targeted sampling locations.

**TARGET DATE:** 12/31/2021

**SUMMARY:** This report summarizes project activities conducted between January 1 and December 31, 2022. During this period, we selected a total of 12 eelgrass sites between Fort Wetherill and Quonochontaug Pond to monitor and collect estimates benthic and fish community biomass that will be used in combination with other metrics to quantify the increase in production of sportfish at eelgrass sites compared to habitat controls.

**RECOMMENDATIONS:**

The non-invasive methods used to collect eelgrass morphometrics as described in Neckless et al 2012, was successful and proved to be time efficient since all measurements were collected in the field. We recommend continuing this method for all eelgrass canopy height, shoot density, and percent cover estimates. Hobo pendant replacement light loggers were redeployed at the 4 sites during the 2022 season.

**INTRODUCTION:**

Species of submerged aquatic vegetation (SAV), including Eelgrass (*Zostera marina L.*), perform several ecological functions, including chemical cycling, sediment stabilization, structural modifications of the water column, as well as provide critical habitat for marine life (Dennison et al. 1993; Fonseca 1996, Havel and ASMFC Habitat Committee 2018). Several recreationally important finfish species found in RI utilize eelgrass beds for refugia and foraging, including tautog, black seabass, striped bass, summer flounder, and winter flounder (Kritzer et al. 2016, Laney 1997). Although widely recognized as a both a sensitive and critical habitat for marine fish, studies that quantify fish productivity of SAV beds (in Nordlund et al. 2019) and responses of fish communities to changes in eelgrass bed size and health (e.g., Hughes et al. 2002, McCloskey and Unsworth 2015) have not focused on areas in the temperate northeast. Developing production estimates of recreationally important fish species for eelgrass habitat in Rhode Island waters will provide a quantitative metric for comparison with other important habitats (e.g., kelp, artificial reef, and oyster reef), as well as further information regarding the need for protecting this critical resource.

### **APPROACH:**

#### *Activities addressing Objective 1:*

The approach will be similar to the dive transect survey methodologies proposed for kelp and artificial reefs, and comparable to oyster reefs. During 2022 we will use existing eelgrass habitat maps, combined with field survey work to identify two (2) targeted sampling locations (sites), one (1) near the mouth of Narragansett Bay for potential comparison with kelp bed survey sites, and one (1) in a coastal pond for potential comparison with FHE oyster reefs. Each site will have two (2) to four (4) transects, each separated by at least 100m, sampled annually between July and September, during peak biomass, to ensure a good site-level description of the community. Treatment sites should have continuous eelgrass beds, whereas control sites should not have eelgrass or complex structure present. All sites should have one temperature/light loggers (Hobo Onset 64K Pendant Loggers UA-002-64) placed within the site, set to collect data every 30 minutes.

We expect to address the same 5 components (Quadrat, Uniform Point Count, Swath, Fish Counts, and Morphometrics) as in kelp. Five sampling methodologies are used along each transect were the same as the kelp methods (See Section 5A) with the exception that quadrats for the eelgrass survey will be 0.25m<sup>2</sup> and the morphometrics. For eelgrass morphometrics the transect, divers should swim and take selected morphometric measurements described in Neckles et al 2012 every 4 meters (n=10 plots transect). At each plot a 0.25m quadrat is placed, the percent coverage is estimated and eelgrass shoot density is estimated by direct counts of all shoots rooted within the entire quadrat. Transects will still be 40m in length and should run roughly parallel to shore following a depth contour line between 2-5m.

#### *Activities addressing Objective 2:*

##### *Analytical Approach*

The Uniform Point Count (UPC) survey data was distilled into two categories, substrate and biological cover. The percent substrate for each transect was calculated by multiplying the



number of substrate counts per substrate type by the total number of counts per transect (n=80). Biological percent cover is presented as the mean  $\pm$  SE for each site (Fort Wetherill and Quonochontaug Pond) and grouped by habitat type (Eelgrass or Control). The mean percent cover of algae and sessile inverts were used to calculate species richness and diversity, using both the abundance of unique species and the Shannon's H index of diversity respectively. Eelgrass and invertebrate densities were determined using the quadrat and swath datasets. The quadrat dataset was used primarily to estimate eelgrass percent cover, shoot density, and canopy height, as well as invertebrates present in the quadrats. For each transect, a mean,  $\pm$  SE, was calculated in order to present a more precise estimate of the overall transect eelgrass, or invertebrate, density. The swath dataset was used to count the total abundance of rare or less uniformly distributed sessile and mobile invertebrates species. For both the quadrat and swath methods, the average quadrat density or total abundance within the swath were standardized per meter squared. To compare how invertebrate densities differed between the habitat treatments (e.g., Control and Eelgrass) we present the average invertebrate density per meter squared, summarized for each site (Fort Wetherill and Quonochontaug Pond) and grouped by survey method (Quad or Swath). Using the fish count survey data, we converted abundance at estimated length, to total fish mass per transect, using the DMF age and growth lab data to convert fish length in cm, to weight in grams. For our target we used RI specific allometric growth models,  $W = \alpha * L^\beta$  (where W = weight, L = length, and alpha and Beta are constants). For species not currently dissected in our growth lab, we used the geometric mean alpha and beta coefficients presented on Fishbase.org. To compare total fish biomass between our eelgrass and control, we then standardized the total fish mass by dividing the total area surveyed, to get grams per meter squared. For the two years since the begging in of the King's Beach site, we present total fish biomass per habitat treatment,  $\pm$  SE, grouped by region (e.g., Narragansett Bay and Coastal Ponds). We then proceeded to estimate the effect size of the eelgrass habitat with respect to the control sites for each eelgrass region using the average fish biomass and standard deviation for each habitat size using the "effsize" package in R (R Core Team 2021).

In 2022, we began preliminary modeling efforts looking at the impact of eelgrass density on the observed biomass of finfish, using a simple linear regression model to predict fish biomass as a function of increasing eelgrass density. We present observed fish biomass and eelgrass density data and the significant linear relationship as well as 95% confidence interval obtained resampling the data points via bootstrap methods. We resampled the data 1000 times, each time refitting a new linear model of fish biomass  $\sim a * \text{eelgrass density} + b$ . We then used the 97.5 and 2.5 quantiles of the slope and intercept to represent the 95 % CI interval around those predictions. Linear regression models and mean biomass effect sizes were also summarized for other three habitats monitored in the greater Job5 assessment (5A, Kelp; 5D Eelgrass; 5C Oyster) for the 2020 – 2022 field seasons when applicable.

## **RESULTS:**

In 2022, the eelgrass monitoring team completed activities relating to objective one by setting up 2 eelgrass monitoring sites, one in Quonochontaug Pond and the other in Jamestown, RI (Figures 1 and 2). Each location containing 4 eelgrass transects and 2 control transects. These locations were chosen to represent the Coastal Pond and Narragansett Bay Regions and will be used to compare fish productivity between one another as well as kelp and oyster reef habitat contained

within those respective regions (Kelp in Narragansett Bay and Oysters in Quonochontaug Pond). All eelgrass transects were selected based off of specific knowledge of these regions as well as at least one confirmed observation from the SAV ariel surveys (2006, 2009, 2016). Control transects were also identified through the same process, thus these locations could contain eelgrass but the percent cover is less than 10%. In 2022, we completed 12 dives to monitor eelgrass habitat in RI waters. During the 2022 season, 4 temperature and light loggers were deployed. Different loggers will be purchased and deployed during the 2022 season field season.

We found the substrate conditions at each eelgrass sites (e.g. Fort Wetherill and Quonochontaug Pond) to be quite different based on the regions they reside in (Narragansett Bay and Coastal Ponds). The most evident difference between the two eelgrass regions is that the substrate in the Coastal Ponds contained mostly mud and more fluid sediments where as the Narragansett bay eelgrass sites were mostly sand and coble with sections of small boulders. In 2022, the average proportion of boulders (large, medium, and small combined) was approximately 4.33% at the Fort Wetherill eelgrass sites only and 0.16% percent at the coastal pond eelgrass transects (Figure 3). In 2021, the percent cover of eelgrass continued to be numerically 4 % greater at the Quonochontaug Pond (89.38%) sites compared to those at Fort Wetherill (85.62%), but in 2022 percent cover was numerically greater in Fort Wetherill (81%) than in Quonochontaug Pond (71%) (Figure 4). In the absence of eelgrass, at our control locations (where eelgrass was less than 2.5% percent on average), we found very little algae. In both the coastal ponds and the bay, in the absence of eelgrass we mostly saw brown algae mats and *Gracillaria* sp. at low percent cover as well as mantis shrimp burrows in the softer sediment in Quonochontaug Pond (Figure 4). In 2022, the algae and invertebrate species richness was highest at the eelgrass sites regardless of region, but diversity was greater on the on the eelgrass sites in the coastal ponds (Table 1).

The major differences between the eelgrass quadrats and swaths varied by region but were mostly driven by the epiphytic organisms that were present on the blades of eelgrass. In eelgrass beds we saw a much higher percent of sponges and tunicates (Figure 5 & 6). Opposite of 2021, in 2022 we found that Fort Wetherill quahog density was greater than the coastal ponds, with 3.5 ind./m<sup>2</sup> compared to 0.33 in the pond (Figure 5), which is greater bay average of 0.8 ind./m<sup>2</sup>. We found a higher density of crepidula across both the control and eelgrass sites in Fort Wetherill (658.66 ± 516 and 239.33 ± 18.99) relative to the coastal ponds (0 and 10 ind./m<sup>2</sup>).

Quonochontaug is a lower energy environment than Fort Wetherill and is comprised of finer substrate creating a more suitable habitat for burrowing mantis shrimp, which averaged (0.33 ± 0.33 ind./m<sup>2</sup>) (Figure 6). We found the average 2022 eelgrass shoot density to vary by transect location, but on average were fairly similar, but greater at Fort Wetherill for the first time since the survey started (Figure 7). Within the two regions, eelgrass shoot density varied by transect locations, ranging from 34 ± 11.16 – 160.18 ± 18.33 in Narragansett Bay and 41.33 ± 8.92 – 78.67 ± 13.84 in the Coastal Ponds (Table 2). In both 2020 and 2021, we found that both the mean fish biomass per meter squared of eelgrass habitat as well as the effect size of the eelgrass transects relative to the controls to be larger in the coastal pond region at the Quonochontaug Pond transect; however, in 2022 the effect size was greater at Fort Wetherill (Figure 8 and Table 3). In 2022, the effect size of eelgrass in the coastal ponds was over 4 times larger (2.39 ± 1.22 in the ponds and only 0.43 ± 0.86 in the bay) but as density of eelgrass decline in the ponds relative to the bay, we found that in 2022 the effect of eelgrass on fish biomass was numerically greater in the bay than the coastal ponds for the first time since 2020 (Table 3). In our preliminary

regression analyses comparing the rates at which each habitat enhances fish biomass per unit area, we found all habitats to positively correlate with increasing fish biomass, but the rate at which biomass increased, as well as total fish biomass was greatest at the kelp sites, compared to the eelgrass. (Figure 9). Comparing the effect sizes between each habitat and their respective controls, we found the 2022 effect size for eelgrass in the coastal pond to be the highest, whereas the bay eelgrass sites were lowest. Aside from the 2021 eelgrass sites in Quonochontaug Pond, we found the kelp sites typically have the greatest effect, then oyster and artificial reefs, the eelgrass (Table 3).

## **DISCUSSION:**

Across the globe, there has been an accelerating rate of decline of seagrass meadows. Waycott et al. 2009, found that this rate was greater than that of the Amazon Rain forests and comparable to the rate of mangrove loss of -1.6 per year. As nursery seagrass habitats, like *Zostera marina*, continue to decline, our coastal ecosystems will be negatively impacted through the loss of services and enhanced fisheries production (Blandon et al 2014). Through this project we establish a long-term eelgrass and fish productivity dataset for RI, as well as track how changes in eelgrass density impact the community assemblage around them. In our second year of the survey we found that eelgrass in the coastal ponds continue to have one of the strongest effect on the fish biomass estimates regardless of region and habitat type. As the dataset continues to grow and more environmental parameters are added to the analyses we can more accurately address what factors may be driving the differences we observed. We acknowledge that there are often unique habitat associated fish-assemblages and that more target, species-specific analyses, may be required to establish how fish production differs by between eelgrass locations and other habitat types (e.g. Eelgrass and Kelp; Furness et al 2021). Landscape setting will also be important to consider, as the ecosystem function of eelgrass may differ depending on the its proximity to different habitats. For example, the eelgrass transects in Narraganset Bay are in deeper water and in close proximity to kelp locations that had the highest effect size across all habitat types, but in a more nursery setting of coastal ponds, we found that the eelgrass beds had a much stronger impact on the finfish community around them.

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Figure 1: Eelgrass fish productivity transect locations for the Coastal Pond eelgrass region. Green circles denote eelgrass transects and grey circles are controls. Green map layers represent eelgrass layers identified during SAV mapping projects that took place from 2006-2016.



Figure 2: Eelgrass fish productivity transect locations for the Narragansett Bay eelgrass region. Green circles denote eelgrass transects and grey circles are controls. Green map layers represent eelgrass layers identified during SAV mapping projects that took place from 2006-2016. One additional control site, not pictured, is located further north located near the Jamestown Marina.

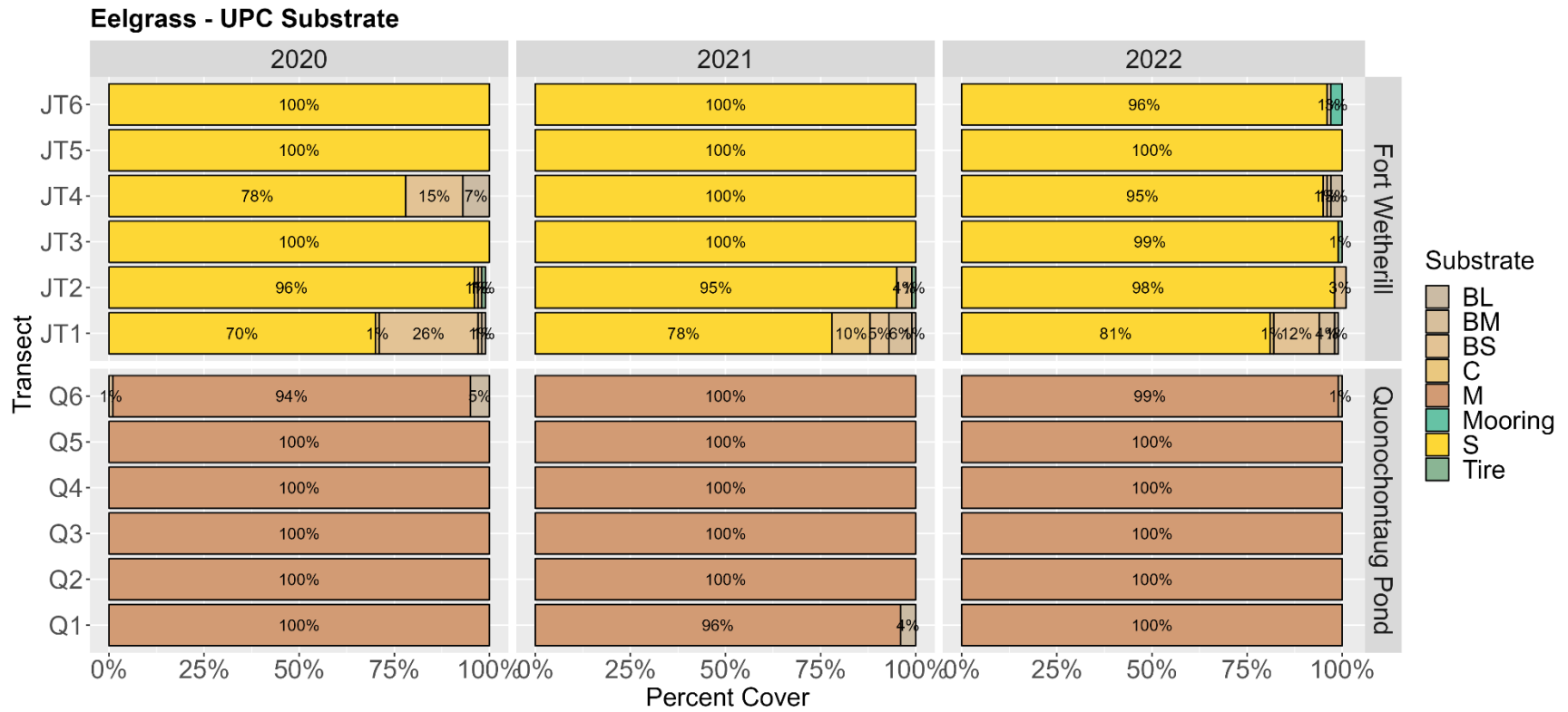


Figure 3. Percent cover of substrate along the y-axis plotted for each transect along the x-axis, for each 2020 - 2022 fish productivity Eelgrass survey. Percent cover is faceted by year and site (Fort Wetherill and Quonochontaug Pond), grouped by substrate type (BL = boulder large, BM = boulder medium, BS = boulder small, C= cobble, M = mud/fines, M\_S = sandy mud mix, S = Sand)

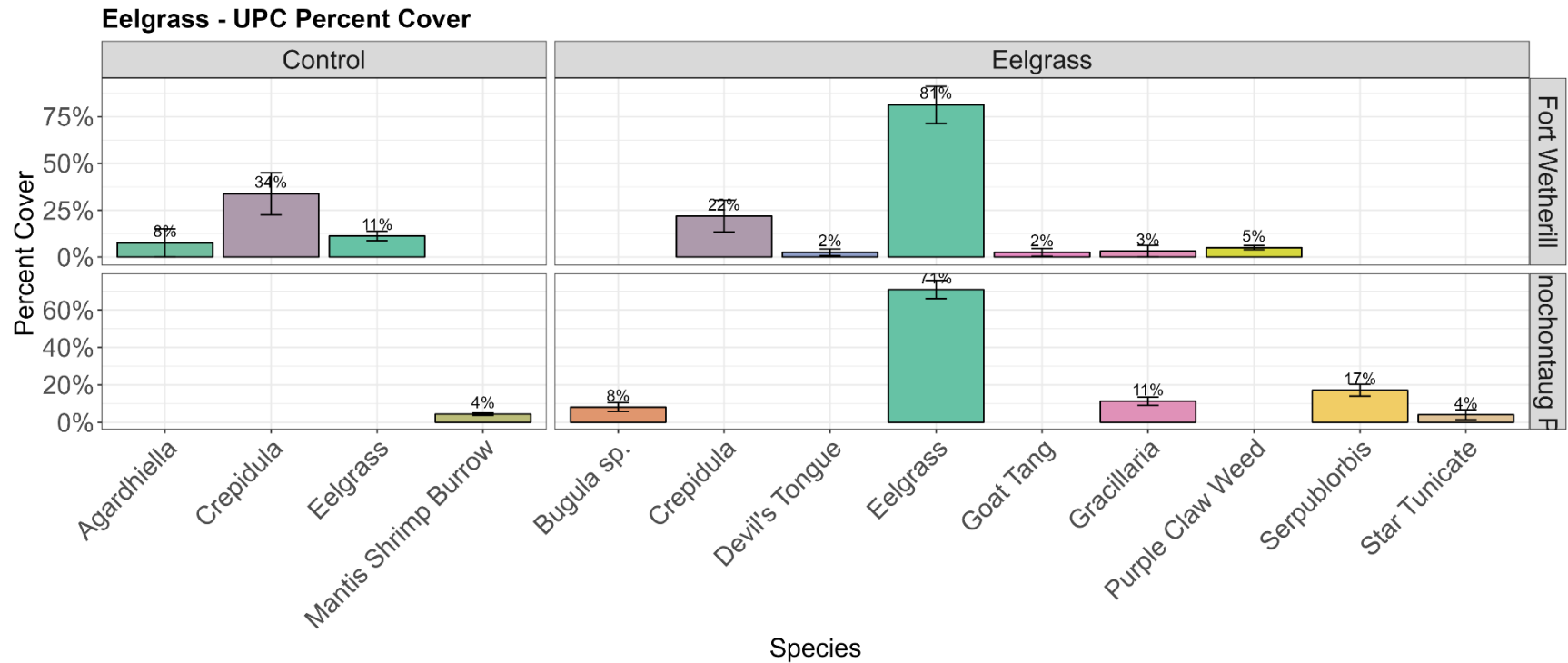


Figure 4. Mean algal and sessile invertebrate cover  $\pm$  SE, for each site (Fort Wetherill and Quonochontaug Pond) and habitat type (Eelgrass or Control) during the 2021 eelgrass productivity uniform point count survey.



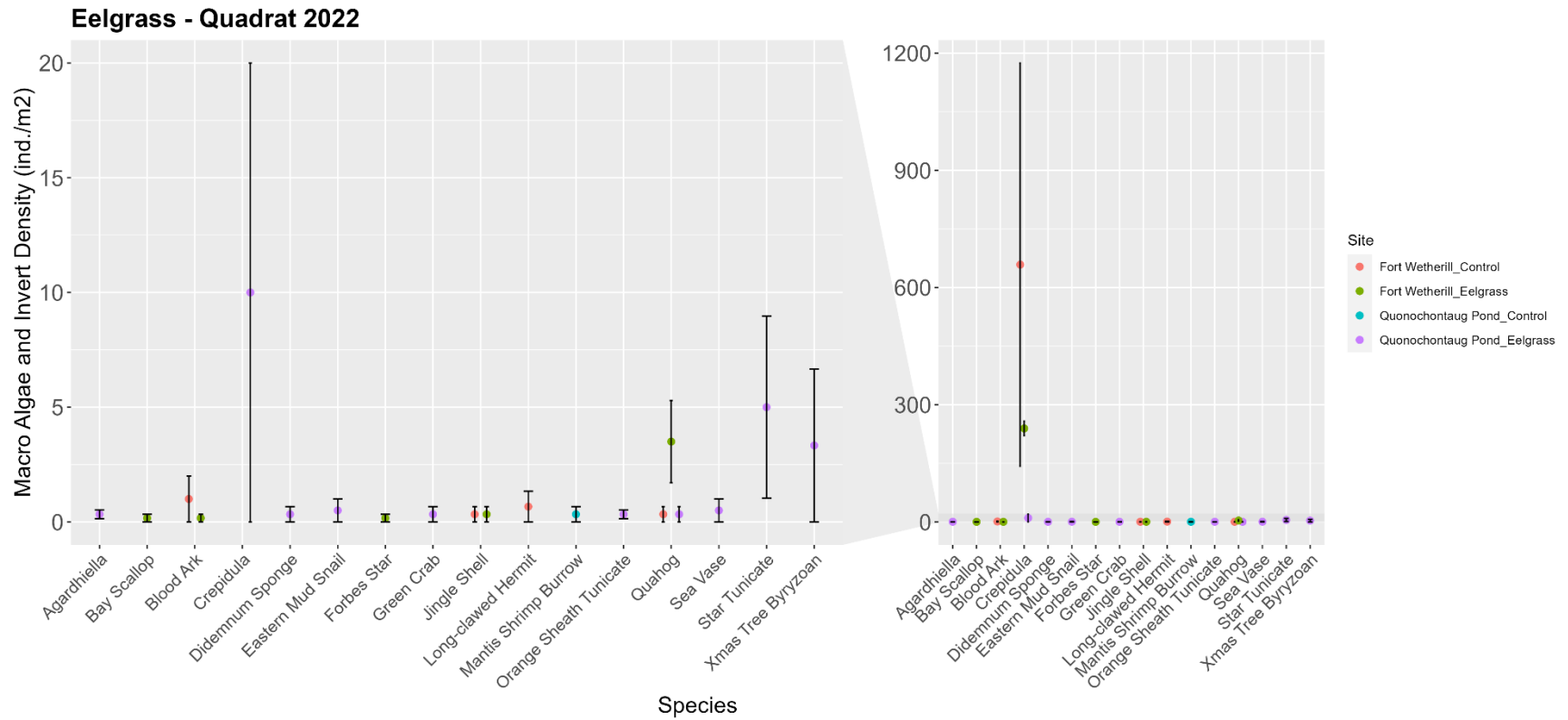


Figure 5. Mean invertebrate and macro algae density  $\pm$  SE, for each species identified on the 2022 eelgrass productivity quadrat survey, faceted by habitat treatment (Control, Eelgrass) and site (Forth Wetherill and Quonochontaug Pond).

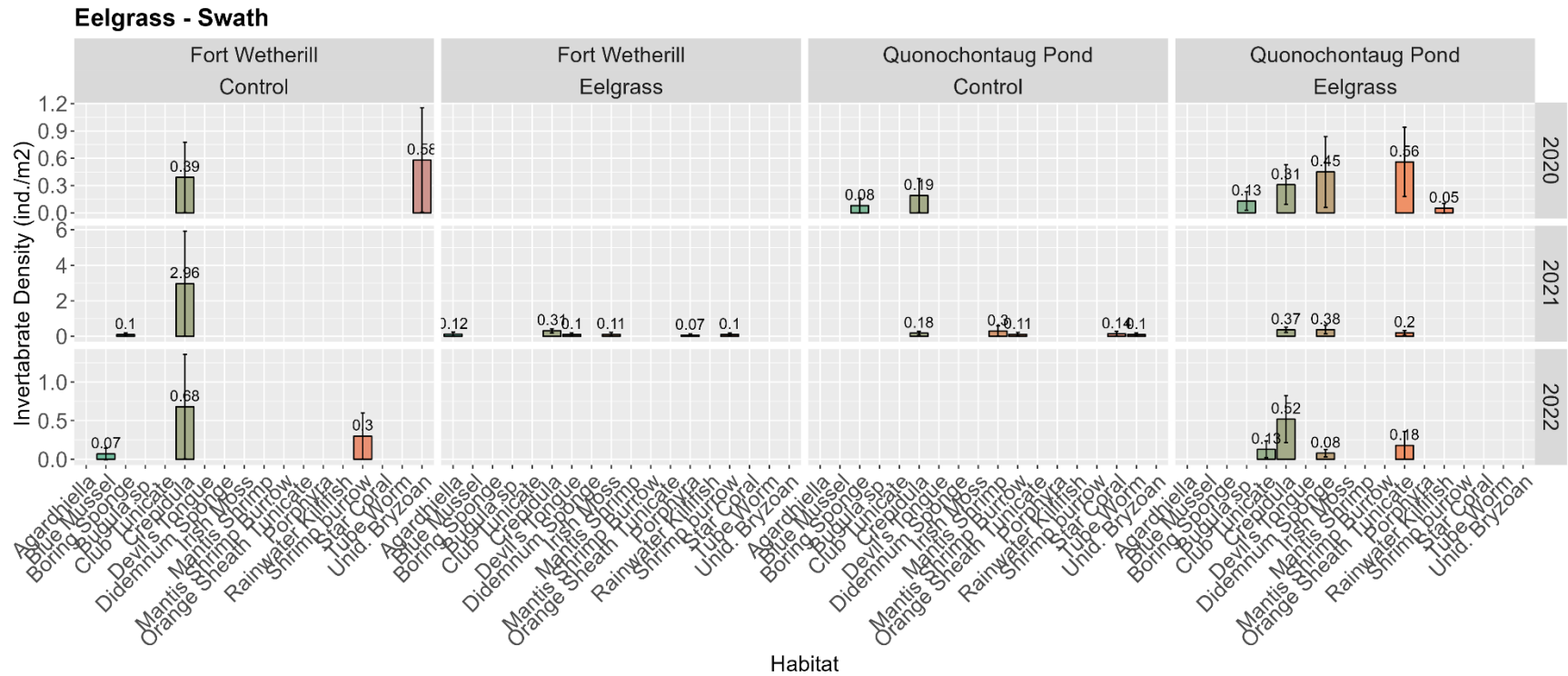


Figure 6. Mean invertebrate and macro algae density  $\pm$  SE, for each species identified on the 2020-2022 eelgrass productivity swath survey, faceted by habitat treatment (Control, Eelgrass) and site (Forth Wetherill and Quonochontaug Pond).

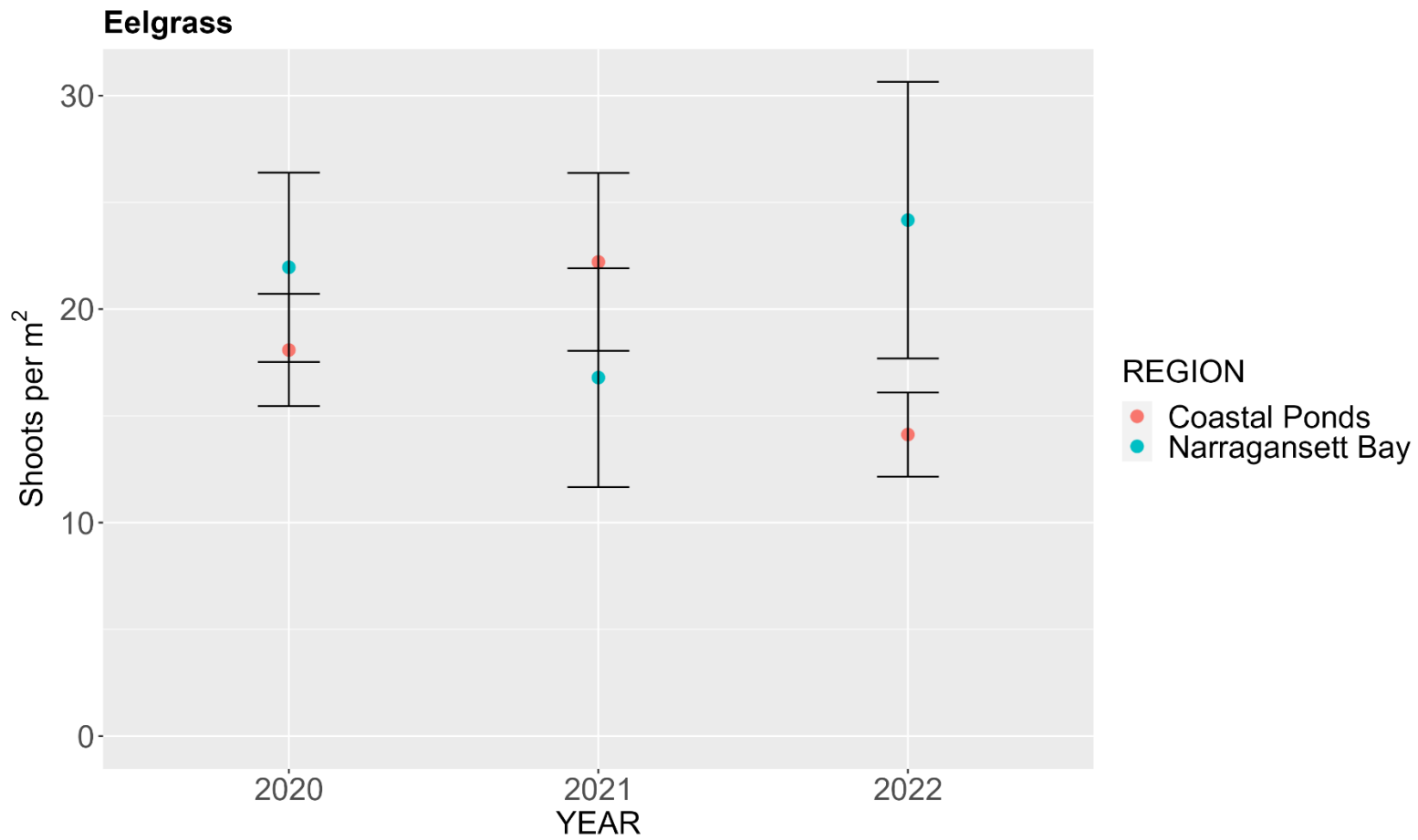


Figure 7. Eelgrass shoot density (y-axis), by mean density (x-axis),  $\pm$  SE, by year and each eelgrass productivity region (Coastal Ponds = Red, Narragansett Bay = Blue).

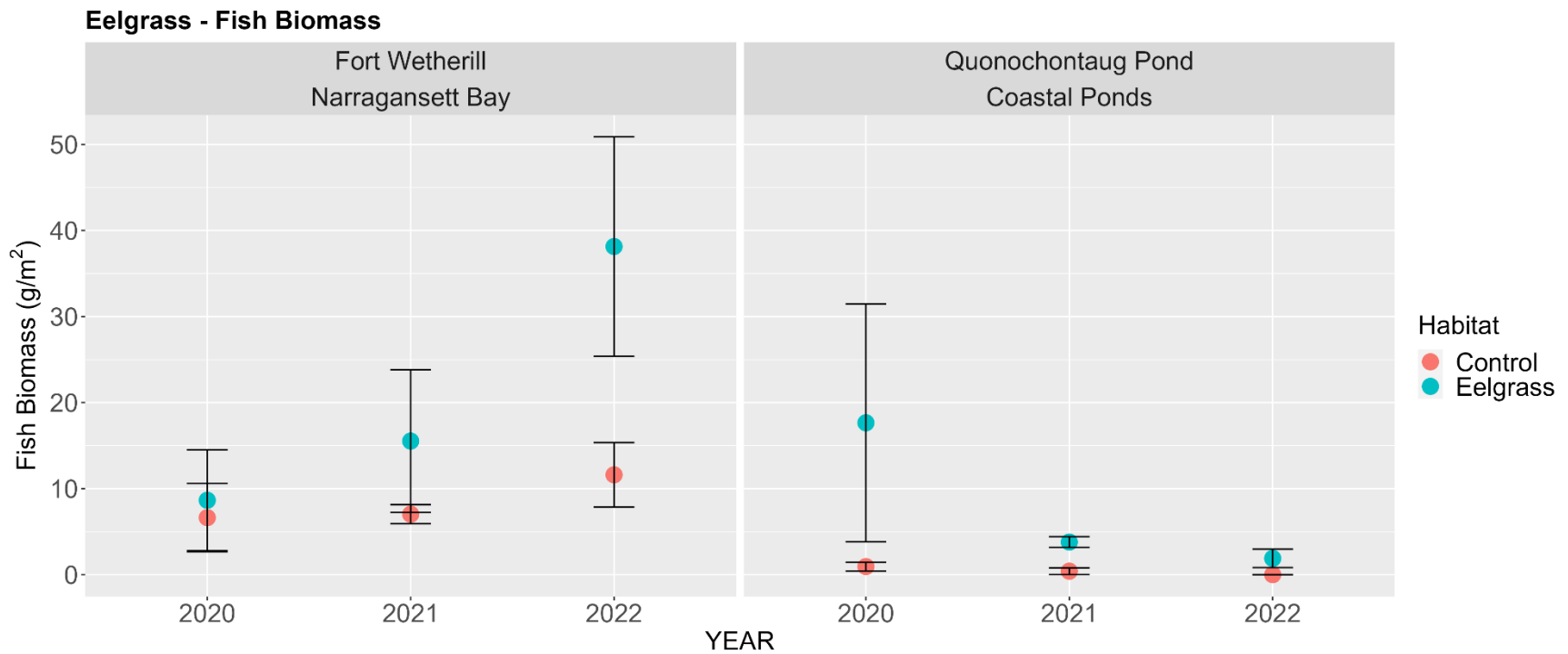


Figure 8: Mean fish biomass ( $\text{g/m}^2$ ) estimates for the Eelgrass productivity fish count survey grouped by habitat treatment (Control = Red, and Eelgrass = Blue) and year for each site (Fort Wetherill, left panel; Quonochontaug Pond, right panel). Fish biomass is standardized per meter squared and presented as the average biomass  $\pm$  SE, for each habitat treatment

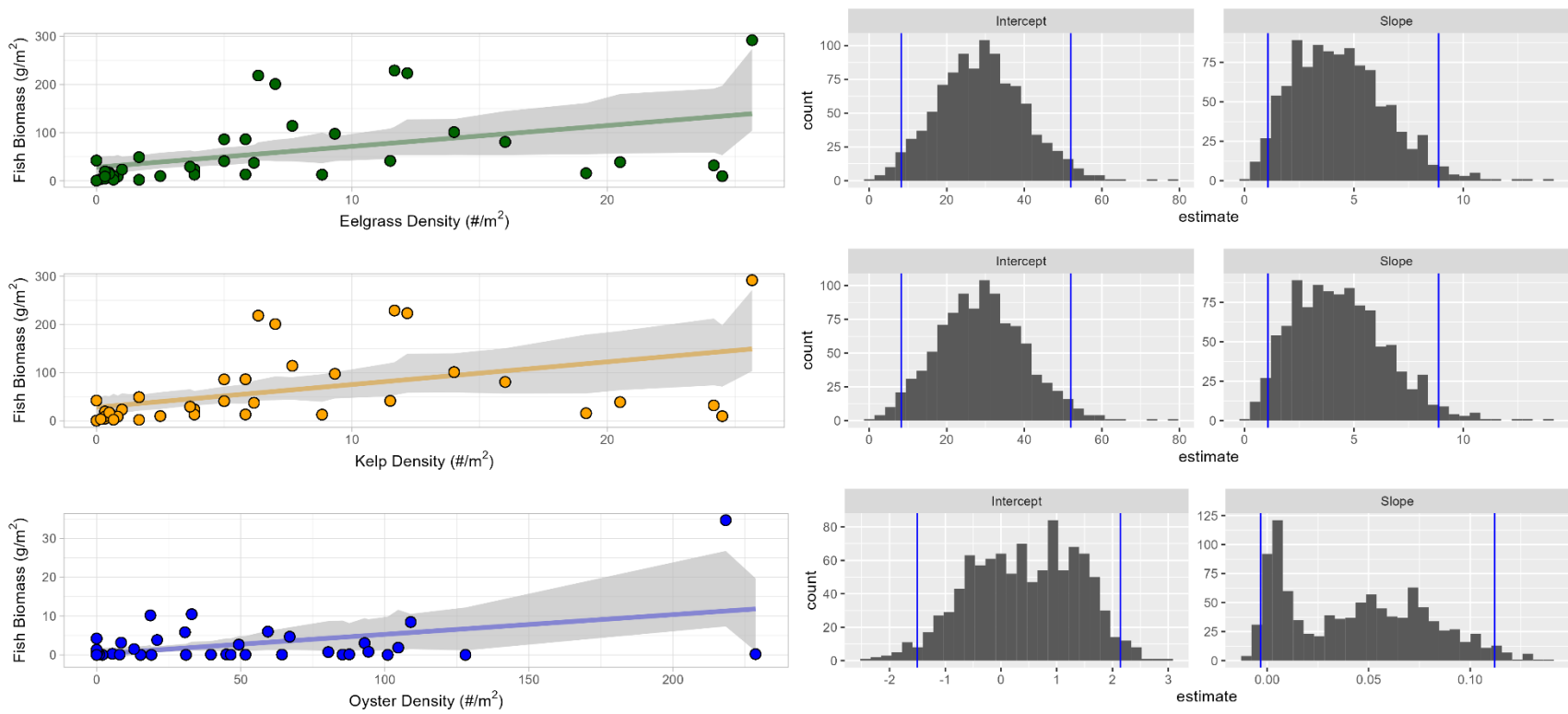


Figure 9: Mean fish biomass ( $\text{g/m}^2$ ) as a function of increasing habitat density for each of the habitat forming species in Job 5 (Eelgrass = green (top row); Kelp = orange (middle row); Oyster = blue (bottom row)). Linear regression models plotted with 95% CI estimated from 1,000 bootstrap samples for the 2020-2022 fish productivity dive surveys. The slope and intercept estimates from the 1,000 bootstraps samples are plotted next to their respective model with blue lines indicating the 95% CI of the estimates themselves.

Table 1: Algae and Sessile Invertebrate species richness and diversity calculated from the uniform point count transect method for the 2020 - 2022 Eelgrass surveys. These estimates only characterize the richness and diversity of species that adhere to the substrate or habitat and does not include mobile inverts or finfish.

YEAR	REGION	SITE	HABITAT	R	H
2020	Coastal Ponds	Quonochontaug Pond	Eelgrass	8.25 ± 1.11	1.25 ± 0.1
2020	Narragansett Bay	Fort Wetherill	Eelgrass	7.25 ± 0.85	0.87 ± 0.16
2021	Coastal Ponds	Quonochontaug Pond	Eelgrass	8.25 ± 0.95	1.22 ± 0.11
2021	Narragansett Bay	Fort Wetherill	Eelgrass	5.75 ± 0.63	0.96 ± 0.14
2022	Coastal Ponds	Quonochontaug Pond	Eelgrass	7.5 ± 0.5	1.31 ± 0.07
2022	Narragansett Bay	Fort Wetherill	Eelgrass	8.5 ± 1.55	1.21 ± 0.13

Table 2: Eelgrass Morphometrics table. Mean percent cover (%), shoot density (#/m<sup>2</sup>), and canopy height (cm), ± se, for each 2020 - 2022 eelgrass productivity transect.

DATE	REGION	SITE	TRANSECT	n	Percent Cover	Shoot Density (ind./m2)	Canopy Height (cm)
2020-09-14	Narragansett Bay	Fort Wetherill	FW JT1	6	61.67 ± 16.87	124 ± 35.57	67.5 ± 14.3
2020-09-14	Narragansett Bay	Fort Wetherill	FW JT2	6	30.83 ± 5.69	42 ± 6.26	79 ± 5.72
2020-09-15	Narragansett Bay	Fort Wetherill	FW JT3	6	0 ± 0	0 ± 0	0 ± 0
2020-09-16	Narragansett Bay	Fort Wetherill	FW JT6	6	0 ± 0	0 ± 0	0 ± 0
2020-09-16	Narragansett Bay	Fort Wetherill	FW JT4	6	19.17 ± 5.39	80 ± 17.22	61 ± 10.5
2020-09-16	Narragansett Bay	Fort Wetherill	FW JT5	6	86.67 ± 13.33	105.33 ± 14.15	73.33 ± 8.43
2020-09-28	Coastal Ponds	Quonochontaug Pond	Q1	6	0 ± 0	0 ± 0	0 ± 0
2020-09-28	Coastal Ponds	Quonochontaug Pond	Q2	6	80 ± 12.65	97.33 ± 15.65	55 ± 5.05
2020-09-28	Coastal Ponds	Quonochontaug Pond	Q3	6	50.83 ± 13.81	79.33 ± 12.79	43.67 ± 4.7
2020-09-29	Coastal Ponds	Quonochontaug Pond	Q4	6	0 ± 0	0 ± 0	0 ± 0
2020-09-29	Coastal Ponds	Quonochontaug Pond	Q5	6	29.17 ± 6.88	48 ± 6.61	54.67 ± 5.49
2020-09-29	Coastal Ponds	Quonochontaug Pond	Q6	6	43.33 ± 14.59	64.67 ± 10.45	48.33 ± 2.76
2021-09-16	Coastal Ponds	Quonochontaug Pond	Q5	6	77.5 ± 4.23	77.33 ± 4.34	51.67 ± 2.11
2021-09-16	Coastal Ponds	Quonochontaug Pond	Q6	6	55 ± 8.27	76 ± 8	60 ± 4.65
2021-09-17	Narragansett Bay	Fort Wetherill	FW JT3	6	0 ± 0	0 ± 0	0 ± 0
2021-09-17	Narragansett Bay	Fort Wetherill	FW JT2	6	40 ± 8.56	53.33 ± 10.86	76.67 ± 7.92
2021-09-18	Narragansett Bay	Fort Wetherill	FW JT4	6	30 ± 4.28	52 ± 7.45	0 ± 0
2021-09-18	Narragansett Bay	Fort Wetherill	FW JT4	6	0 ± 0	0 ± 0	41.67 ± 6.15
2021-09-18	Narragansett Bay	Fort Wetherill	FW JT5	6	56.67 ± 13.27	66 ± 10.21	55.83 ± 9.95
2021-09-28	Coastal Ponds	Quonochontaug Pond	Q1	6	0 ± 0	0 ± 0	0 ± 0
2021-09-28	Coastal Ponds	Quonochontaug Pond	Q2	6	85 ± 7.96	138 ± 29.84	34.17 ± 3.96
2021-09-28	Coastal Ponds	Quonochontaug Pond	Q3	6	35.83 ± 14.34	64 ± 11.27	23.33 ± 4.01
2021-09-30	Narragansett Bay	Fort Wetherill	FW JT6	6	0 ± 0	0 ± 0	0 ± 0
2021-09-29	Coastal Ponds	Quonochontaug Pond	Q1	6	0 ± 0	0 ± 0	0 ± 0
2021-09-29	Coastal Ponds	Quonochontaug Pond	Q4	6	0 ± 0	0 ± 0	0 ± 0
2021-09-30	Narragansett Bay	Fort Wetherill	FW JT6	6	0 ± 0	0 ± 0	0 ± 0
2021-09-30	Narragansett Bay	Fort Wetherill	FW JT1	6	63 ± 13.01	123.33 ± 28.2	46.67 ± 4.01
2022-10-18	Coastal Ponds	Quonochontaug Pond	Q1	6	0 ± 0	0 ± 0	0 ± 0
2022-10-18	Coastal Ponds	Quonochontaug Pond	Q2	6	65.83 ± 16.15	41.33 ± 8.92	31.67 ± 5.11
2022-10-18	Coastal Ponds	Quonochontaug Pond	Q3	6	61.67 ± 13.82	78.67 ± 13.84	38.17 ± 3.42
2022-10-18	Coastal Ponds	Quonochontaug Pond	Q6	6	74.17 ± 10.6	53.33 ± 7.13	27.5 ± 2.5
2022-09-21	Narragansett Bay	Fort Wetherill	FW JT3	6	4.33 ± 4.14	14 ± 13.22	13.33 ± 9.28
2022-09-21	Narragansett Bay	Fort Wetherill	FW JT6	6	0.5 ± 0.34	3.33 ± 2.17	8.67 ± 5.7
2022-09-21	Narragansett Bay	Fort Wetherill	FW JT1	6	18 ± 6.03	88.67 ± 26.8	40 ± 9.92
2022-09-21	Narragansett Bay	Fort Wetherill	FW JT2	6	25.17 ± 9.85	104 ± 35.07	55.83 ± 4.36
2022-09-21	Narragansett Bay	Fort Wetherill	FW JT4	6	5 ± 3.09	34 ± 11.16	29.17 ± 9.35
2022-09-21	Narragansett Bay	Fort Wetherill	FW JT5	6	63.33 ± 14.7	160 ± 18.33	58.33 ± 6.41
2022-09-27	Coastal Ponds	Quonochontaug Pond	Q4	6	0 ± 0	0 ± 0	0 ± 0
2022-09-27	Coastal Ponds	Quonochontaug Pond	Q5	6	42.5 ± 17.5	52.67 ± 14.69	36.67 ± 8.33

Table 3: Hedge’s G effect size table. Effect size (es) was calculated with average fish biomass and standard deviation from the fish productivity survey estimated for each Habitat type (Eelgrass, Kelp, Oyster, and Artificial Reed) and Region (Providence River, Narragansett Bay, and Coastal Ponds) with respect to the habitat controls for each respective region.

Year	Habitat	Region	es	sample.size	se
2021	Eelgrass	Coastal Ponds	2.3991314	6	1.2245233
2020	Kelp	Narragansett Bay	2.0836088	11	0.7930510
2019	Kelp	Narragansett Bay	1.3460090	10	0.8579268
2020	Oyster	Coastal Ponds	1.3083960	12	0.7267442
2020	AR	Providence River	1.2757619	8	0.7965731
2021	AR	Providence River	1.1168801	8	0.7765997
2021	Kelp	Narragansett Bay	1.0921858	11	0.7233241
2022	Eelgrass	Narragansett Bay	0.9546185	6	0.9320185
2022	AR	Providence River	0.9249625	8	0.7554582
2022	Eelgrass	Coastal Ponds	0.8204236	6	0.9152282
2022	Kelp	Narragansett Bay	0.7158655	11	0.6486318
2021	Oyster	Coastal Ponds	0.6828920	12	0.6835560
2020	Eelgrass	Coastal Ponds	0.5585098	6	0.8891661
2021	Eelgrass	Narragansett Bay	0.4321016	7	0.8478246
2022	Oyster	Coastal Ponds	0.2382767	24	0.4727484
2020	Eelgrass	Narragansett Bay	0.1529409	6	0.8677821
2019	AR	Providence River	-0.7791448	6	0.9105192



**PERFORMANCE REPORT**

**STATE:** Rhode Island

**PROJECT NUMBER:** F-61-R  
**SEGMENT NUMBER:** 21

**PROJECT TITLE:** Holistic Fish Habitat Assessment and Fish Productivity Estimations

**PERIOD COVERED:** January 1, 2022 - December 31, 2022

**JOB NUMBER AND TITLE:** V, Part C: Oyster Monitoring and Productivity Assessment

**STAFF:** Patrick Barrett and Eric Schneider (RI DEM, Div. of Marine Fisheries) and Drs. Randall Hughes and Jonathan Grabowski (Northeastern University)

**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 productivity of young of the year to juvenile 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*).

**SUMMARY:** This report summarizes project activities conducted between January 1 and December 31, 2022. During this period, we continued previously established surveys at fish habitat enhancement (FHE) sites in Ninigret and Quonochontaug Ponds to monitor oyster status and fish abundance, while implementing new survey techniques, using habitat trays and dive transect surveys, to collect estimates of benthic and fish community biomass. These estimates will be used in combination with other metrics to quantify the degree to which FHE restored oyster reefs increase in production of juvenile sportfish.

**TARGET DATE:** December 2024

**RECOMMENDATIONS:**

None

**INTRODUCTION**

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. In Rhode Island, complex shellfish reefs formed by oysters (*Crassostrea virginica*) 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 growing recognition of

the ecological and economic importance of these habitats have led to an increase in the efforts to construct structured habitats, such as oyster reefs (Coen and Luckenback 2000, Brumbaugh et al. 2006).

Previous work in the Mid-Atlantic and Gulf of Mexico found that oyster reefs can increase the growth and survival of juvenile finfish (e.g., Peterson et al. 2003, Emgassen et al. 2016), as well as fish and invertebrate biomass (e.g., Grabowski et al. 2005, Humphries and La Peyre 2015, Ermgassen et al. 2016,) compared to unenhanced habitats. Work conducted from 2014-2019 via a partnership between RI DEM, Div. of Marine Fisheries (DMF), The Nature Conservancy (TNC), and Northeastern University (NU) during the last USFWS Sportfish Restoration (SPR) grant cycle (summarized in RI DEM 2019 F-61 Performance Report, Job 6-B) explicitly explored the response in the abundance and species assemblage of recreationally important finfish species to the creation of Fish Habitat Enhancement (FHE) oyster reefs in Rhode Island. Overall, fish abundances at FHE oyster reefs after reef construction increased relative to the pre-enhancement baseline habitat (Barrett et al. in prep). In addition, specific reef-dwelling species, such as tautog and black sea bass, were observed more frequently at FHE reefs sites compared to unseeded reefs and unenhanced control plots. Additional sampling and analyses are needed to better understand long-term fishery and habitat responses, and quantify the fisheries production provided by the FHE oyster reef habitat created by the previous USFWS SPR work.

## **APPROACH**

### *Site Locations and Experimental Design*

In partnership with Drs. Randall Hughes and Jon Grabowski (NU), we are utilizing oyster reefs created for fish habitat enhancement (hereafter, FHE reefs) to determine if oyster reef construction can be used to improve productivity of young of the year to juvenile 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*). For this evaluation, we are using FHE reefs created using two different, but similar, experimental designs in the coastal ponds of Rhode Island (Figure 1). In Ninigret Pond we had previously created four replicates of three distinct treatments that include a cultch only reef, a seeded reef, and bare plot control, to test the influence of not only enhanced structure (cultch only reefs), but enhanced biomass (seeded reefs), on the abundance of juvenile finfish that utilize these reef habitats. In the fall of 2019, we re-seeded both the cultch only and previously seeded reefs in Ninigret Pond with a new set of Green Hill Pond seed sourced oysters. In Quonochontaug Pond, the goal is to assess whether specific genetic lines (lineage) of oysters contain desirable traits for both fish habitat and reef longevity. To evaluate this effect, we used two 'wild' lineages of oysters, spawned from adults collected from existing populations that will be compared against a commercial strain of oysters (eyed larvae purchased from Aquaculture Research Corporation in Dennis, Massachusetts) commonly used in oyster reef restoration and enhanced projects in RI. The commercial hatchery lineage in Quonochontaug Pond was the same used for all the 2015 Ninigret Pond FHE seeded reefs. The experimental design in Quonochontaug included creating three reefs, each seeded with one oyster lineage, and a bare control plot at three different sites (replicates). In total, there are a 12

sample locations, which is consistent with Ninigret Pond; however, the number of replicates from four to three (Figure 1).

### *Oyster reef monitoring*

Consistent with monitoring conducted at these sites beginning in 2016, reef status was evaluated by monitoring each FHE reef twice a year (May and September) using the Rhode Island Oyster Restoration Minimum Monitoring Metrics and Assessment Protocols (Griffin et al. 2012). At each reef, a 0.25m<sup>2</sup> quadrat was haphazardly placed six times. Using standard cover practices, the percent cover of macroalgae was estimated, then all algae was brushed away to allow for percent cover estimation of benthic substrate. Relief, quadrat height relative to the bottom, was measured by finding the difference between the water depth at the reef edge and the depth from the center of the quadrat. All oysters and dead shell were then excavated from the quadrat. All live oysters and dead oysters per quadrat were counted as well as the presence of boring sponge. The shell height of a sub-sampled of 50 living and 30 recently dead oysters were also measured for each quadrat. Density was calculated for both living and recently dead oysters by multiplying abundance per quarter meter quadrat by 4. All material was then returned to the sampling location so as not to disturb the reef. An additional 30 oysters from each reef are collected for disease and pathological work conducted by the Hughes Lab at NU.

In addition to the standard oyster sampling, mean spat length and density at the time of seeding were collected by averaging a sub sampled of seeded cultch bags provided by the oyster growers during reef construction. This average length and density per bag was then multiplied by the total number of bags deployed per reef, and divided by the total area (m<sup>2</sup>) of the reef to calculate initial seed length and density. These initial seeding density and length measurements are only used during the creation of the oyster growth and mortality curves discussed below.

### *Habitat Trays*

Beginning in 2020, habitat trays were initiated as a new standardized sampling approach to quantify the abundance of finfish and invertebrates at FHE oyster reefs and control sites. Habitat trays were deployed for 30 days at FHE reefs once a year between July and September in 2020, 2021, and 2022. This approach builds on previous work conducted by NU in collaboration with DEM, and summarized in T. Davenport 2022 (PhD Dissertation, in development).

During 2020, 2021, and 2022 habitat trays consisting of plastic bread trays (22" x 26" each, 0.369 m<sup>2</sup>) lined with 1mm mesh, were deployed at FHE reefs and controls sites in Ninigret and Quonochontaug Ponds. Habitat trays deployed at oyster reefs were filled with 5 gallons of recycled oyster shell, whereas trays deployed at control sites were filled with 10 gallons of sand. The additional volume of sand compensated for sand loss during filling and deployment. Once deployed, trays at both locations contained the same volume of material. At each site, trays were placed adjacent to the reef edge to minimize its impact to the intact oyster reef, at one of 4 predetermined random locations (e.g., north, east, south, or west edge of the reef). During 2022, habitat trays were deployed at sites in Ninigret and Quonochontaug Pond on August 9 and 10, respectively. After 30 days trays were collected from each site by a diver at reef sites and pair of divers at control sites. The diver(s) would lift the tray directly up from the substrate, out of the

water, and into a vessel anchored nearby. Once on the vessel, the contents of the trays were transferred to small-mesh sampling bags. Samples were transported to the laboratory and all biological material was separated from the shell and sand. Fish, crabs, and all other macroinvertebrates were separated into separate jars, preserved with Ethyl Alcohol, and stored in a climate-controlled facility until processing.

All samples collected during 2020, 2021, and 2022 were processed at the Grabowski Lab at the Northeastern University Marine Science Center (Nahant, MA). Results for 2020 were reported in last year's performance report. Samples from 2021 and 2022 were processed during 2022 and results are included in this performance report. For each sample jar (e.g., fish, crabs, or other) a subsample of 20 organisms were identified to species (if possible), measured, and weighed to the hundredth of a gram consistent with methods described in summarized in Davenport et al. 2022 (in review). Remaining organisms were counted and total biomass by species at size were extrapolated based on subsamples.

### *Eel Pot and Minnow Trap Survey*

During 2022, we continued the previously conducted fishery survey work, using eelpots and minnow traps, once each month from April through October. Fish pot sampling consisted of setting 2 eel pots and 3 minnow pots connected on a trot line at each site once per month. The pots were soaked (i.e., fished) for 24 hours before hauling. Environmental data such as temperature, salinity, and dissolved oxygen are collected using YSI Professional Plus Multiparameter instrument at each sampling station while hauling gear.

### *Fish Productivity Assessment*

Using methods similar to those used for kelp, artificial reefs, and eelgrass, we conducted dive survey transects at FHE oyster reef and control sites once during mid to late summer (September 2022). To assess fish-habitat linkages at oyster reefs, the monitoring protocol utilized the same 5 dive transect methods outlined above (see Kelp section; 5A). Along each 10m transect a diver placed a 0.25m<sup>2</sup> PVC frame on the bottom (substrate or reef) at each the beginning and end of the transect, and two locations spaced in the middle of the transect on the targeted habitat ( $n = 4$  quadrat per transect). Substrate beneath understory algae was searched, however, neither the substrate nor the organisms attached to it are removed. Due to the complex surface of an oyster reef, divers searched around and between oysters to locate and identify fish and invertebrates that may hide in crevasses. Substrate, reef habitat (i.e., oysters and shell), and organisms will not be removed or captured from the quadrat. The quadrat will remain in place for use in morphometrics. A subset of FHE oyster reefs are surveyed each year, with an expectation that two reefs and one control per site (replicate) in Quonochontaug Pond (9 transects) and at one reef and one control per site in Ninigret Pond (8 transects) will be surveyed annually.

### *Analytical Approach*

Prior to ANOVA analyses, all oyster data were tested for homogeneity of variance and conformance to a normal distribution using a Levine's test and Shapiro Wilks, respectively (Levene's  $p > 0.05$ , Shapiro Wilks  $p > 0.05$ ). Oyster quadrat data that did not meet the

assumptions was log transformed prior to analysis. We present values as mean oyster density and mean shell length  $\pm$  one standard error and set level of significance for all tests at  $p < 0.05$ , unless stated otherwise. All significant differences between the ANOVA factors were denoted using letters derived from Tukey's post hoc tests on the ANOVA models.

Oyster density (ind./m<sup>2</sup>) and mean length (mm) per quadrat were used to calculate a mean oyster density and length value for each oyster restoration reef. To evaluate if oyster density or length differed between monitoring events in Quonochontaug Pond, we used one-way ANOVAs testing the effect of time (monitoring event) on mean density and length per monitoring event. When only the main effects were significant, without a significant interaction, one-way ANOVAs were then run on the individual main effects. Since the treatments were changed during the 2019 re-seeding event in Ninigret Pond, mean density and oyster length for the 2021 season is presented as mean  $\pm$  standard error and grouped by the new treatments (e.g. Green Hill Pond, and Green Hill Pond/Old Hatchery Reef). Before the Ninigret reefs were re-seeding in 2019, we determined the average oyster spat per tote deployed on each reef using the oyster spat on shell subsample collected before the reseeded began. By dividing by the average surface area of the FHE reefs in Ninigret, we were able to determine the oyster density per meter squared for the Fall of 2019 and compared that to the density of oysters that survived until the fall of 2021 to estimate 1<sup>st</sup> year survival of the Green Hill Pond brood stock spawned oysters that were set.

In 2020 we began the first year of post-reseeding fish monitoring at the FHE reef sites in Ninigret and began Year-4 of post-enhancement monitoring in Quonochontaug Pond. A Before-After-Control-Impact (BACI) approach was used to determine how reef construction can impact the fish assemblage, relative species abundance, and juvenile length distributions in the coastal ponds. We specifically assessed how relative species abundance and community assemblages have changed over time between our baseline surveys and up to 3 years post reef construction. For the BACI analysis we derived mean catch per haul by aggregating the number of fish caught per minnow trap plus eel pot haul (herein after, CPUE) and then finding the average CPUE for each month by habitat treatment. For each recreational species of interest, such as Black Sea Bass, Winter Flounder, Tautog, and Cunner, we created a mean CPUE plots from the aforementioned CPUE data, and analysis of augmented YOY abundance when data permitted. Ninigret and Quonochontaug Ponds were analyzed separately for each species.

Substrate and species cover were summarized for each fish habitat productivity transect by using the uniform point count data to derive both a geological and biological percent cover for each dive transect. The total number of observations were summarized for each species or substrate and then divided by the total number of uniform point counts collected along the length of each transect ( $n = 20$ ). We also estimated average species richness and Shannon's Index of diversity. Algae and invertebrate densities were summarized using the quadrat, and swath datasets when applicable, by averaging the total number of observations across all quadrats ( $n=4$ ) within each transect. To evaluate how enhanced oyster habitat compares to the unstructured and natural controls, we calculated the mean density of individuals per meter squared  $\pm$  SE and present the averages grouped by habitat type (e.g. oysters and corresponding controls).

Using the fish count survey data, fish abundance at length was converted to total fish mass per transect by leveraging the DMF age and growth lab data to convert fish length in centimeters, to

weight in grams, for the target sportfish species (i.e. Tautog, Black Sea Bass, Winter Flounder). To do this we used Rhode Island specific allometric growth models. For species not currently dissected in the growth lab, the geometric mean alpha and beta coefficient estimated on Fishbase.org were considered. To compare total fish biomass between the oyster reef enhancement sites and unenhanced controls the total fish mass was standardized by dividing the total area surveyed, to get grams per meter squared. Then we calculated the effect size of the oyster reef with respect to the control sites using the Hedge's *g* computed on the mean biomass per meter square estimates. Hedge's *g* effect size was calculated using the mean values and standard deviations from the mean biomass estimates.

## RESULTS

### *Oyster Reef Performance*

In 2022, we monitored the status of the Fall 2019 FHE reseeded efforts in Ninigret Pond as well as the Spring 2017 FHE seeded reefs in Quonochontaug Pond. In Ninigret Pond the Green Hill Pond oysters used to reseed the FHE reefs exhibited a 57.9% first year survival rate, and a mean density average of 682 and 564 ind./m<sup>2</sup> during the first two monitoring events following reef enhancement (Figure 2). Between spring and fall monitoring events in 2021, density on both the green hill only and the green hill overseeded reefs fell by over 125 ind./m<sup>2</sup> (Figure 2: Ninigret Pond). Survival 18 months post construction for the newly reseeded Ninigret reefs were 54.13% and 47.28% for the Green Hill Pond only and Green Hill Pond overseeded reefs respectively (Figure 2). Through 2022 there was no change density between the spring and fall and the current densities at the two seeding treatments are 109.9 ± 31.9 (Green Hill overseeded old Hatchery line) and 116.5 ± 46.63 ind./m<sup>2</sup> (Green Hill only), The density of the remnant Hatchery line on the "old reef" treatments was roughly ranged from 0-20 with an average of 9 ind./m<sup>2</sup>. In Quonochontaug Pond, we continued to see a significant effect of monitoring event on oyster density and shell length, with the Green Hill Pond treatments out performing the other treatments with respect to overall density and mean length (Figure 2 and 3).

Pathology analyses were completed on time. Pathology results are most informative when considered in the context of multiyear analyses, as well as reef- and habitat-level variables. Results from FHE pathology work are being incorporated into peer-review manuscript (Hanley et al. 2023 (in press)). This article will be appended to future reports, once published. Briefly, results from 2022 showed that the prevalence of macro-parasites, such as mud blister and boring sponge, often varied between reefs within regions and between ponds. The prevalence and intensity of micro-parasites (e.g., Dermo and SSO) also varied between reefs within and between sites, and between ponds.

### *Habitat Trays*

Samples collected in 2021 and 2022 were sorted, counted, weighed, and measured at the MSC during 2022. In general, In Ninigret Pond during 2021 and 2022, 3,791 macroinvertebrates and fish were collected with a total mass of 0.62 kg. Approximately 49% of individuals were glass

shrimp (*Palaemonidae*), 41% mud crabs (*Panopeidae*), and 4% fish. In Quonochontaug Pond during 2021 and 2022, 3,571 individuals were collected with a total mass of 1.16 kg. Approximately 59% of individuals were mud crabs, 30% glass shrimp, and 5.5% fish. Across both ponds, there were 24 identifiable species from 23 taxonomic groups ranging from subphyla to genera.

Quonochontaug Pond showed a greater diversity of fish compared to Ninigret Pond, including black sea bass (*Centropristis striata*), cunner (*Tautogolabrus adspersus*), and tautog (*Tautoga 175 onitis*). Ninigret Pond showed a greater diversity of unique clams compared to Quonochontaug Pond, such as quahog (*Mercenaria mercenaria*), 178 awning clams (*Solemya sp.*), purplish tagelus clams (*Tagelus divisus*), and false angelwing clams 179 (*Petricolaria pholadiformis*). In Ninigret Pond, the density and biomass of organisms was significantly higher on oyster reefs than control plots, with density and biomass being significantly higher in 2022 than in 2021 (Fig. 4a, 4b, respectively). In Quonochontaug Pond, the density of organisms was significantly higher on oyster reefs than control plots (4c); however, density was not significantly different between years and biomass did not differ between habitat type (e.g., oyster reef vs. control) and year (4d).

### ***Eel Pot and Minnow Trap Survey***

Average CPUE per has been summarized for four target species, Black Sea Bass, Winter Flounders, Tautog, and Cunner for each coastal pond (Ninigret Pond: Figures 5; Quonochontaug Pond : Figure 6). These four species are the most frequently caught species in the eel pot and minnow trap survey. In Ninigret pond, mean CPUE during the 2022 field season was numerical greater than 2021 and about equal to 2020. Out of the treatments, Green Hill Pond reef had the greatest abundance of tautog, and both the Green Hill Pond and Green Hill Pond/Hatchery reefs had greater abundances of Black Sea Bass and Cunner than the control in Ninigret Pond (Figure 5). We found between both experiments, juvenile tautog were most positively augmented on the oyster reefs relative to the control sites (Figure 5 and Figure 6, respectively). In 2022, we found mean CPUE in Ninigret to be greater for all target species relative to 2021 (Figure 5 and 6). Similarly the mean CPUE at the Green Hill Pond oyster reefs in Quonochontaug Pond was greater than both the control and other reef treatment (Hatchery and Narrow River) for Black Sea Bass, Tautog, Cunner, and Winter Flounder (Figure 6).

### ***Fish Productivity Assessment***

During September 2022, dive surveys were conducted to determine the baseline floral and faunal communities for use in productivity estimation at 9 enhancement reefs and 3 controls sites in Quonochontaug Pond. Investigators successfully conducted the third year of the post oyster reef productivity dive surveys, completing 11 dives in total. In Quonochontaug Pond, the percent cover at the three control sites varied depending on their location with Pond. In the northwest region of the pond, the control habitat (1A) was 100% mud or fine sediment, whereas the North and northeast control locations (2D, 3C) had increasingly more sand, gravel, and shell substrate. The northern region, or Site 2 control, is sandier than Site 3, which had a higher percent of mud

and finer sediment mixed in (3D = 20% ; Figure 7). Site 3 also contains a greater proportion of natural boulders compared to Site 2 (3C = 55%, 2D =20%. Figure 7).

In 2022, the overall species diversity, with respect to the algae and sessile invertebrate species, was equal between the oyster reef habitat than the controls. Diversity has slightly declined in Quonochontaug overtime as the reefs age and compared to Ningiret Pond had lower diversity (Table 2) The biggest difference between the reef substrate locations and controls is the abundance of branching and filamentous red algae sponge species are able to adhere to the firmer substrate. Most notably *Polysiphonia* species, *Ceramium* species, and Boring Sponge (Figure 8). Investigators found invertebrate densities to vary depending on the species and survey location. At the control sites, investigators found the highest abundance of mud snails (up to 30 ind./m<sup>2</sup>) (Figure 9). The reef sites harbored a wider array of inverts, most notably increased abundance of barnacles, boring sponge, and red beard sponge (Figure 9). When comparing swath and quadrat survey techniques, it seems the swath method provides a lower estimate of shellfish densities across all locations. In the swath we found greater abundance of mud crabs on the oyster reefs and quahogs at the control sites (Figure 10). In 2020, the average total fish biomass at the oyster reef treatments ( $4.33 \pm 1.07 \text{ g/m}^2$ ) was greater than the unenhanced control sites ( $0.24 \pm 0.09 \text{ g/m}^2$ ). Again in 2021, the oyster reef sites had a greater biomass than the controls but overall biomass was lower. In 2022 we found the fish biomass at the Quonochontaug reefs was about equal to controls ( $\sim 1.8\text{-}2.0 \text{ g/m}^2$ ) and continued to decrease with decline oyster abundances on the reefs (Figure 11). Using Hedge's g effect size we compared the average biomass per meter squared of reef habitat to control habitats, and found the enhancement reef to have an effect size of 1.9 in 2020,  $0.68 \pm 0.68$  in 2021, and  $0.23 \pm 0.47$  in 2022.

## DISCUSSION

Oyster reef monitoring suggest our FHE reef establishment approaches have thus far been successful in both Ninigret and Quonochontaug Ponds. In Ninigret Pond, where surveys represented the first year of monitoring post re-seeding, we the Green Hill lineage exceeded the first-year survival of the previously used hatchery lineage by approximately 10 %. Various environmental and biological factors like predation play an important role in the survival of first year oysters, and determining how a given lineage may perform in certain environments provides crucial information for habitat restoration practitioners and resource managers. We will continue to look for evidence of enhanced performance in addition to susceptibility to different parasite borne diseases and the ability to enhance fish production. In Quonochontaug Pond, the oyster performance was status quo. We observed a slight drop in density and a slight increase in average oyster length suggesting that for the reefs that are successful are maintaining densities well above the minimum ecological threshold, with respect to augmented fish abundance, and that oyster growth is itself starting to plateau at about 4.5-5years of age.

Providing the health of these reefs are maintained, the quality of habitat provided should increase over time in response to successional changes on these reefs. That said, it's generally agreed that oyster reefs provide some level of enhancement to fish habitat beginning at time of reef creation. Consistent with this expectation, we observed that the abundance of fish increased across sites after reef creation, in comparison to preconstruction baseline monitoring. We also observed an increase in targeted species, such as black sea bass, tautog, and winter flounder.



In Ninigret Pond, we found lower overall catch rates for the target sportfish species between the habitat treatments. In Quonochontaug Pond, Black Sea Bass, Tautog, and Cunner all showed that enhancement potential of the oyster habitat, provided greater catch than their respective controls at the green hill pond reefs which still have sufficient oyster densities. Black Sea Bass and Winter Flounder were more positively influenced at the eastern basin that has a sandier and more rugose substrate, whereas Tautog were more positively increased at the western basin that is relatively flat and muddy between the reefs compared to the eastern sites. In accordance with reef production literature, Tautog are typically a recruitment enhanced species, as opposed to growth enhanced like black sea bass, and the placement of reefs in areas relatively devoid of other structured habitat may have a higher potential for fish augmentation by providing adequate substrate for juvenile tautog to recruit (Powers et al. 2003).

Scup and Summer Flounder have yet to show any strong trends at our FHE sites, which is similar to work in the Mid-Atlantic (Peterson et al. 2003) where It's possible that the methodology used to determine the CPUE on and off reefs was not sufficient to document the relative use for these different FHE treatments by striped bass, scup, and other pelagic (e.g., bluefish, menhaden).

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Table 1. Biological Cover, species richness and diversity. Average species richness (R) and diversity (Shanon’s H index) derived from the individual transect richness and diversity values for each site. This data only represents the diversity and richness observed via the uniform point count transect method and does not reflect mobile inverts and finfish species present at these locations.

YEAR	REGION	SITE	HABITAT	R	H
2020	Coastal Ponds	Quonochontaug Pond	Oyster	4 ± 0.55	1.17 ± 0.19
2021	Coastal Ponds	Quonochontaug Pond	Oyster	3.78 ± 0.32	1.13 ± 0.1
2022	Coastal Ponds	Ninigret Pond	Oyster	4.5 ± 0.19	1.26 ± 0.04
2022	Coastal Ponds	Quonochontaug Pond	Oyster	3.33 ± 0.37	1.03 ± 0.1

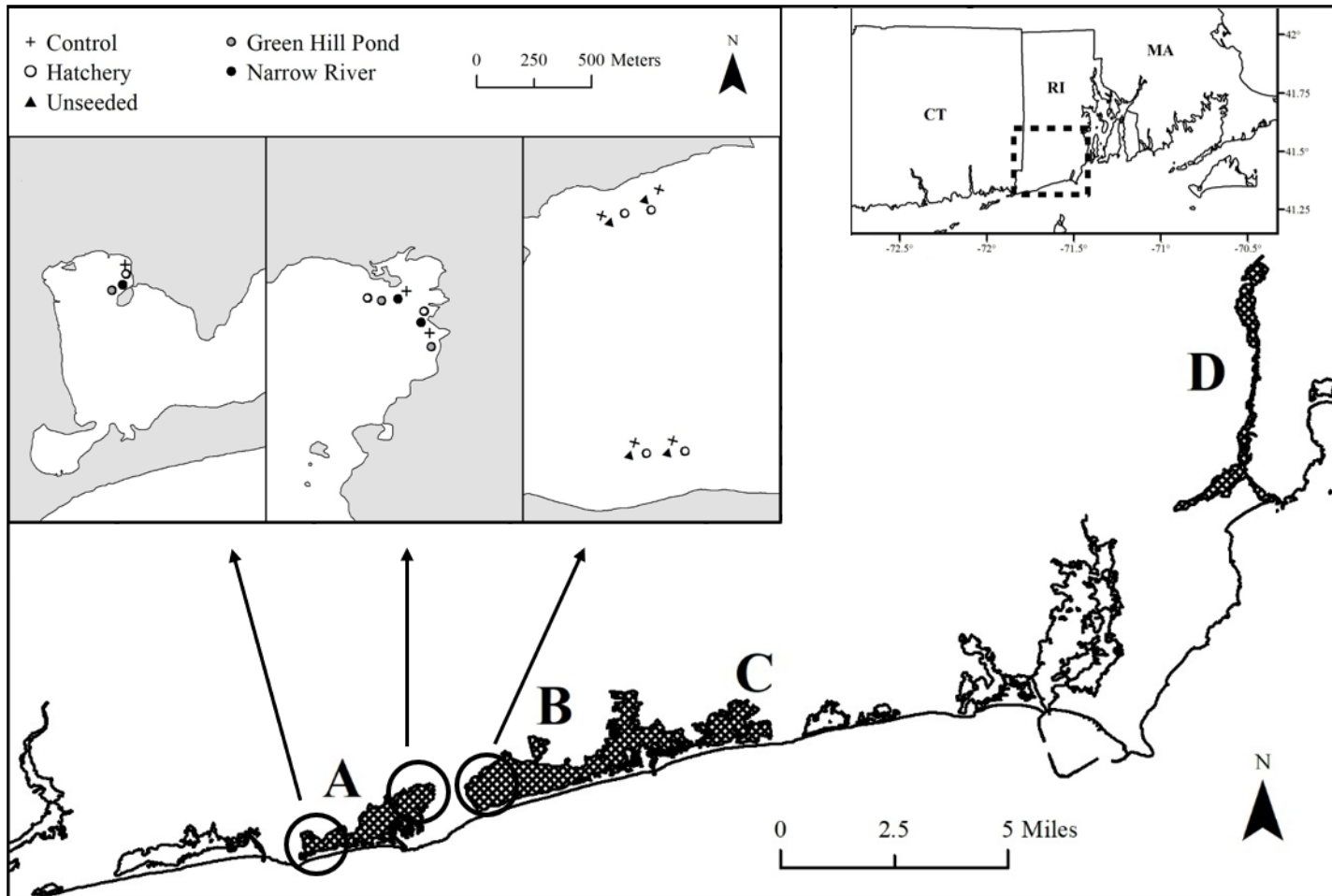


Figure 1: Map of the Rhode Island coastal ponds and rivers. Includes restoration locations (A = Quonochontaug Pond and B = Ninigret Pond), as well as oyster broodstock collection sites (C = Green Hill Pond and D = Narrow River). Restored oyster reefs for both experiments ordered from west to east. Quonochontaug Pond includes three seeded reefs (white = Hatchery, grey = Green Hill Pond, and black = Narrow River) per region. Ninigret Pond includes two unseeded (triangle) and two seeded (circle) reefs in each region. Both ponds also include unenhanced control (+) sites.

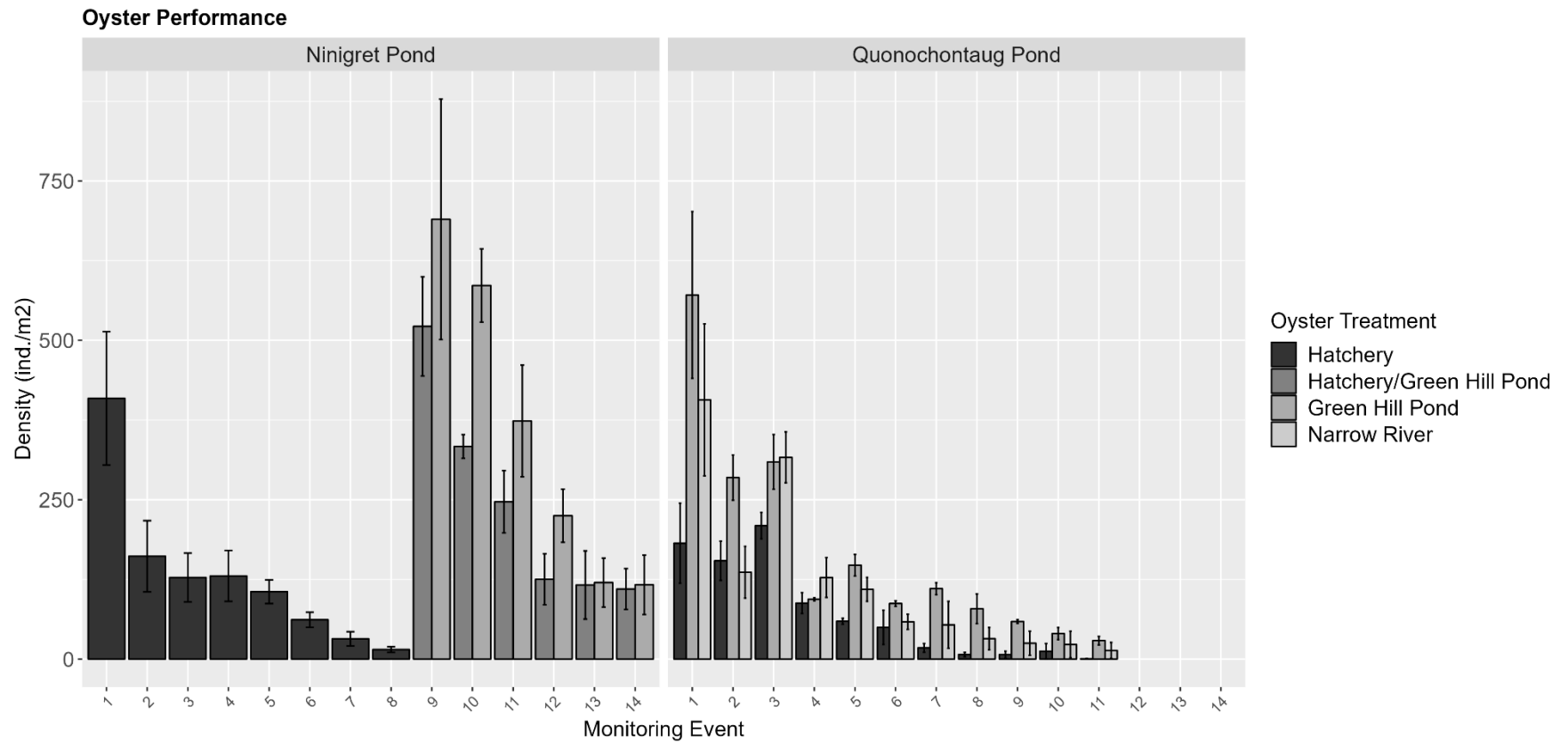


Figure 2: Bar graph of mean oyster density per meter squared,  $\pm$  se, in Ninigret Pond as a function of oyster monitoring event (sampled twice annually spring and fall), grouped by oyster seed source (Ninigret Pond: black = original hatchery lineage seeded in 2016, dark grey = Green Hill Pond overseeding, grey = Green Hill Pond only; Quonochontaug Pond: black = hatchery, grey = Green Hill Pond, light grey = Narrow River), for Ninigret (left) and Quonochontaug Pond (Right).

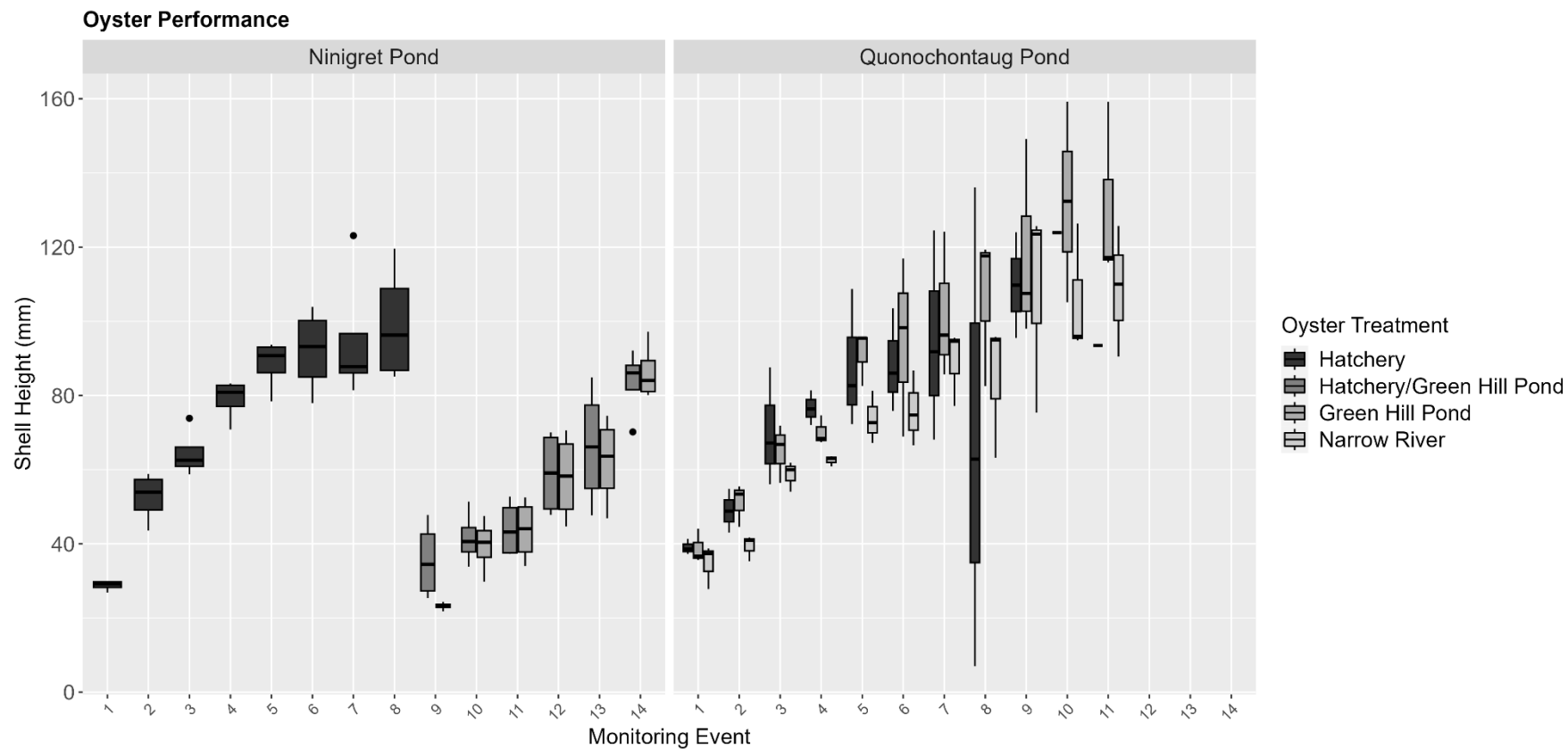


Figure 3: Box plot of mean oyster shell height (mm) per reef in both Ninigret Pond (left) and Quonochontaug Pond (right) as a function of oyster monitoring event (twice year, May and October), a proxy for time, and oyster seeding treatment (black = original hatchery, dark grey = green hill pond overseeding of old hatchery line, grey = Green Hill Pond only, light grey = Narrow River).

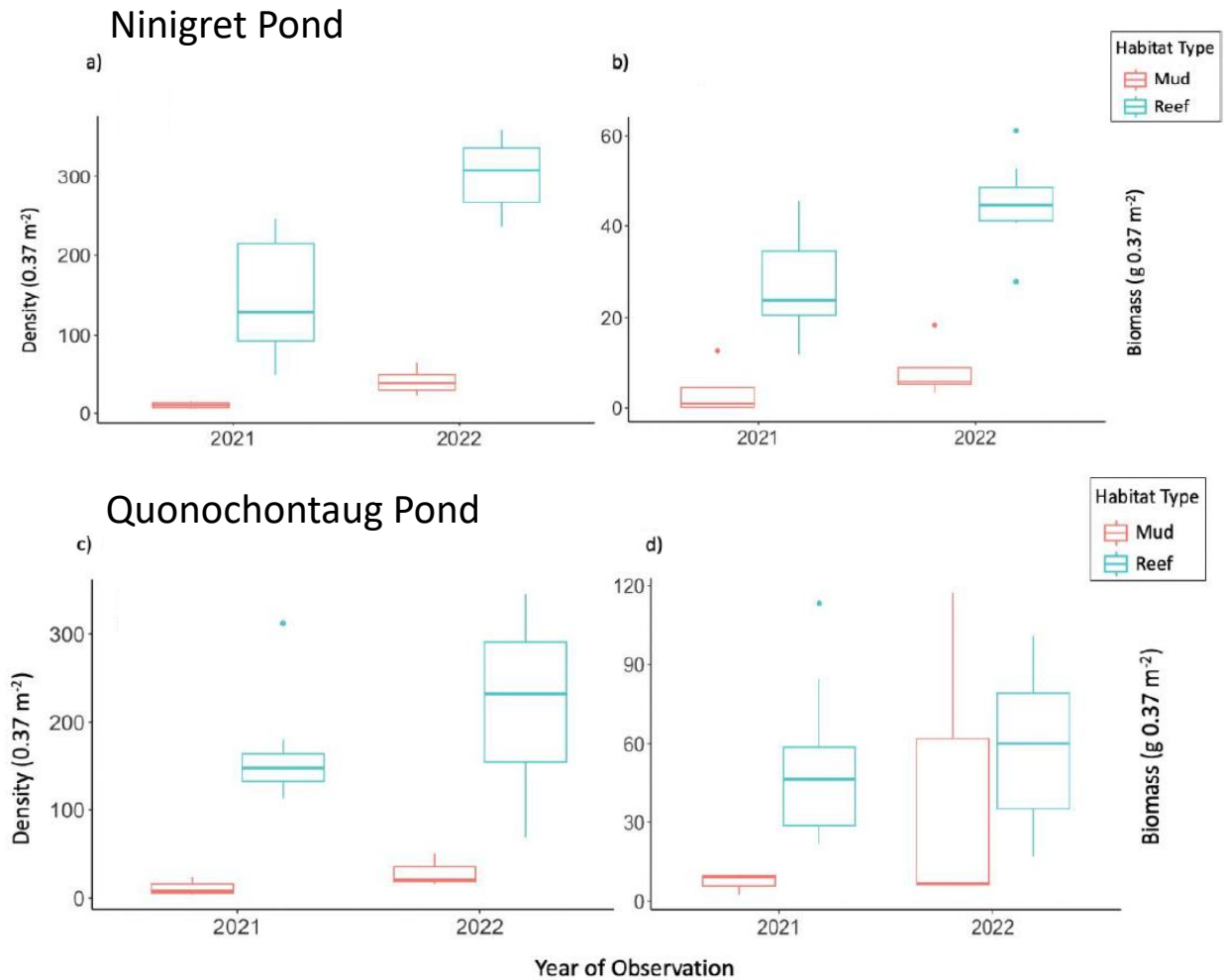


Figure 4. The mean  $\pm$  SE density (individuals  $0.37/\text{m}^2$ ) and biomass ( $\text{g } 0.37/\text{m}^2$ ) of reef species by sampling year and habitat type in Ninigret Pond (a and b, respectively) and Quonochontaug Pond (c and d, respectively).

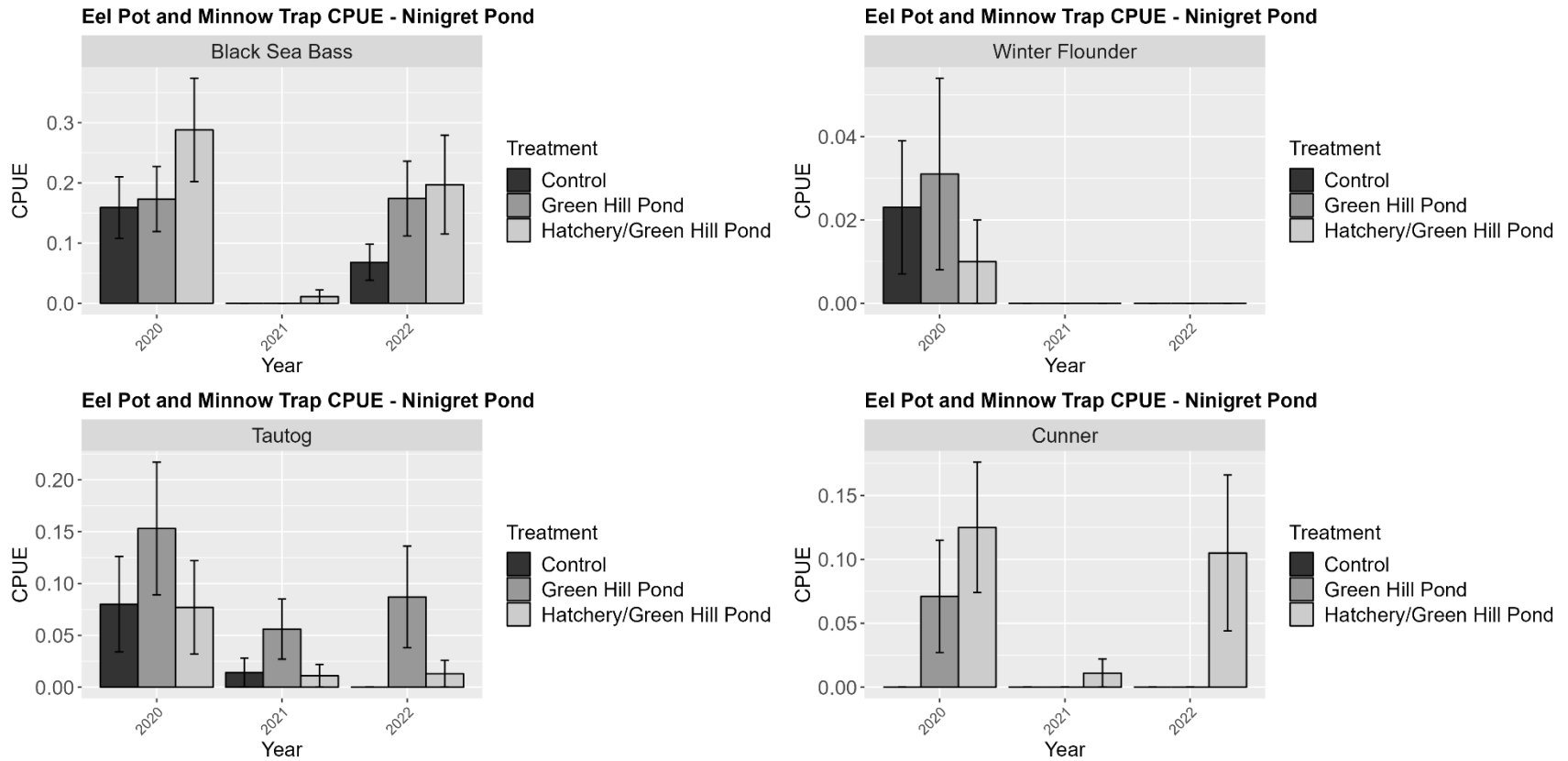


Figure 5: Ninigret Pond, mean catch per unit effort (CPUE) (ind./hours fished)  $\pm$  se, observed during the 2020 – 2022 field seasons. Averages represent the average monthly CPUE from each habitat treatment. The average CPUE is plotted by year, grouped by habitat treatment (black = control, dark grey = Green Hill Pond seed source, light grey = former hatchery reefs over seeded with Green Hill Pond), and faceted by finfish species (Top left = Black Sea Bass, Top right = Winter Flounder, Bottom Left = Tautog, Bottom Right = Cunner).



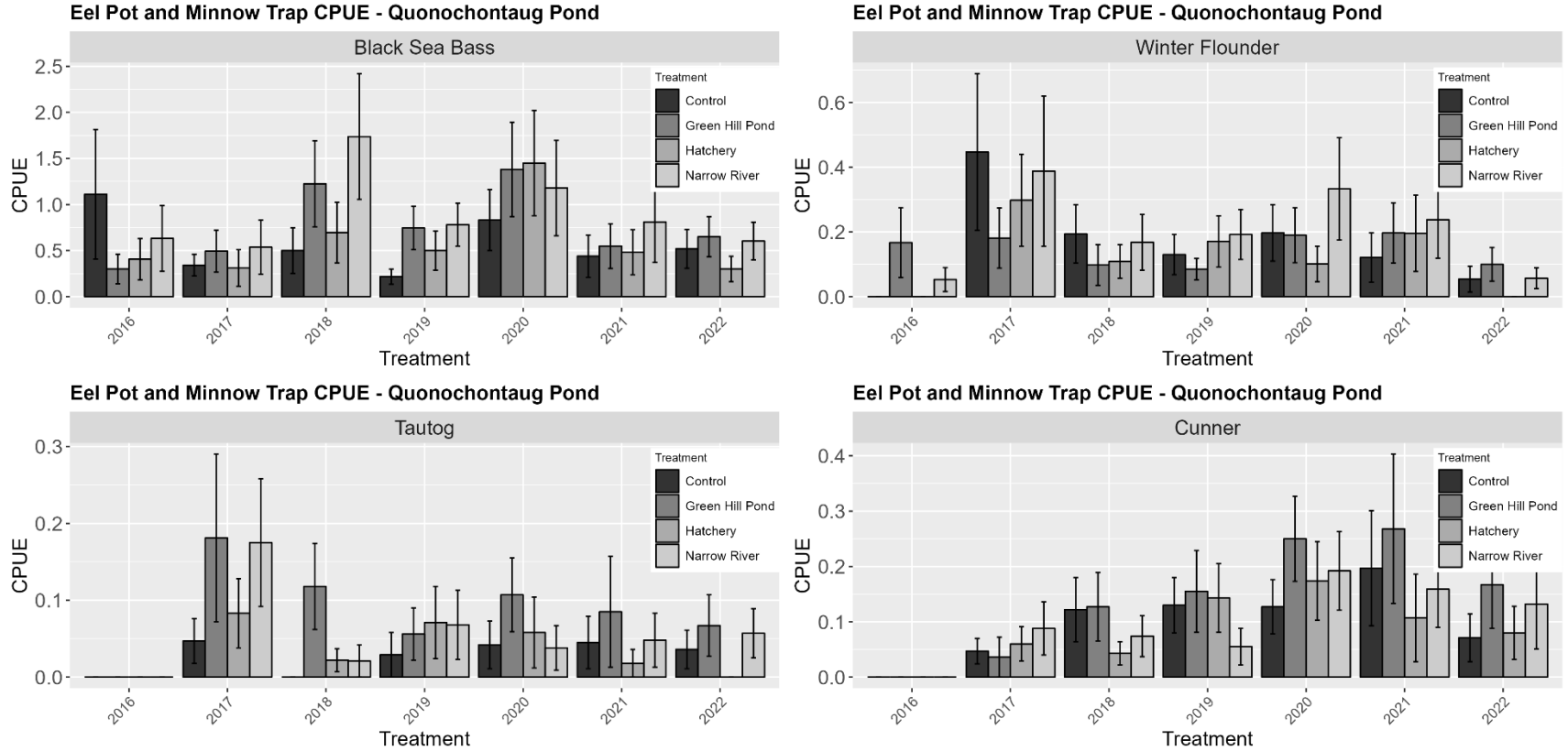


Figure 6: Quonochontaug Pond, mean catch per unit effort (CPUE) (ind./hours fished)  $\pm$  se, observed during the 2016-2022 field seasons. Averages represent the average monthly CPUE from each habitat treatment. The average CPUE is plotted by year, grouped by habitat treatment (black = control, dark grey = Green Hill Pond seed source, grey = hatchery, light grey = narrow river seed source), and faceted by finfish species (Top left = Black Sea Bass, Top right = Winter Flounder, Bottom left = Tautog, Bottom Right = Cunner).

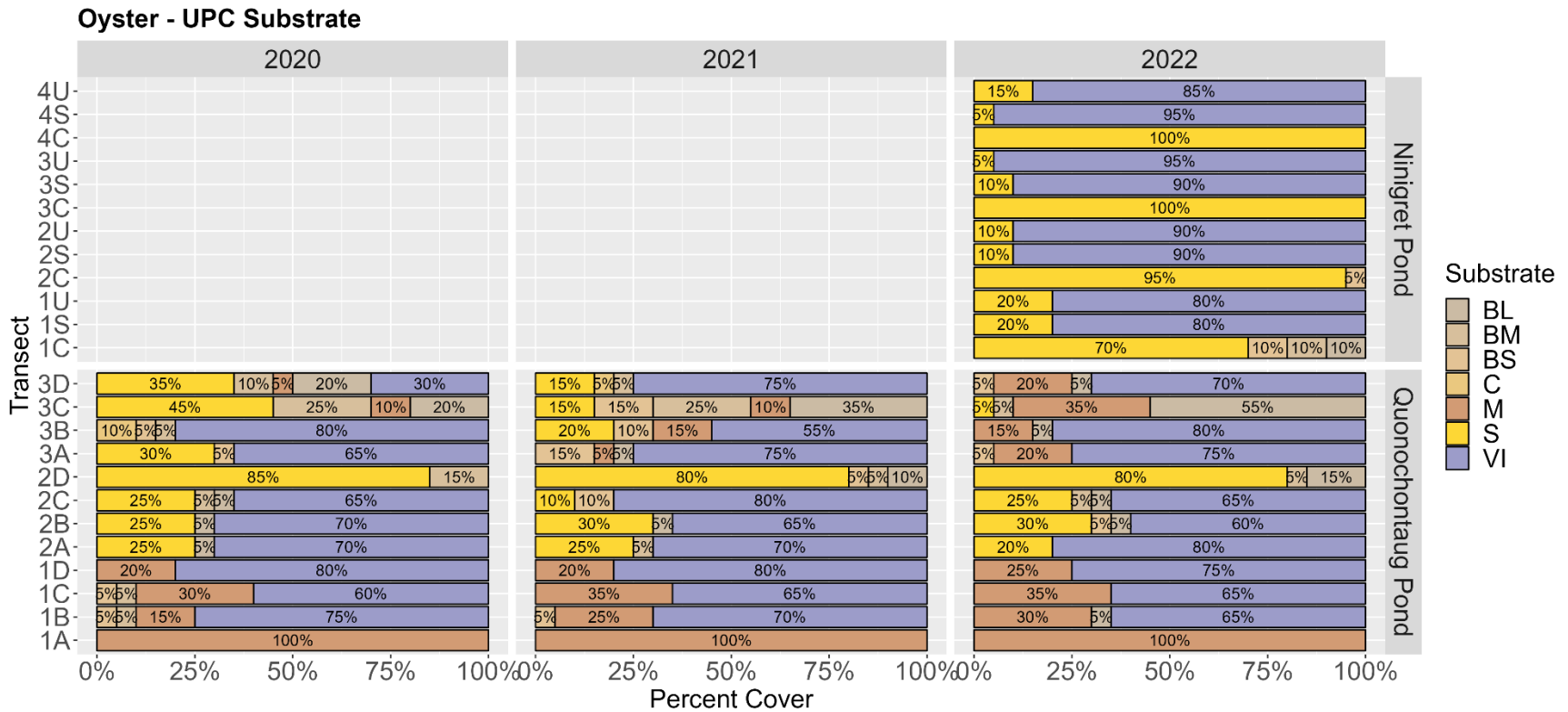


Figure 7. Percent cover of substrate along the y-axis plotted for each transect along the x-axis, for each 2020-2022 fish productivity survey. Percent cover is grouped by substrate type (BL = boulder large, BM = boulder medium, BS = boulder small, M = mud/fines, M\_S = sandy mud mix, C = cobble, S = Sand, VI = Oyster/ Oyster Shell).

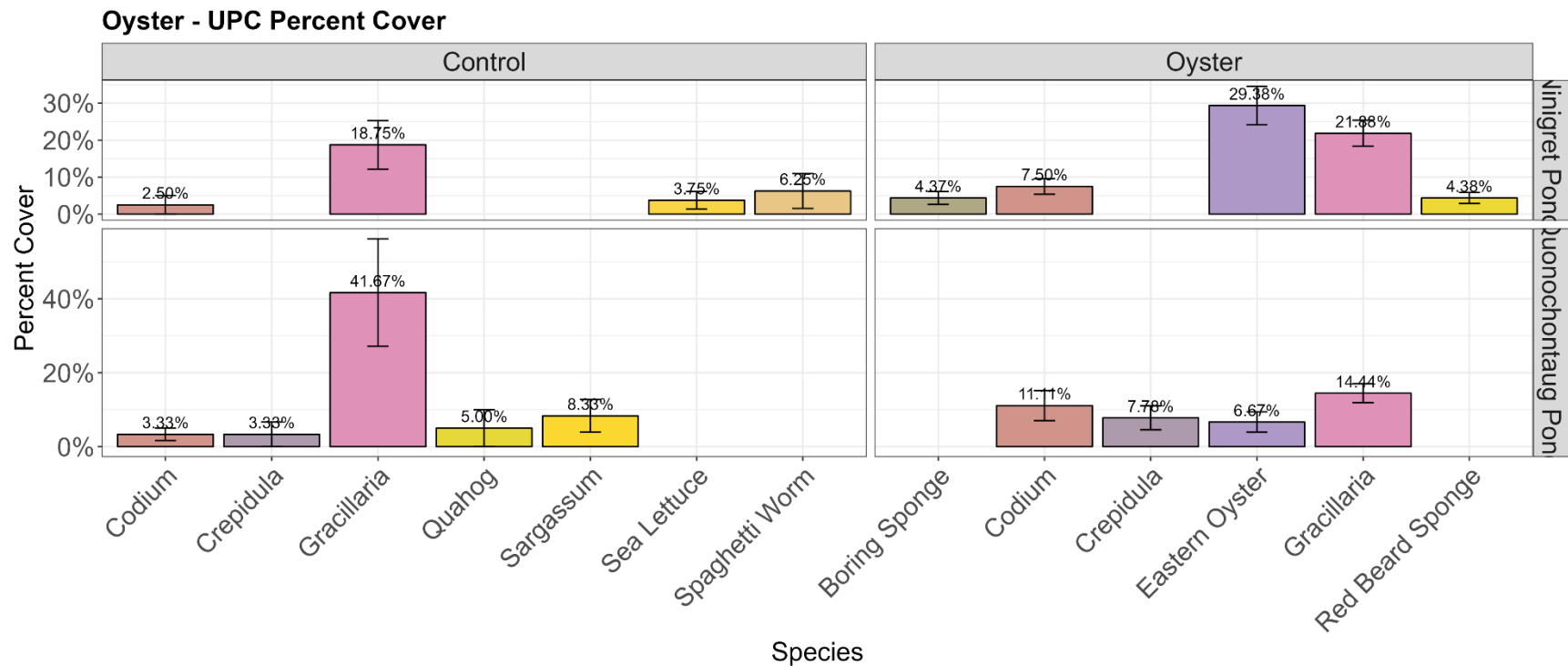


Figure 8. Quonochontaug Pond, mean algal and sessile invertebrate cover  $\pm$  SE, for each habitat treatment (Control or Oyster Habitat) during the 2022 productivity dive survey.

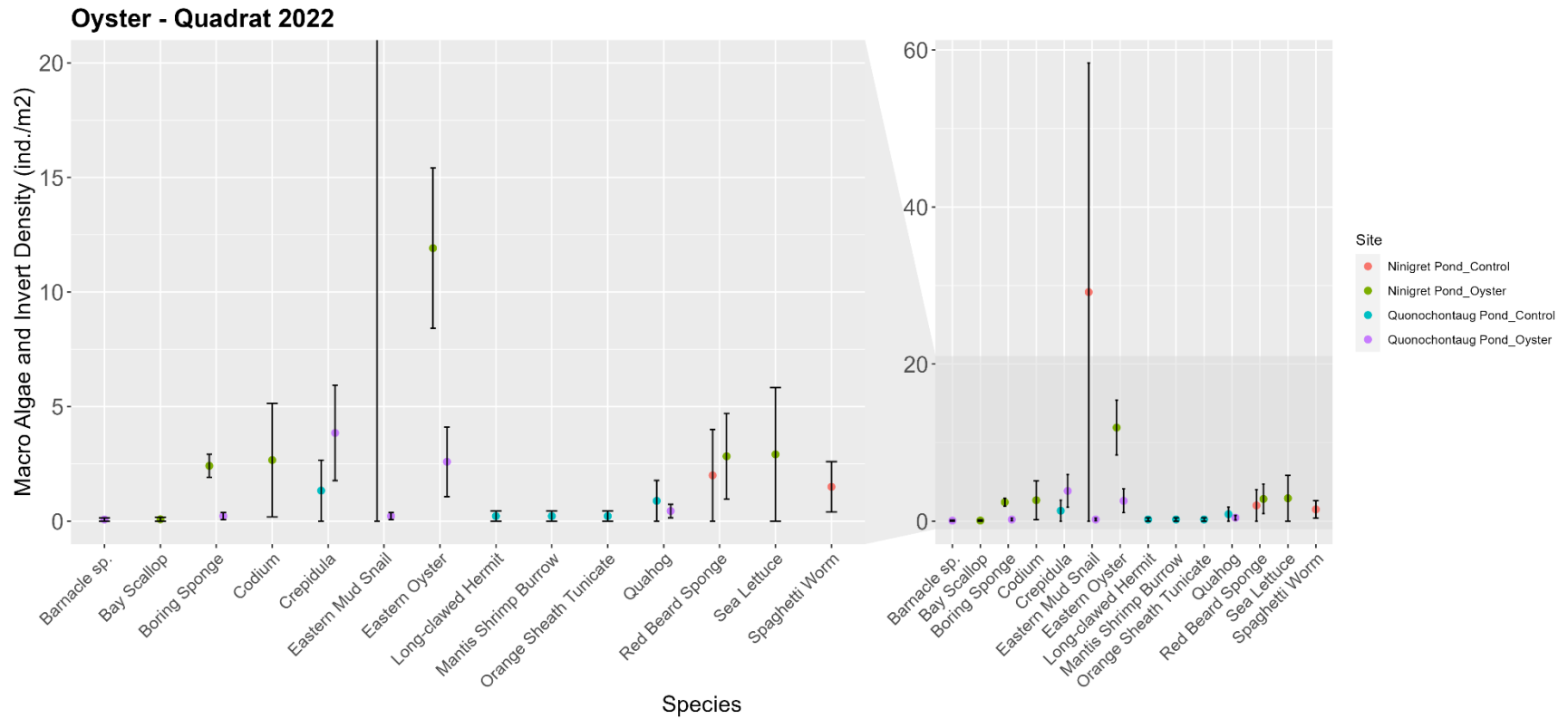


Figure 9. Quonochontaug Pond, mean invertebrate density  $\pm$  SE, per habitat treatment (Control or Oyster Habitat) and Pond (Ninigret and Quonochontaug Pond) for the quadrat survey method.

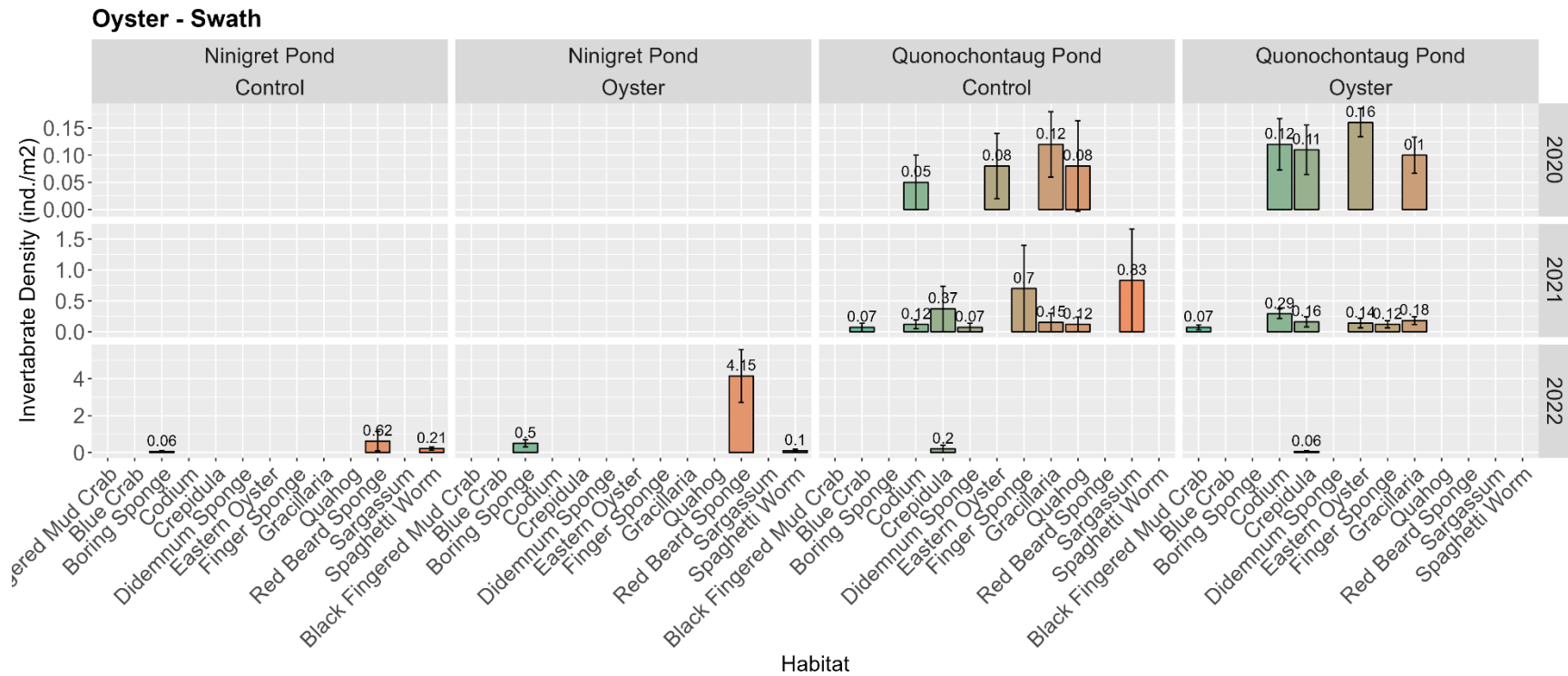


Figure 10. Quonochontaug Pond, mean invertebrate density  $\pm$  SE, per habitat treatment (Control or Oyster Habitat) and pond (Ninigret and Quonochontaug Pond) for the swath transect method, faceted by year.

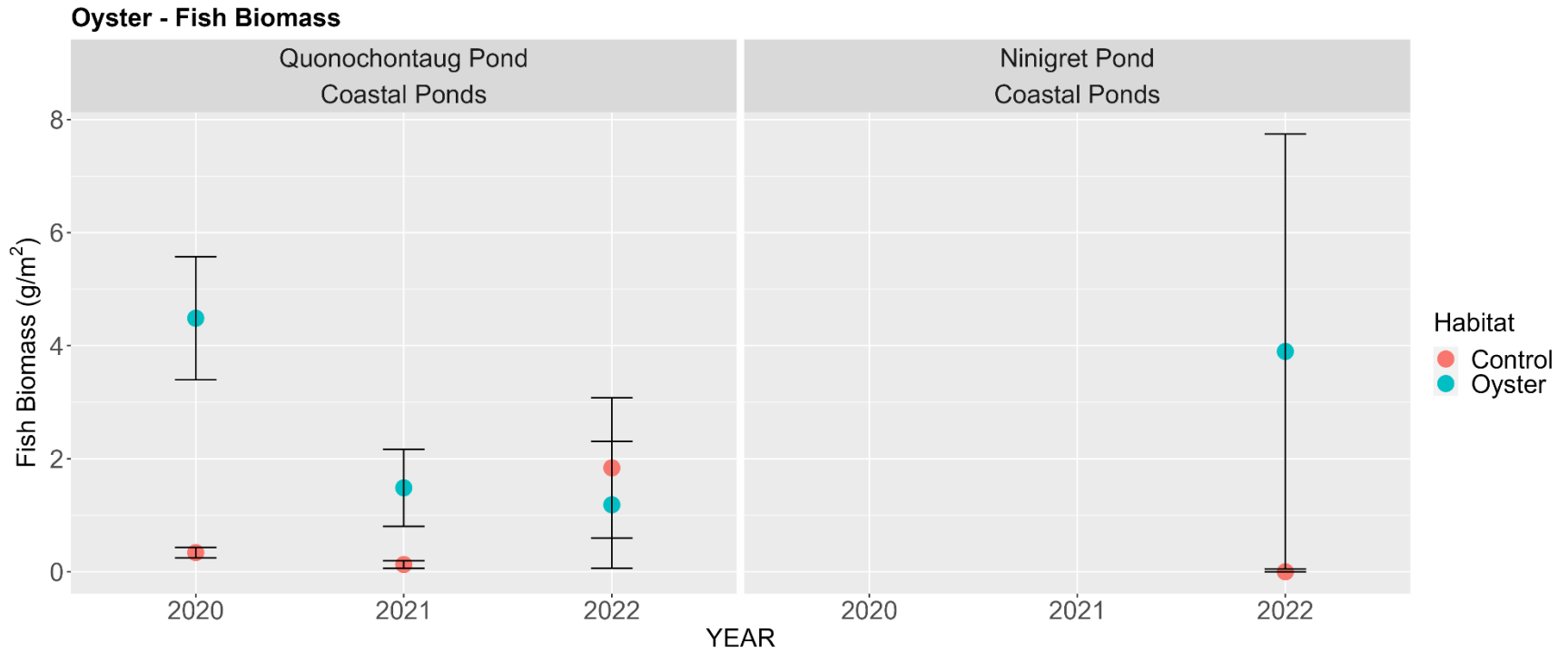


Figure 11. Quonochontaug Pond, mean fish biomass during the 2020-2022 productivity dive surveys. Fish biomass is standardized per meter squared and presented as the average biomass  $\pm$  SE, for each habitat treatment (Control = red, Oyster = blue)

# **Protecting and Minimizing Adverse Impacts to Marine Fish Habitat**

Eric Schneider, Anna Gerber-Williams, Katie Rodrigue, and Julia Livermore

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Federal Aid in Sportfish Restoration  
F-61-R-21

2022 Performance Report

**Performance Report: Job 6**

**March 16, 2023**

**State:** Rhode Island

**Project Number:** F-61-R-21

**Period Covered:** January 1, 2022 - December 31, 2022

**Job Number:** Job 6: Protecting and Minimizing Adverse Impacts to Marine Fish Habitat

**Staff:** Eric Schneider, Anna Gerber-Williams, Katie Rodrigue, and Julia Livermore

**Job Objectives:**

The goal of this project is to protect important marine habitat to support healthy marine ecosystems and stocks of recreationally important sportfish by addressing the following objectives:

(1) 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.

(2) In the event of a significant environmental incident: coordinate hazard mitigation, assessment of natural resource damages, and resulting habitat restoration.

(3) Collect and contribute data and staff expertise in municipal, state-wide, and regional planning processes, risk assessments, and habitat and/or spatial planning processes and committees to ensure marine habitat data is incorporated and/or impacts to marine habitat and recreational important sportfishing opportunities are adequately considered and addressed.

**Target Date:** December 31, 2022

**Deviations:** No deviations occurred during 2022.

**Recommendations:** *None*

**Remarks:** *None*

**Summary:**

Objective 1: As part of its environmental review program during 2022, DMF reviewed 91 permit applications that contained approximately 170 separate activities that posed potential impacts to marine resources (Table 1). The number of applications reviewed in 2022 ( $n = 91$ ) was slightly above the eight year average ( $\bar{x} = 82$ , Table 2), and the number of activities that posed potential impacts to marine resources was again above the average number of over the past eight years ( $\bar{x} = 130$ , Table 2). Activities such as the construction of new residential docks, modification to exiting residential docks, and public works projects were more frequent than the eight-year



average (Table 2), with potential impacts to submerged aquatic vegetation (SAV) and benthic habitat, and salt marsh or coastal wetlands also appearing more often than average over the past eight years (Table 2).

During 2022, the CRMC aquaculture permitting process was largely on hold while the CRMC Bay SAMP Aquaculture Element Working Group evaluated comments and incorporated new policies into the management program. During this period, DMF participated in and formulated responses for one preliminary determination meeting with an aquaculture applicant. DMF also provided formal, written responses for two public noticed lease applications, and held RI Marine Fishery Council (RIMFC) Shellfish Advisory Panel (SAP) meetings to gain input from industry on aquaculture sites for and to provide scientific opinion to the RIMFC regarding the sites.

Objective 2: DMF staff continued to participate in collaborative emergency response training and engagement with other state agencies, NOAA, the USCG, and the University of Rhode Island by attending the annual summer workshop for SSEER (Scientific Support for Environmental Emergency Response) as well as a “table-top” oil spill response training. In addition, RI DMF received a total of five reports of fish kill events. In 2022, RI DMF responded to two of the five reported fish kill events. It was determined that all events were due to natural causes, the majority of which being related to intermittent hypoxia or elevated-water temperatures.

Objective 3: DMF staff continued to participate in the Northeast Regional Marine Fish Habitat Assessment (NRHA), which is a collaborative effort lead by the Mid-Atlantic Marine Fishery Management Council (MAMFC) in partnership with the New England Fishery Management Council (NEFMC), to describe and characterize estuarine, coastal, and offshore fish habitat distribution, abundance, and quality in the Northeast. The project aims to develop habitat science products that support habitat and stock assessments. The first phase of the work associated with the NRHA completed in the fall of 2022.

## **Objective No. 1**

### *Objective 1 – Approach*

To address Objective 1, the DMF 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 occur in 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 provide important information to permitting agencies to allow for more informed permitting decisions.

Depending on the size, scope, and location of the proposed project or activity the review process involves 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 need to be collected, analyzed, and summarized. Prior to data collection a sampling plan is designed to address specific permitting-related data deficiencies and outline anticipated field and data analyses methods. When possible, any information that would improve anticipated future reviews should be collected. Similarly, when possible this work takes advantage of collaborative efforts by other agencies. Collection of marine habitat and resource (finfish) data may require 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, acoustic receivers, 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. Other sources of habitat data may need to be purchased, such as aerial photography, lidar, side-scan sonar, or GIS data depicting habitat (e.g. eelgrass, submerged aquatic vegetation, sediment, or structures).

In most cases the aforementioned data sources must be compiled, reviewed, and analyzed before a permit can be issued. Given the regulatory timelines set up for permit reviews, being able to accomplish these tasks timely and accurately often requires a collaborative approach that utilizes present and cutting-edge technologies, and sometimes outside expertise.

### *Objective 1 – Results and Discussion*

As part of its environmental review program during 2022, verbal and/or written comments were provided on all general permit reviews through the monthly general permit meeting with CRMC, RI DEM OWR, U.S. EPA, and USACE. As part of these reviews, RI DMF provided comments and time of year windows for all dredge-related all projects. The DMF continued to participate in the Manchester Street Power Station 316(b) review process, as well several additional large-scale projects. More specifically, DMF reviewed 91 permit applications that contained approximately 170 separate activities that posed potential impacts to marine resources (Table 1). The number of applications reviewed in 2022 ( $n=91$ ) was slightly above the eight-year average ( $\bar{x} = 82$ , Table 2), and the number of activities that posed potential impacts to marine resources was again above the average number of over the past eight years ( $\bar{x} = 130$ , Table 2). Activities such as the construction of new residential docks, modification to existing residential docks, and public works projects were more frequent than the eight-year average (Table 2), with potential impacts to submerged aquatic vegetation (SAV) and benthic habitat, and salt marsh or coastal wetlands also appearing more often than average over the past eight years (Table 2).

As part of DMF's responsibility to evaluate whether proposed aquaculture activities could impact recreational fisheries and the fish habitat, DMF participated in and formulated a response for one aquaculture preliminary determination meeting during 2022. DMF also provided formal, written responses for two public noticed lease applications, and held RIMFC SAP meetings to gain input from industry on aquaculture sites for and to provide scientific opinion to the RIMFC regarding the sites. We coordinated all responses with RI DEM Fish and Wildlife Program for waterfowl habitat and hunting concerns, and drafted DMF official response letters related to fish habitat impacts that were identified through a detailed review of applications for new and modifications to aquaculture leases beginning in January 2021

In general during 2022, the CRMC aquaculture permitting process was largely on hold while the CRMC Bay SAMP Aquaculture Element Working Group evaluated comments and incorporated new policies into the management program. During this period DMF staff participated in one working group meeting and three seminars focused on best practices to minimize impacts to marine resources. DMF also continued internal review and editing to the aquaculture siting review protocol. The aquaculture siting review protocol was created to provide general guidance and justification for siting recommendations for the DMF. Justification includes peer-reviewed and gray literature, conversations with topic-specific experts, and analysis of DEM survey data. Recommendations presented within the protocol are effective for applications currently under review or under future review, including proposed expansions to existing leases. Factors addressed within the aquaculture siting review protocol included: fish habitat, shellfish habitat, proximity to long-term monitoring and habitat restoration sites, proximity to seal habitats, shellfish densities, and commercial and recreational fishing densities, which are areas under the DMF purview. The document will be presented to the shellfishing and aquaculture industries for further feedback before being made public.

The Division has made the active sites layer public via an interactive map on the Department's website:

<http://ridemgis.maps.arcgis.com/apps/webappviewer/index.html?id=8beb98d758f14265a84d69758d96742f>. This interactive map features mapping tools for future applicants to aid in the site selection process and help them avoid areas of public use or historic eelgrass habitat. Several applicants utilized the interactive map since it was made available to the public and DMF plans to make further modifications and improvements during 2023.

## **Objective No. 2**

### *Objective 2 - Approach*

The DMF will provide available scientific information identifying 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 DMF will provide a staff member with recreational fishery habitat expertise for coordination of DMF responses related to assisting the Office of Emergency Response Incident Command in assessing the environmental impacts of a major oil spill or incident on recreational habitat and biota in Rhode Island marine waters. The staff member will work with appropriate RIDEM and federal representatives in Incident Command during the response to provide needed DMF coordination and technical information during such an incident, including immediate responses related to impact assessment, monitoring of environmental conditions in the vicinity of a spill, immediate biota mortality estimates, as well as involvement in the Natural Resource Damage component of a major incident response following the “Bay Response Team” (BART) protocols. We will assess staff training needs and seek training and/or refreshers that include response protocols and techniques, as needed.

### *Objective 2 – Results and Discussion*

In 2022, RI DMF responded to two of the five reported fish kill events. Table 3 shows a summary of these events. It was determined that all events were due to natural causes, the majority of which being related to intermittent hypoxia or elevated-water temperatures. The species most affected was Atlantic menhaden, but one event affected blue mussels. All events occurred during a one month period between August 2 and September 2, 2022.

In the event of an incident that causes significant environmental impact, it is imperative for RI DMF to be able to respond quickly and efficiently to assess the effects on fish habitat in Rhode Island waters. Coordination with other state agencies (including RI DEM Office of Emergency Response, OWR, and Office of Law Enforcement) has proven fundamental to this fast response time and impact assessment. A relatively high number of fish kill events were reported in 2019 and 2020 (11 and 17 reported events respectively), and due to the diligence of staff throughout RI DEM, all events requiring action were responded to in a timely manner. The continuation of this coordinated effort is necessary to ensure that a fast and efficient response is maintained. Also, continued emergency response training will allow further improved response to these incidents. Trainings that RI DMF staff have participated in over the last few years include oil spill response training such as boom deployment and other geographic response protocols, Natural Resource Damage Assessment training, and FEMA’s Incident Command System. RI DMF staff will continue to take advantage of training opportunities as they become available in the future to further hone our skills in emergency response.

### **Objective No. 3**

#### *Objective 3 – Approach*

The DMF actively participates in municipal, state-wide, and regional planning processes, risk assessments, and habitat and/or spatial planning processes and committees, including but not limited to NOAA Environmental Assessment Indexes, Special Area Management Plans (SAMPs), Harbor Management Plans, state-side and regional Environmental Risk Assessments, Restoration Plans, and other plans and committees that include spatial management aspects with potential impacts to recreational sportfish activities and associated habitat. As needed, DMF provides marine habitat, recreational sportfish related data, survey data collected by DMF, and other pertinent marine data to these review and processes. DMF staff ensures that data is considered and used appropriately. As deemed necessary and appropriate, DMF provides analyses and technical assistance at various stages of these processes, as well as technical and logistical support for the activities that result in the collection of additional data that can increase the amount of information available to assess impacts (positive and negative) to recreational important sportfish. Support for data collection activities includes, but is not limited to on-water assistance with maintaining water quality meters, acoustic receivers, and other measures used for fish and habitat qualification within these processes.

#### *Objective 3 – Results and Discussion*

DMF staff continued its participation in the Northeast Regional Marine Fish Habitat Assessment (NRHA), which is a collaborative effort lead by the Mid-Atlantic Marine Fishery Management Council (MAMFC) in partnership with the New England Fishery Management Council (NEFMC) and Atlantic States Marine Fishery Council (ASFMC), to describe and characterize estuarine, coastal, and offshore fish habitat distribution, abundance, and quality in the Northeast. The project aims to develop habitat science products that support habitat and fish stock assessments. Work associated with the NRHA is expected to occur continue into future years.

Species habitat modeling was a core component of the assessment, aimed at improving our understanding of how environmental variables govern species distribution. The team is working to leverage climate forecasts to project how habitat distributions may change allowing the Councils, ASMFC, and NOAA Fisheries to consider future management scenarios. Initial modeling work was completed in 2021, during which the inshore and offshore teams began joint and single species modeling efforts to determine species distributions and habitat use. The inshore working group continued work to link species assemblages to habitat types and using an online shiny App, mapped locations and extent of habitat utilization by focus species including inshore habitat types (SAV, oyster reefs etc.), building on existing databases, and began to develop species distribution maps and future predicted distribution. During future years, the team is expected to identify habitat and species climate vulnerabilities, and the dependence of species on habitats.

**Table 1.** Activities and potential impacts identified during the permit review process performed in 2022 by RI DMF for 91 separate projects. Aquaculture-related reviews are excluded from this table.

Activities & Potential Impacts	Coastal Ponds	Narragansett Bay			Sakonnet		Coastal	Total
		Lower Bay	Upper Bay	Providence and Seekonk Rivers	River	Rivers		
Potential Impacts to SAV or Benthic Habitat	12	7	2	2			1	24
Saltmarsh Restoration			3					3
Eelgrass Restoration								0
Artificial Reef								0
Maintenance Dredging	1	2	1	2				6
New Dredging		2					1	3
New Marina								0
Marina Expansion or Reconfiguration		2						2
Restoration of Tidal Flow or Dam Removal			3	1				4
Residential Docks (New)	10	4	5		2	3		24
Residential Docks (Modifications)	16	6	9		4			35
Commercial/Municipal Piers or Docks		8						8
Commercial/Municipal Mooring Field Expansion		1						1
Potentail Salt Marsh or Coastal Wetland Impacts	11	4	6		3	2		26
Beach Nourishment or Coastal Feature Resiliency								0
Waterfront Bulkhead/Riprap	1	6	2					9
Waterfront Development		3						3
Public Works, Utility, Energy		3		4			1	8
Fish Passage				3				3
Potential Shellfish Impacts		1		1				2
Channel Maintenance		1		1				2
Boat Ramps		1	1					2
Oyster Restoration								0
Recreational Access or Fishing (Improve/Impacts)		1	1					2
Impacts from Discharge or Stormwater			1	2				3
<b>Total</b>	<b>51</b>	<b>52</b>	<b>34</b>	<b>16</b>	<b>9</b>	<b>5</b>	<b>3</b>	<b>170</b>

**Table 2.** Activities and potential impacts identified during the permit review process over the last eight years. Aquaculture-related reviews are excluded from this table.

Activities & Potential Impacts	Permit Review During Previous 8 Years									2022 Total
	2014	2015	2016	2017	2018	2019	2020	2021	Average Per Year	
Potential Impacts to SAV or Benthic Habitat	0	0	1	5	11	13	30	36	12.0	24
Saltmarsh Restoration	4	5	3	3	6	4	4	5	4.3	3
Eelgrass Restoration	1	0	0	1	4	0	1	2	1.1	0
Artificial Reef	1	0	0	0	1	1	0	0	0.4	0
Maintenance Dredging	8	8	10	17	6	8	12	9	9.8	6
New Dredging	3	1	0	2	2	2	3	7	2.5	3
New Marina	3	2	0	0	2	0	0	0	0.9	0
Marina Expansion or Reconfiguration	0	1	3	2	2	5	8	3	3.0	2
Restoration of Tidal Flow to Coastal Pond	1	0	0	2	5	0	2	1	1.4	4
Residential Docks (New)	40	20	23	0	29	18	35	41	25.8	24
Residential Docks (Modifications)	7	2	7	39	39	13	30	5	17.8	35
Commercial/Municipal Piers or Docks	1	3	0	13	5	5	13	10	6.3	8
Commercial/Municipal Mooring Field Expansion	0	0	5	0	0	2	1	1	1.1	1
Salt Marsh or Coastal Wetland Impacts	0	0	0	16	14	8	21	15	9.3	26
Beach Nourishment or Coastal Feature Resiliency	2	0	3	1	4	6	4	0	2.5	0
Waterfront Bulkhead/Riprap	4	1	2	11	6	11	18	6	7.4	9
Waterfront Development	1	0	0	0	1	4	2	6	1.8	3
Public Works or Utility	1	0	1	1	6	7	17	6	4.9	8
Fish Passage	0	0	0	0	0	0	12	6	2.3	3
Potential Shellfish Impacts	0	0	0	4	4	4	5	1	2.3	2
Channel Maintenance	0	0	0	5	1	4	6	7	2.9	2
Boat Ramps	1	1	0	2	1	2	10	1	2.3	2
Oyster Restoration	0	4	0	2	4	0	5	0	1.9	0
Recreational Use (Improve/Impacts)	0	0	0	0	7	3	8	7	3.1	2
Impacts from Discharge	0	0	0	6	3	2	3	6	2.5	3
Coastal Restoration Other	0	0	0	5	0	0	0	0	0.6	0
<b>Total - Activities &amp; Potential Impacts</b>	<b>78</b>	<b>48</b>	<b>58</b>	<b>137</b>	<b>163</b>	<b>122</b>	<b>250</b>	<b>181</b>	<b>130</b>	<b>170</b>
<b>Total - Projects Reviewed</b>	<b>85</b>	<b>68</b>	<b>51</b>	<b>77</b>	<b>95</b>	<b>72</b>	<b>118</b>	<b>87</b>	<b>82</b>	<b>91</b>

**Table 3.** Summary of fish kill events in 2022.

Date Reported	Water Body	Persons / Agencies Notified	Response	Date of Response	Species Affected	Approximate number affected/dead	Water Quality Measured	Samples Taken	Photos	Cause	Comments
8/2/2022	Bristol Harbor	DEM, OWR, DLE	DMF responded to the scene	8/2/2022	Blue mussel <i>Mytilus edulis</i>	Moderate to major (thousands)	Y	N	Y	Natural mortality due to heat wave	Water temperature above ideal threshold for blue
8/26/2022	Seekonk River	DEM, DLE, OER, OWR	DMF could not respond to the scene (location information too vague and no callback info)	8/26/2022	Atlantic menhaden <i>Brevoortia tyrannus</i>	Unknown	N	N	N	Most likely natural - ongoing intermittent hypoxia combined with high concentration of fish and predators chasing	
9/2/2022	Sapowet Cove, Sakonnet River	DEM, DLE, OWR, OER	Response not deemed necessary	NA	Atlantic menhaden <i>Brevoortia tyrannus</i>	Moderate to major (thousands)	N	N	Y	Most likely natural - ongoing intermittent hypoxia combined with high concentration of fish and predators chasing	
9/2/2022	Nanaquaket Pond	DEM, DLE, OWR, OER	Response not deemed necessary	NA	Atlantic menhaden <i>Brevoortia tyrannus</i>	Moderate to major (thousands)	N	N	Y	Most likely natural - ongoing intermittent hypoxia combined with high concentration of fish and predators chasing	Two reports: Tiverton Harbor Commission and recreational kayaker
9/2/2022	Congdon Cove	DEM	Response not deemed necessary	NA	Atlantic menhaden <i>Brevoortia tyrannus</i>	Moderate	N	N	Y	Most likely natural - ongoing intermittent hypoxia combined with high concentration of fish and predators chasing	



The Rhode Island Chapter of The Nature Conservancy  
Annual Progress Report

Submitted to

The Rhode Island Department of Environmental Management  
Division of Fish and Wildlife

Title: Providence River Estuary Seine Survey

Cooperative Agreement Award Number: 3481879

Award Term: January 30, 2020 to December 31, 2024

Reporting Period: January 30, 2022 to December 31, 2022

Prepared By

Sarah Paulson (Coastal Restoration Science Technician) and  
Heather Kinney (Coastal Restoration Scientist)

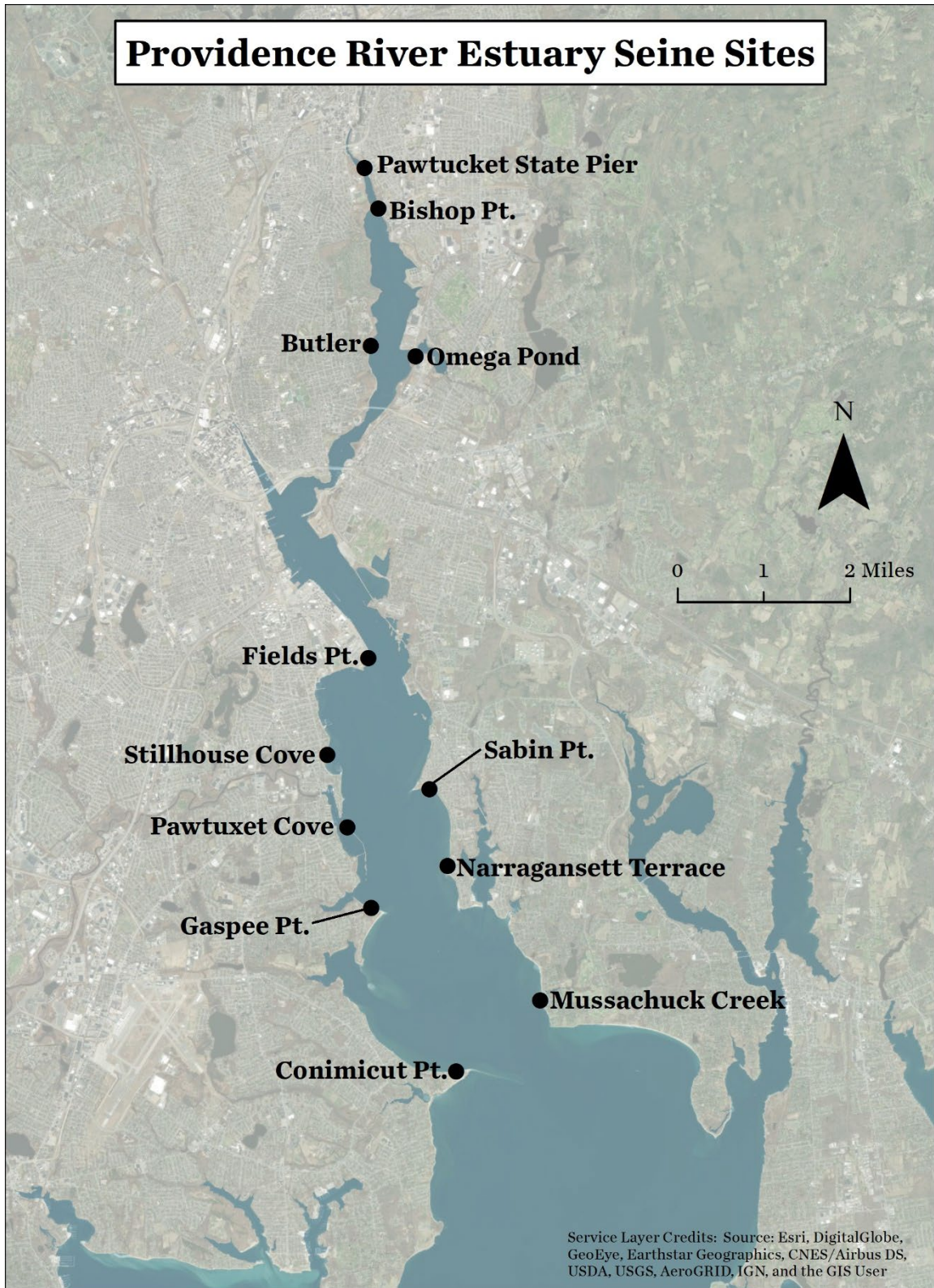
Approved By

Scott Comings, Associate State Director

The Nature Conservancy Rhode Island Chapter  
159 Waterman Street  
Providence, RI 02906



Map of the study area and sampling locations.



## **SUMMARY**

During the 2022 season, a total of 72 seines were hauled across 12 sites from May through October resulting in the enumeration of 51,566 individuals. Of the animals caught, 6,393 were measured and 41 species were identified (see Table 1). All scoped work was completed despite the additional considerations for safely working in the field during the COVID-19 pandemic. All raw data have been shared with the appropriate Division of Marine Fisheries staff for incorporation into existing datasets.

## **TARGET DATE:**

December 31, 2022

## **NEXT STEPS**

Investigators intend to continue sampling with the same methodology during the field season of 2023. Additionally, the project team will continue coordinating with the primary investigators of the Coastal Ponds and Great Salt Pond juvenile fish surveys to evaluate variations in fish assemblages across regions.

## **INTRODUCTION**

Estuaries are also known as “nurseries of the sea” because they provide critical habitat for many marine species in the early parts of their life cycle. Unfortunately, estuaries are also some of the most threatened natural systems across the globe, primarily due to human development and industrialization (Halpern et al. 2008; Lotze et al. 2006). Rhode Island’s Narragansett Bay, the defining water feature of the state, is no exception, and negative human impacts on the bay have been well-documented (NBEP 2017). Among the most heavily degraded waters of Narragansett Bay are the Providence and Seekonk rivers, found in the northern range of Narragansett Bay and collectively known as the Providence River Estuary (PRE). The PRE is located along the City of Providence and is fed by the Blackstone, Mosshasuck, and Woonasquatucket rivers.

For decades, nutrient over-enrichment has been found to have many negative effects on this area, including increases in hypoxic events and fish kills (Carey et al. 2005; Deacutis 2008). In recent years, improvements in wastewater treatment facilities have led to an estimated reduction in nutrient concentration of around 60% within the PRE (Oviatt et al. 2017). This notable and rapid improvement has been dubbed by Nixon et al. in 2008 as a “Grand Ecological Experiment” as not much was known about the impacts of this abrupt change. As a result of these reduced nutrient inputs and perceived improvements in water quality to support fish populations, interest from managers grew in evaluating the utilization of this historically important estuary by juvenile fishes. Additionally, a subsequent literature review revealed that very little empirical data existed on the fish assemblages within the estuary. In fact, the most recent fisheries resource study conducted by the Rhode Island Department of Environmental Management, Division of Marine Fisheries (DMF) within the Providence and Seekonk Rivers was in 1996 (Satchwill et al. 1997). This missing information is critically important because it has also been estimated that more than 70% of Rhode Island’s recreationally and commercially important finfish spend at

least part of their lives in estuarine and coastal waters, usually when young (Meng and Powell 1999).

In 2014, the DMF and The Nature Conservancy (TNC) entered into a cooperative agreement to begin evaluating the PRE and its role in supporting fish populations. Through a holistic approach the estuary's water quality, benthic and coastal habitat, and fish assemblages were evaluated. Not only did this monitoring reveal that the PRE supported recreationally and commercially important juvenile finfish, but it also recognized that the study area could support habitat improvements aimed at increasing fish recruitment.

Among the study's approaches, a juvenile fish seine survey was established in 2016. The results of this initial evaluation have shown the seine survey to be a valuable tool for DMF in managing fish populations. Continuation of this survey contributes to DMF's ability to evaluate juvenile fish populations across Rhode Island and aligns with other active, established seine surveys across the state within the coastal ponds along the southern shores of the state and Great Salt Pond on Block Island. As the habitat and water quality of the PRE continue to change, this seine survey will also serve to document how these changes affect the fish assemblage within the study area.

## **METHODS**

Twelve sites were sampled at monthly intervals from May through October. At each site a 130' long, 5.5' deep, ¼" mesh net beach seine was used. This net was also outfitted with a bag at its midpoint for fish collection, a weighted footrope, and a floated headrope, all consistent with the net used in the Young of the Year Survey of Selected RI Coastal Ponds and Embayments (conducted as part of F-61-R-23, Job #3). For sampling, the net was deployed along the shoreline in a semicircle by boat. The net was then hauled onto shore from both ends toward the beach by hand. Animals caught were then emptied from the bag and transferred into a water-filled tote. All collected animals were then identified to genus or species and measured to the nearest centimeter (except winter flounder which were measured to the nearest millimeter). Additionally, the gender of any blue crabs was recorded. When appropriate, species were subsampled by measuring the first 30 individuals identified then enumerating the remainder. Upon completion, all animals were discarded back into the water at the collection site. While at the sampling site, temperature (°C), salinity (ppt), and dissolved oxygen (mg/L) were recorded with a Professional Plus series handheld YSI multiparameter meter, which was calibrated monthly throughout the sampling season per manufacturer recommendations.

## **RESULTS**

For the 2022 field sampling season, a total of 72 seines were hauled across the 12 sampling sites. A total of 51,566 individuals were identified and enumerated, and 6,393 of those were measured. A total of 41 species were caught (Table 1). Of the species caught, only finfish were included in the results below (all crustaceans were excluded).

Excluding Atlantic Menhaden from the analysis, a mean of  $293.25 \pm 47.25$  finfish were caught per haul. Catch per haul across sites was greatest at Butler at  $620.17 \pm 384.60$  and lowest at

Sabin Point at  $129.83 \pm 39.16$  SE (Figure 1). Catch per haul across months was greatest in September at  $666.58 \pm 216.15$  and lowest in May at  $56.73 \pm 16.14$  SE (Figure 2).

### *TARGET SPECIES*

#### Winter Flounder (*Pseudopleuronectes americanus*)

Of the total 300 winter flounder caught in 2022 seines, all were young of the year (max length = 99mm; Able and Fahay 1998; Berry et al. 1965). Winter flounder were caught in all months and at all sites except Bishop Point. The most abundant site for winter flounder was Pawtucket State Pier at a catch per haul of  $29 \pm 21.18$  SE. The most abundant month for winter flounder was June at a catch per haul of  $15.5 \pm 10.5$  SE (Table 2).

#### Summer Flounder (*Paralichthys dentatus*)

A total of 29 summer flounder were caught in 2022 beach seines, ranging in size from 3cm to 17cm. Summer flounder were caught at 5 of the 12 sites: Pawtucket State Pier, Bishop Point, Butler, Omega Pond, and Pawtucket Cove. Summer flounder were most abundant at Omega Pond, at a catch per haul of  $2.0 \pm 1.48$  SE. Most individuals were caught in June at a catch per haul of  $1.92 \pm 0.98$  SE (Figures 3a and 3b).

#### Tautog (*Tautoga onitis*)

A total of 339 tautog were caught in 2022 beach seines, ranging in size from 2cm to 17cm. Tautog were caught at 8 of the 12 sites: Fields Point, Stillhouse Cove, Sabin Point, Pawtucket Cove, Narragansett Terrace, Gaspee Point, Mussachuck Creek, and Conimicut Point. Of the 8 sites they were caught, tautog were most abundant at Fields Point, with a catch per haul of  $16.67 \pm 7.28$  SE. Most individuals were caught in July at a catch per haul of  $11.75 \pm 3.68$  SE (Figures 3a and 3b).

#### Black Sea Bass (*Centropristis striata*)

A total of 239 black sea bass were caught in 2022 beach seines, ranging in size from 1cm and 13cm. These fish were caught at 6 sites: Fields Point, Gaspee Point, Conimicut Point, Sabin Point, and Stillhouse Cove. They were most abundant at Fields Point, at a catch per haul of  $3.17 \pm 2.24$  SE. Most individuals were caught in September at a catch per haul of  $1.67 \pm 1.28$  SE (Figures 3a and 3b).

#### Scup (*Stenotomus chrysops*)

A total of 115 scup were caught in 2022 beach seines, ranging in size from 3cm to 11cm. Scup were caught in July, August, and September at 6 out of 12 sites - Fields Point, Stillhouse Cove, Narragansett Terrace, Gaspee Point, Mussachuck Creek, and Conimicut Point. They were most abundant at Conimicut Point, at a catch per haul of  $10.00 \pm 6.83$  SE. Most individuals were caught in September at a catch per haul of  $3.75 \pm 3.31$  SE (Figure 3a and 3b).

## *OTHER SPECIES OF INTEREST*

### Atlantic Menhaden (*Brevoortia tyrannus*)

In the 2022 sampling season, 29,785 Atlantic menhaden were caught, ranging in size from 4cm to 14cm. The total survey mean abundance index is  $413.68 \pm 146.51$  SE. Atlantic menhaden were found July through October and at all sites.

### River Herring (*Alosa pseudoharengus* & *Alosa aestivalis*)

A total of 1,048 river herring were caught in 2022. Both Alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) are classified as river herring in this survey. River herring ranged in size from 4cm to 24cm and were found May through October. They were found at 8 sampling sites (all except Sabin Point, Gaspee Point, and Conimicut Point) with a total survey mean abundance of  $14.56 \pm 10.94$

### Bluefish (*Pomatomus saltatrix*)

A total of 50 bluefish were caught in 2022. The total mean abundance per haul is  $0.69 \pm 0.36$  SE ranging in size from 8cm to 14cm. Bluefish were found in July, September, and October at 7 sites (Fields Point, Stillhouse Cove, Sabin Point, Narragansett Terrace, Gaspee Point, Mussachuck Creek, and Connimicut Point).

### Gizzard Shad (*Dorosoma cepedianum*)

A total of 723 gizzard shad were caught in 2022. The total mean abundance is  $10.04 \pm 5.11$  SE ranging in size from 5cm to 15cm. Gizzard Shad were found July to October at 8 sites including Pawtucket State Pier, Bishop Point, Butler, Fields Point, Omega Pond, Sabin Point, Stillhouse Cove, and Mussachuck Creek.

### Silverside (*Menidia spp.*)

A total of 11,007 silversides were caught in 2022. For the purposes of this survey, both Atlantic silversides (*Menidia menidia*) and inland silversides (*Menidia beryllina*) are categorized as silversides (*Menidia spp.*). The total mean abundance is  $152.88 \pm 40.09$  SE and silversides ranged in size from 2cm to 13cm, found in all months and at all sites.

### Striped Killifish (*Fundulus majalis*)

A total of 3,759 striped killifish were caught in 2022, ranging in size from 4cm to 14cm. The total mean abundance is  $52.21 \pm 12.83$  SE, and they were found at all sites except Bishop Point from May through October.

### Common Mummichog (*Fundulus heteroclitus*)

A total of 1,383 common mummichog were caught in 2022, ranging in size from 3cm to 11cm. The total mean abundance is  $19.21 \pm 7.86$  SE, and they were found at all sites except Fields Point and Narragansett Terrace from May through October.

## *WATER QUALITY DATA*

Water quality data for the 2022 season can be found in Table 3. Water temperature ranged from 9°C in May to 27.7°C in June. The mean salinity of the four sites within the Seekonk River was

10.34ppt  $\pm$  2.19 SE and the mean salinity of the eight sites within the Providence River was 24.63ppt  $\pm$  3.55 SE. The lowest dissolved oxygen value recorded across all sites was 4.24mg/L in September at Sabin Point, while the mean was 9.27mg/L  $\pm$  1.09 SE.

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**FIGURES:**

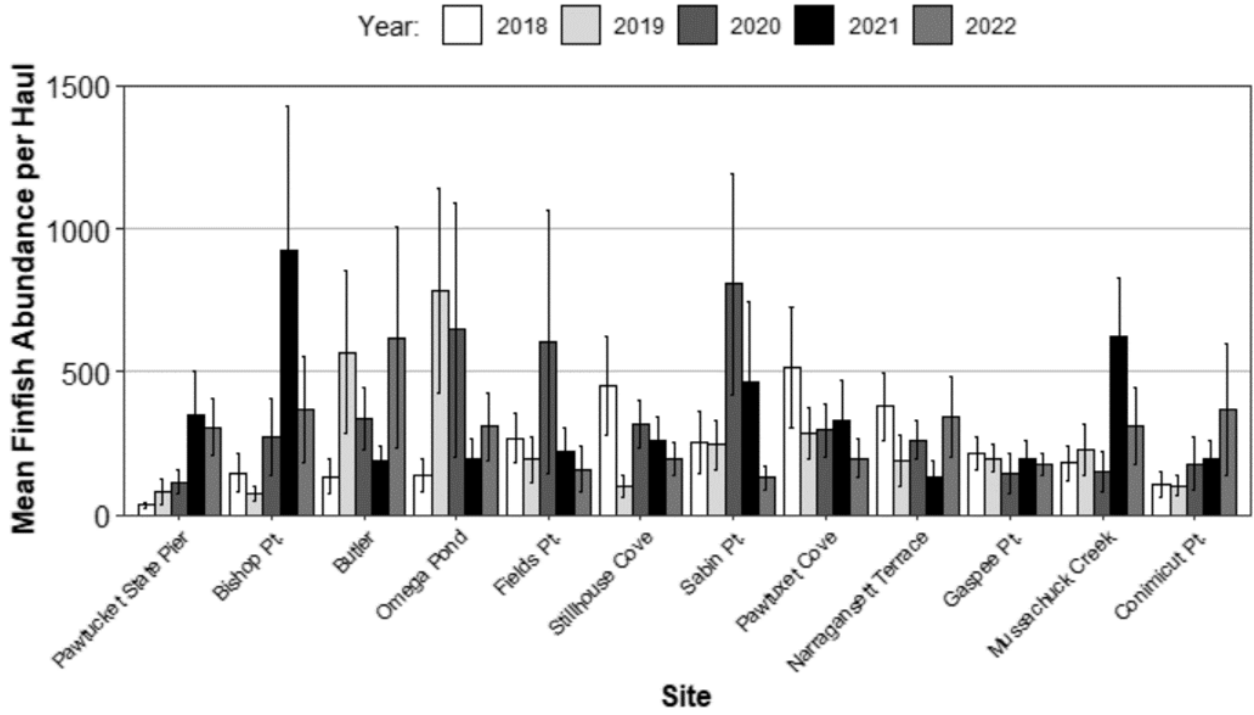


Figure 1. Mean abundance of finfish (excluding Atlantic Menhaden) across sites ( $\pm$ SE) in 2018-2022 beach seines.

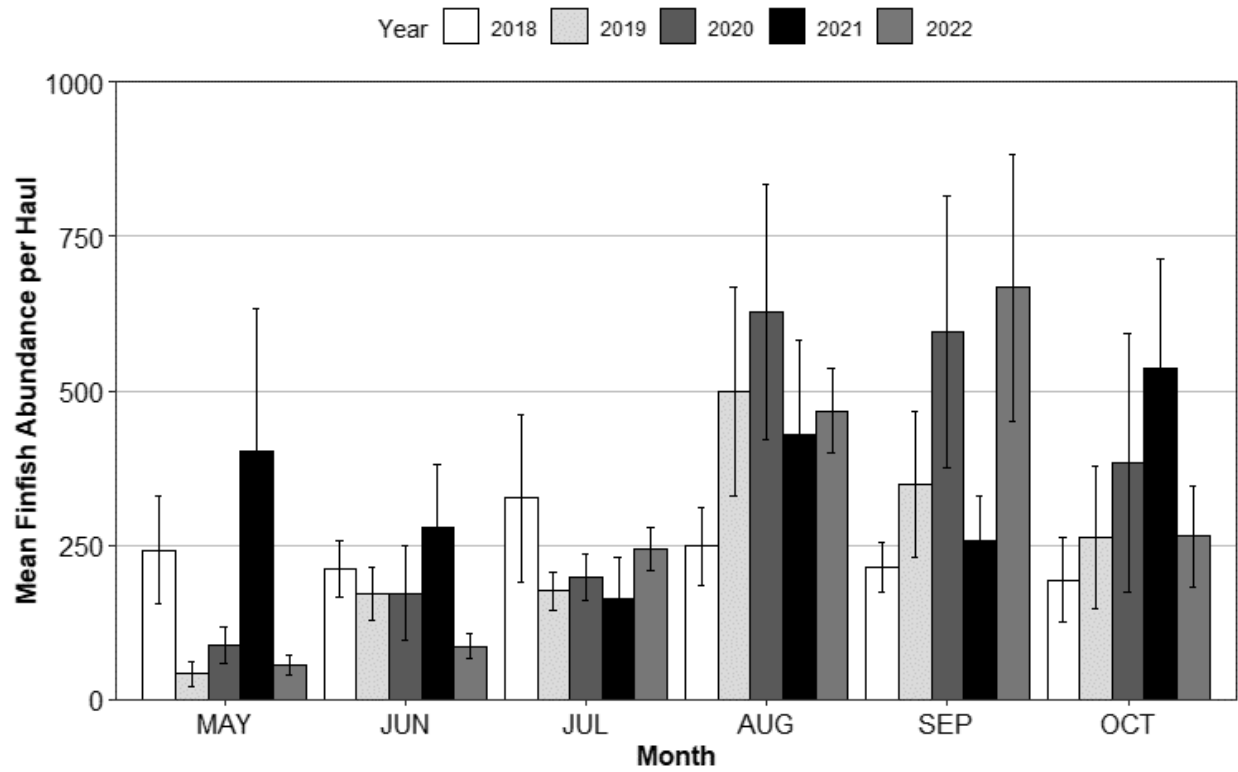


Figure 2. Mean abundance finfish (excluding Atlantic Menhaden) caught each month ( $\pm$ SE) in 2018-2022 beach seines.

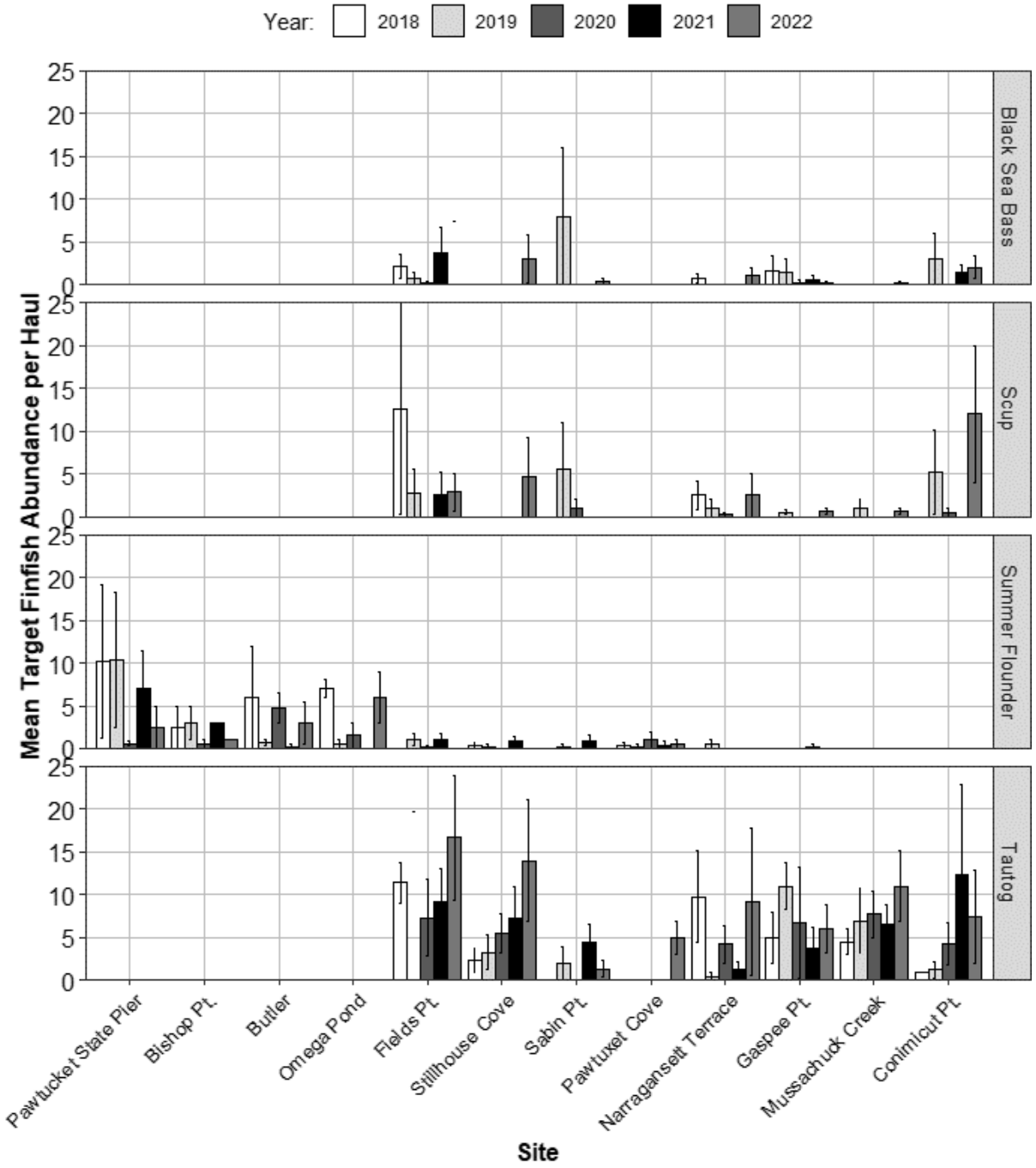


Figure 3a. Mean abundance of target finfish (except winter flounder) caught by site ( $\pm$ SE) in 2018-2022 beach seines.

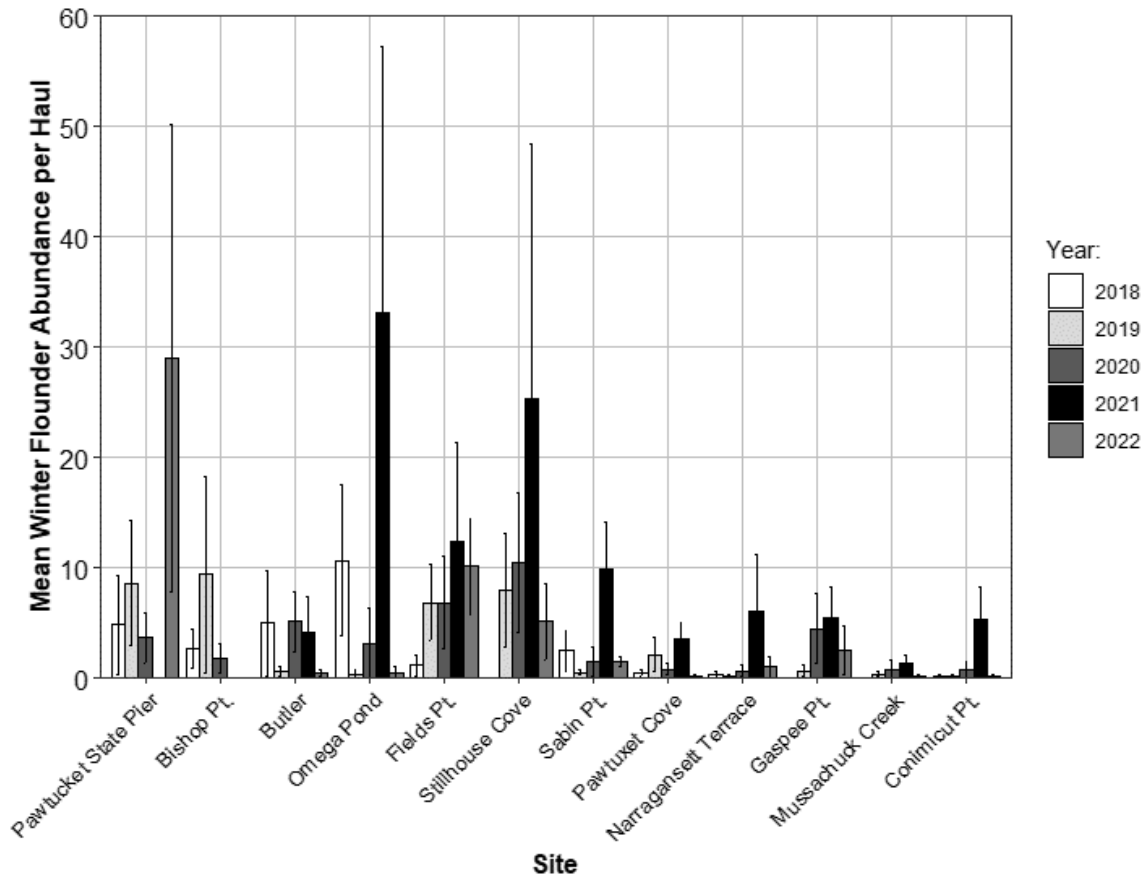


Figure 3b. Mean abundance of winter flounder caught by site in 2018-2022 beach seines.

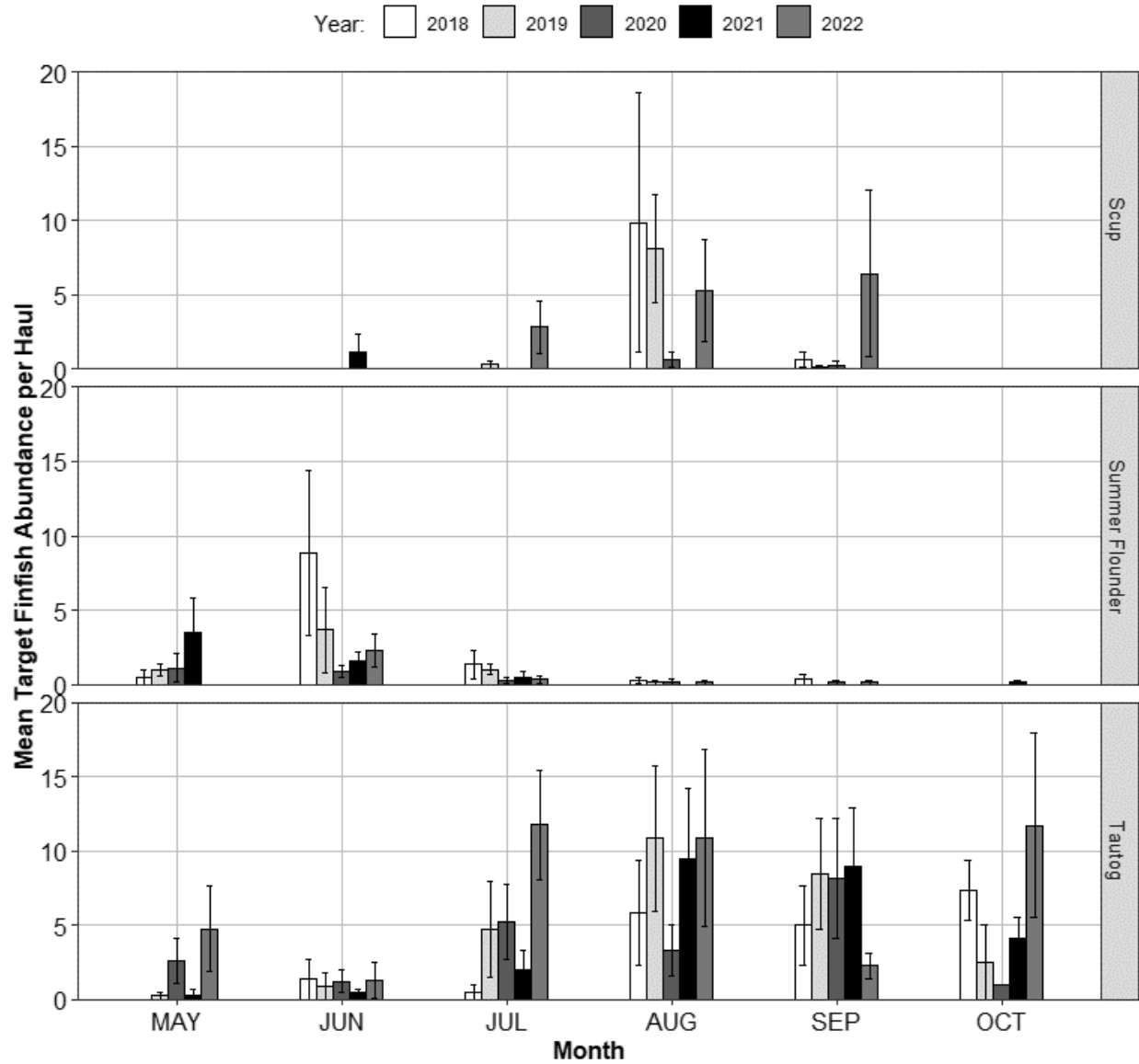


Figure 4a. Mean target finfish (Scup, Summer Flounder, and Tautog) per seine haul ( $\pm$  SE) plotted for each month sampled during the 2018-2022 field seasons.

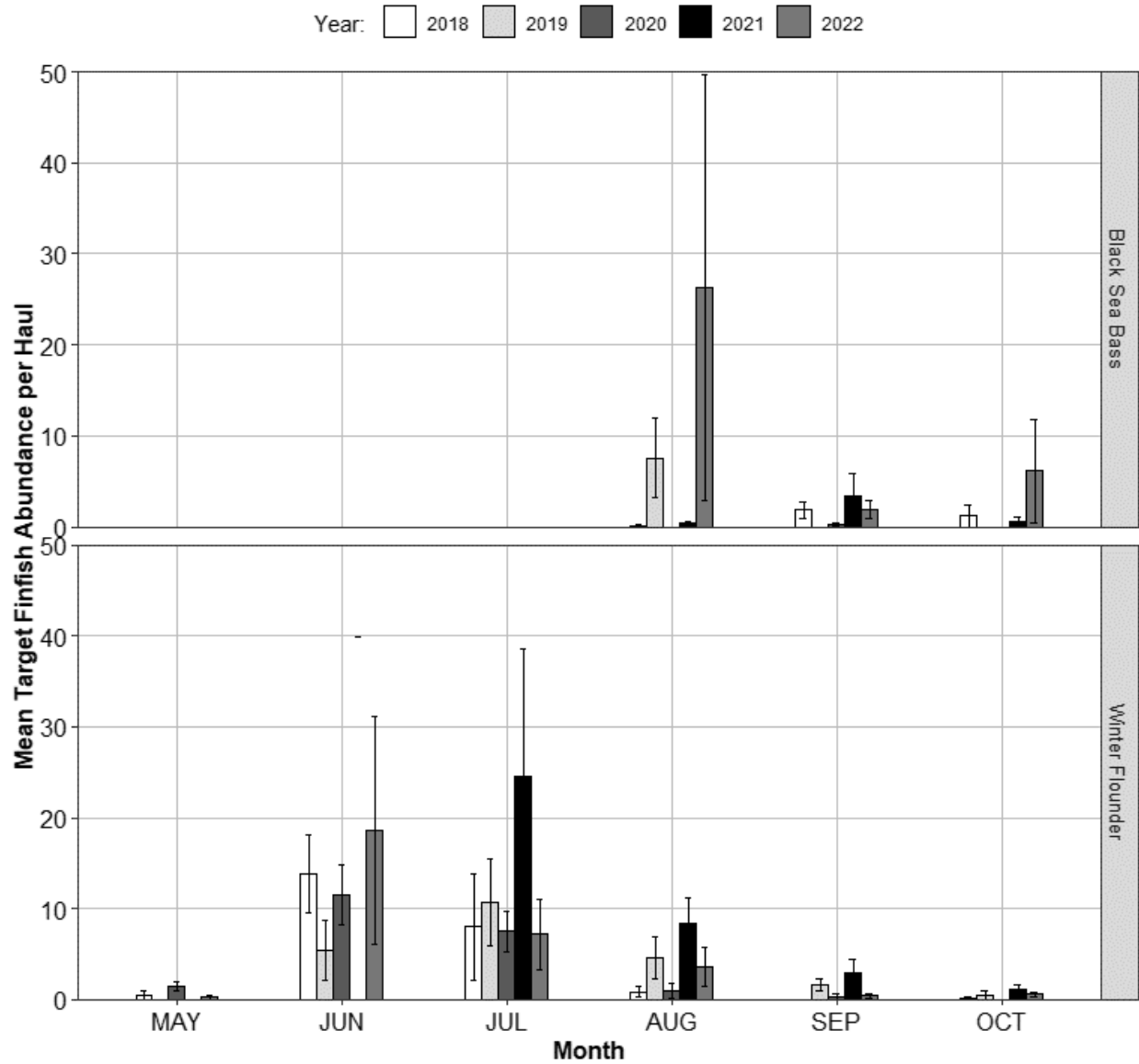


Figure 4b. Mean target finfish (Black Sea Bass and Winter Flounder) per seine haul ( $\pm$  SE) plotted for each month sampled during the 2018-2022 field seasons.

Table 1. Common, scientific names, and total abundance of all species collected in beach seines during 2022.

<b>Common Name</b>	<b>Scientific Name</b>	<b>Abundance</b>
Atlantic Menhaden	<i>Brevoortia tyrannus</i>	29785
Atlantic Silverside	<i>Menidia menidia</i>	11007
Striped Killifish	<i>Fundulus majalis</i>	3759
Common Mummichog	<i>Fundulus heteroclitus</i>	1383
Northern Kingfish	<i>Menticirrhus saxatilis</i>	1214
River Herring	<i>Alosa aestivalis</i> &/or <i>pseudoharengus</i>	1048
Gizzard Shad	<i>Dorosoma cepedianum</i>	723
Weakfish	<i>Cynoscion regalis</i>	502
Blue Crab	<i>Calinectes sapidus</i>	356
Tautog	<i>Tautoga onitis</i>	347
Winter Flounder	<i>Pseudopleuronectes americanus</i>	305
Black Sea Bass	<i>Centropristus striata</i>	240
Northern Searobin	<i>Prionotus carolinus</i>	202
Northern Puffer	<i>Sphoeroides maculatus</i>	180
Scup	<i>Stenotomus chrysops</i>	116
Bay Anchovy	<i>Anchoa mitchilli</i>	93
Bluefish	<i>Pomatomus saltatrix</i>	50
Summer Flounder	<i>Paralichthys dentatus</i>	29
Green Crab	<i>Carcinus maenus</i>	25
Hogchoker	<i>Trinectes maculatus</i>	25
Cunner	<i>Tautogolabrus adspersus</i>	22
Atlantic Tomcod	<i>Microgadus tomcod</i>	21
Rainwater Killifish	<i>Lucania parva</i>	21
Mud Crab	<i>Panopeus spp</i>	20
Largemouth Bass	<i>Micropterus salmoides</i>	14
Northern Pipefish	<i>Syngnathus fuscus</i>	12
Spider Crab	<i>Libinia emarginata</i>	10
4-Spine Stickleback	<i>Apeltes quadracus</i>	9
White Perch	<i>Morone americana</i>	9
Atlantic Needlefish	<i>Strongylura marina</i>	7
Lady Crab	<i>Ovalipes ocellatus</i>	7
American Eel	<i>Anguilla rostrata</i>	4
Sheepshead Minnow	<i>Cyprinodon variegatus</i>	4
White Sucker	<i>Catostomus commersonii</i>	4
Oyster Toadfish	<i>Opsanus tau</i>	3
White Mullet	<i>Mugil curema</i>	3
Japanese Shore Crab	<i>Hemigrapsus sanguineus</i>	2
Naked Goby	<i>Gobiosoma bosc</i>	2
Jack spp.	<i>Carangidae family</i>	1
Striped Bass	<i>Morone saxatilis</i>	1
Striped Searobin	<i>Prionotus evolans</i>	1

Table 2. Abundances of winter flounder in 2022 beach seines.

		Site											Mean	SD	SE	Total	
Winter Flounder	Month	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtuxet Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Conimicut Pt.				
	MAY	0	0	0	0	0	0	1	0	0	0	0	0	0.08	0.29	0.08	1
	JUN	128	0	2	0	23	22	3	0	6	1	1	0	15.50	36.39	10.50	186
	JUL	46	0	1	3	20	5	0	1	0	9	0	1	7.17	13.54	3.91	86
	AUG	0	0	0	0	16	2	3	0	0	0	0	0	1.75	4.59	1.33	21
	SEP	0	0	0	0	0	2	1	0	0	0	0	0	0.25	0.62	0.18	3
	OCT	0	0	0	0	2	0	1	0	0	0	0	0	0.25	0.62	0.18	3
<b>Mean</b>	29.00	0	0.50	0.50	10.17	5.17	1.50	0.17	1.00	1.67	0.17	0.17					
<b>SD</b>	51.87	0	0.84	1.22	10.67	8.45	1.22	0.41	2.45	3.61	0.41	0.41					
<b>SE</b>	21.18	0	0.34	0.50	4.35	3.45	0.50	0.17	1.00	1.48	0.17	0.17					
<b>Total</b>	174	0	3	3	61	31	9	1	6	10	1	1					
																	<b>Total fish:</b>
																	300



Table 3. Temperature, salinity, and dissolved oxygen by site and month during 2022 beach seines.

Site	Month	Temp (°C)	Salinity (ppt)	DO (mg/L)	Site	Month	Temp (°C)	Salinity (ppt)	DO (mg/L)
Pawtucket State Pier	MAY	13.6	5.5	11.86	Sabin Point	MAY	9	27.5	12.48
	JUN	18.1	4.6	8.43		JUN	18.7	24.3	NA
	JUL	24.6	9.8	7.48		JUL	23.7	25.4	9.47
	AUG	26.5	6.8	6.1		AUG	26	27.6	8.16
	SEP	18	3.2	8.42		SEP	22.7	28.1	4.24
	OCT	14.6	5.2	8.22		OCT	18.2	25.6	9.65
Bishop Point	MAY	12.6	7.1	11.39	Pawtuxet Cove	MAY	13.2	25.4	13.33
	JUN	19.8	5.8	7.88		JUN	20.1	7.6	7.72
	JUL	24	12	7.5		JUL	24.4	12.3	10.49
	AUG	27.1	13.3	14.44		AUG	25.6	13.8	7.63
	SEP	21.4	9	11.68		SEP	22.1	10.3	6.13
	OCT	15	7.6	8.2		OCT	16.6	13	8.05
Butler	MAY	16.6	12.2	13.69	Narragansett Terrace	MAY	10.5	25.5	15.03
	JUN	19.5	15.4	7.35		JUN	18.8	22.7	NA
	JUL	25.4	12	NA		JUL	22.9	25.9	9.17
	AUG	26.6	23.8	6.06		AUG	25	27.9	7.35
	SEP	20.9	12.5	15		SEP	23.3	25.4	5.66
	OCT	16	11.8	6.83		OCT	17	29.8	8.98
Omega Pond	MAY	15.7	11.9	11.64	Gaspee Point	MAY	16.9	11	12.27
	JUN	21.9	7	7.74		JUN	18.6	26.4	NA
	JUL	24.2	14.3	8.33		JUL	23.8	26.6	9.23
	AUG	26.1	21	5.75		AUG	NA	NA	NA
	SEP	21.4	13.3	11.85		SEP	21.9	20.2	5.82
	OCT	16.7	12.6	7.42		OCT	17.2	27.6	8.54
Fields Point	MAY	8.9	27.3	11.85	Mussachuck Creek	MAY	13.1	26.6	10.99
	JUN	19.3	23	NA		JUN	18.1	24.7	9.14
	JUL	23.3	26	9.84		JUL	24.2	27.6	8.22
	AUG	26.7	27.9	8.66		AUG	26.8	29.7	8.31
	SEP	22	27	9.32		SEP	21.2	29.2	7.2
	OCT	18.5	27.9	9.24		OCT	16.5	30.5	8.92
Stillhouse Cove	MAY	12.2	20.8	12.77	Conimicut Point	MAY	11.7	27.7	13.4
	JUN	19.4	25	NA		JUN	17.5	28.6	6.45
	JUL	24.5	26.3	9.77		JUL	23	28.1	8.59
	AUG	27.7	27.2	11.08		AUG	26	28.8	8.38
	SEP	22.6	26.2	14.48		SEP	21.2	27.3	8.76
	OCT	15.8	25.1	6.17		OCT	16.4	29	8.1

**APPENDIX**

Species presence by site for May 2022 beach seines.

<b>MAY</b>	<b>Site</b>												
<b>Species</b>	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtucket Cove	Narragansett Cove	Gaspee Pt.	Mussachuck Creek	Conimicut Pt.	<b>Total</b>
Winter Flounder						1							<b>1</b>
Atlantic Silverside		1		1	1		1	1	1	1	1		<b>8</b>
Northern Pipefish				1		1				1			<b>3</b>
Hogchoker		1											<b>1</b>
Cunner				1						1			<b>2</b>
Tautog				1					1		1		<b>3</b>
American Eel	1						1						<b>2</b>
Atlantic Tomcod	1									1			<b>2</b>
Common Mummichog	1		1										<b>2</b>
Striped Killifish			1	1			1	1					<b>4</b>
4-Spine Stickleback									1				<b>1</b>
Spider Crab						1							<b>1</b>
Green Crab				1	1								<b>2</b>
Blue Crab	1	1	1	1			1			1			<b>6</b>

**APPENDIX**

Species presence by site for June 2022 beach seines.

<b>JUNE</b>	<b>Site</b>												
<b>Species</b>	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtuxet Cove	Narragansett Cove	Gaspee Pt.	Mussachuck Creek	Comimicut Pt.	<b>Total</b>
River Herring		1								1			2
Summer Flounder	1	1	1	1									4
Winter Flounder	1		1		1	1	1		1	1	1		8
Atlantic Silverside	1		1	1	1	1	1	1	1	1	1	1	11
Northern Pipefish					1				1				2
Hogchoker	1		1										2
Weakfish			1										1
Striped Searobin									1				1
Tautog									1	1			2
Atlantic Tomcod		1								1			2
Sheepshead Minnow							1						1
Common Mummichog			1	1		1	1			1			5
Striped Killifish							1		1	1			3
Rainwater Killifish									1				1
Spider Crab								1					1
Green Crab										1			1
Mud Crab									1				1
Blue Crab	1		1	1		1	1		1	1			7
Northern Searobin										1			1
Naked Goby					1								1

# APPENDIX

Species presence by site for July 2022 beach seines.

JULY	Site												
Species	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtuxet Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Cominicut Pt.	Total
River Herring	1	1	1	1	1			1		1			7
Atlantic Menhaden	1	1		1				1					4
Summer Flounder		1		1									2
Winter Flounder	1		1	1	1	1		1		1		1	8
Atlantic Silverside	1	1	1	1	1	1	1	1	1	1	1	1	12
Northern Pipefish								1		1			2
Hogchoker				1									1
Bluefish									1	1			2
Scup								1	1	1	1		4
Weakfish	1	1	1	1	1	1		1	1				8
Northern Kingfish	1	1	1	1	1	1	1	1	1	1	1	1	12
Cunner								1	1			1	3
Tautog					1	1	1	1	1	1	1	1	8
Northern Puffer			1		1	1		1	1	1	1	1	7
Gizzard Shad	1	1	1	1						1			5
Common Mummichog			1					1		1	1		4
Striped Killifish					1	1	1	1	1	1	1	1	7
4-Spine Stickleback								1					1
White Mullet				1									1
Rainwater Killifish								1	1				2
Largemouth Bass	1			1									2
White Sucker	1												1
Spider Crab							1		1	1	1	1	5
Lady Crab								1					1
Green Crab					1								1
Mud Crab					1				1				2
Blue Crab	1	1	1	1	1	1	1	1	1		1	1	10
Northern Searobin		1	1	1	1	1	1	1	1	1	1	1	11
Naked Goby									1				1
Japanese Shore Crab							1			1			2

# APPENDIX

Species presence by site for August 2022 beach seines.

AUGUST	Site												
Species	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtucket Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Cominicut Pt.	Total
River Herring	1												1
Atlantic Menhaden	1	1			1								3
Summer Flounder							1						1
Winter Flounder				1	1	1							3
Atlantic Silverside	1	1	1	1	1	1	1	1		1	1		11
Hogchoker			1										1
White Perch	1		1										2
Black Sea Bass				1	1					1	1		4
Scup				1	1								2
Weakfish	1	1		1	1								4
Northern Kingfish	1		1	1	1	1	1	1		1	1		10
Cunner				1				1					2
Tautog				1	1	1	1						4
Oyster Toadfish				1									1
Northern Puffer			1	1	1		1			1			5
American Eel				1									1
Gizzard Shad	1	1	1		1								4
Atlantic Needlefish							1						1
Common Mummichog		1	1	1		1				1	1		6
Striped Killifish	1		1	1	1	1	1	1		1	1		10
Rainwater Killifish			1			1	1						3
Spider Crab										1			1
Lady Crab						1		1					2
Green Crab				1	1	1							3
Mud Crab				1									1
Blue Crab	1	1	1	1	1	1	1						8
Northern Searobin				1	1	1	1				1		5

# APPENDIX

Species presence by site for September 2022 beach seines.

SEPTEMBER	Site												
Species	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtucket Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Cominicut Pt.	Total
River Herring					1				1				2
Atlantic Menhaden	1	1	1	1	1		1	1	1		1		9
Bay Anchovy	1	1											2
Summer Flounder		1											1
Winter Flounder				1	1								2
Atlantic Silverside	1	1	1	1	1	1	1	1	1	1	1	1	12
Northern Pipefish								1					1
Hogchoker	1												1
Bluefish				1	1	1		1		1	1		6
Black Sea Bass				1	1			1			1		4
Scup				1						1	1		3
Weakfish					1								1
Northern Kingfish		1		1	1	1		1	1		1		7
Cunner										1			1
Tautog				1	1					1	1		4
Northern Puffer				1				1					2
Gizzard Shad	1	1	1										3
Atlantic Needlefish								1		1			2
Common Mummichog	1	1	1	1		1	1	1		1	1		9
Striped Killifish		1	1	1	1	1	1	1	1	1	1	1	10
Jack spp.									1				1
White Mullet											1		1
Rainwater Killifish			1										1
Largemouth Bass	1		1										2
Blue Crab	1	1	1	1		1				1			6
Mud Crab			1										1

# APPENDIX

Species presence by site for October 2022 beach seines.

OCTOBER	Site												
Species	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtucket Cove	Narragansett Cove	Gaspee Pt.	Mussachusett Terrace	Conimicut Creek	Total
River Herring					1		1			1			3
Atlantic Menhaden	1	1	1	1	1	1	1	1	1	1			10
Winter Flounder				1		1							2
Atlantic Silverside	1	1	1	1	1	1	1	1	1		1	1	11
Northern Pipefish										1	1		2
Hogchoker	1	1											2
Bluefish				1									1
Striped Bass			1										1
White Perch			1										1
Black Sea Bass				1		1					1		3
Northern Kingfish						1		1			1		3
Cunner				1						1			2
Tautog				1	1	1		1		1	1		6
Gizzard Shad	1			1		1							3
Sheepshead Minnow			1										1
Common Mummichog	1		1	1		1	1	1		1			7
Striped Killifish	1		1		1	1	1	1		1	1		9
Rainwater Killifish										1			1
Largemouth Bass		1											1
Blue Crab	1	1	1	1	1		1						6
Green Crab				1			1			1	1		4

# APPENDIX

Abundances of summer flounder in 2022 beach seines.

Summer Flounder	Sites													Mean	SD	SE	Total
	Month	Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtuxet Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Comimicut Pt.				
MAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JUN	5	1	8	9	0	0	0	0	0	0	0	0	0	1.92	3.40	0.98	23
JUL	0	1	0	3	0	0	0	0	0	0	0	0	0	0.33	0.89	0.26	4
AUG	0	0	0	0	0	0	0	1	0	0	0	0	0	0.08	0.29	0.08	1
SEP	0	0	1	0	0	0	0	0	0	0	0	0	0	0.08	0.29	0.08	1
OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Mean</b>	0.83	0.33	1.50	2.00	0	0	0	0.17	0	0	0	0	0	<b>Total fish:</b>			
<b>SD</b>	2.04	0.52	3.21	3.63	0	0	0	0.41	0	0	0	0	0	24			
<b>SE</b>	0.83	0.21	1.31	1.48	0	0	0	0.17	0	0	0	0	0				
<b>Total</b>	5	2	9	12	0	0	0	1	0	0	0	0	0				



**APPENDIX**

Abundances of black sea bass 2022 beach seines.

		<b>Sites</b>												<b>Mean</b>	<b>SD</b>	<b>SE</b>	<b>Total</b>
		Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtuxet Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Conimicut Pt.				
<b>Black Sea Bass</b>	<b>Month</b>																
	MAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	AUG	0	0	0	0	166	14	0	0	0	0	1	2	15	48	14	183
	SEP	0	0	0	0	1	1	0	0	4	0	0	7	1	2	1	13
	OCT	0	0	0	0	40	0	2	0	0	0	0	1	4	11	3	43
<b>Mean</b>	0	0	0	0	35	3	0	0	1	0	0	2					
<b>SD</b>	0	0	0	0	66	6	1	0	2	0	0	3					
<b>SE</b>	0	0	0	0	27	2	0	0	1	0	0	1					
<b>Total</b>	0	0	0	0	207	15	2	0	4	0	1	10					
													<b>Total fish: 239</b>				

**APPENDIX**

Abundances of scup in 2022 beach seines.

		Sites												Mean	SD	SE	Total
		Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtuxet Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Conimicut Pt.				
<b>Scup</b>	Month	MAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	JUL	0	0	0	0	0	0	0	0	10	2	2	20	2.83	6.12	1.77	34
	AUG	0	0	0	0	13	23	0	0	0	0	0	0	3.00	7.32	2.11	36
	SEP	0	0	0	0	4	0	0	0	0	0	1	40	3.75	11.47	3.31	45
	OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mean	0	0	0	0	2.83	3.83	0	0	1.67	0	0.50	10.00				
	SD	0	0	0	0	5.23	9.39	0	0	4.08	0.82	0.84	16.73	<b>Total fish:</b>			
	SE	0	0	0	0	2.14	3.83	0	0	1.67	0	0	6.83	115			
	Total	0	0	0	0	17	23	0	0	10	2	3	60				

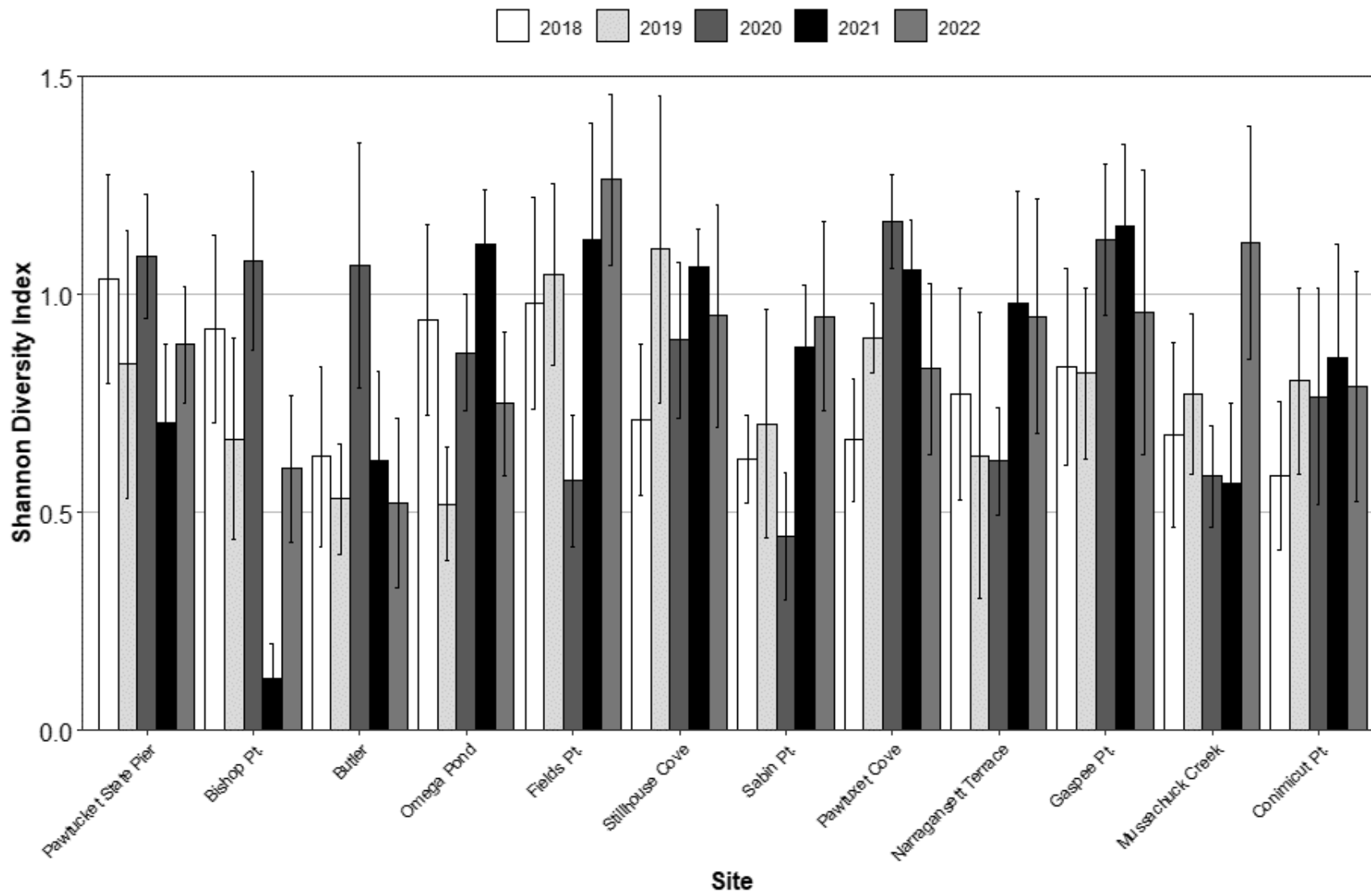
**APPENDIX**

Abundances of tautog in 2022 beach seines.

		Site												Mean	SD	SE	Total
		Pawtucket State Pier	Bishop Pt.	Butler	Omega Pond	Fields Pt.	Stillhouse Cove	Sabin Pt.	Pawtuxet Cove	Narragansett Terrace	Gaspee Pt.	Mussachuck Creek	Comimicut Pt.				
Tautog	Month																
	MAY	0	0	0	0	13	0	0	0	0	4	0	2	1.58	3.80	1.10	19
	JUN	0	0	0	0	0	0	0	0	0	1	12	0	1.08	3.45	1.00	13
	JUL	0	0	0	0	8	24	1	7	35	17	20	29	11.75	12.75	3.68	141
	AUG	0	0	0	0	30	37	1	3	0	0	0	0	5.92	13.00	3.75	71
	SEP	0	0	0	0	3	5	0	0	0	0	3	5	1.33	2.06	0.59	16
	OCT	0	0	0	0	46	4	6	0	2	0	20	1	6.58	13.66	3.94	79
<b>Mean</b>	0	0	0	0	16.67	11.67	1.33	1.67	6.17	3.67	9.17	6.17					
<b>SD</b>	0	0	0	0	17.84	15.29	2.34	2.88	14.15	6.71	9.47	11.34	<b>Total fish:</b>				
<b>SE</b>	0	0	0	0	7.28	6.24	0.95	1.17	5.78	2.74	3.87	4.63	307				
<b>Total</b>	0	0	0	0	100	70	8	10	37	22	55	37					

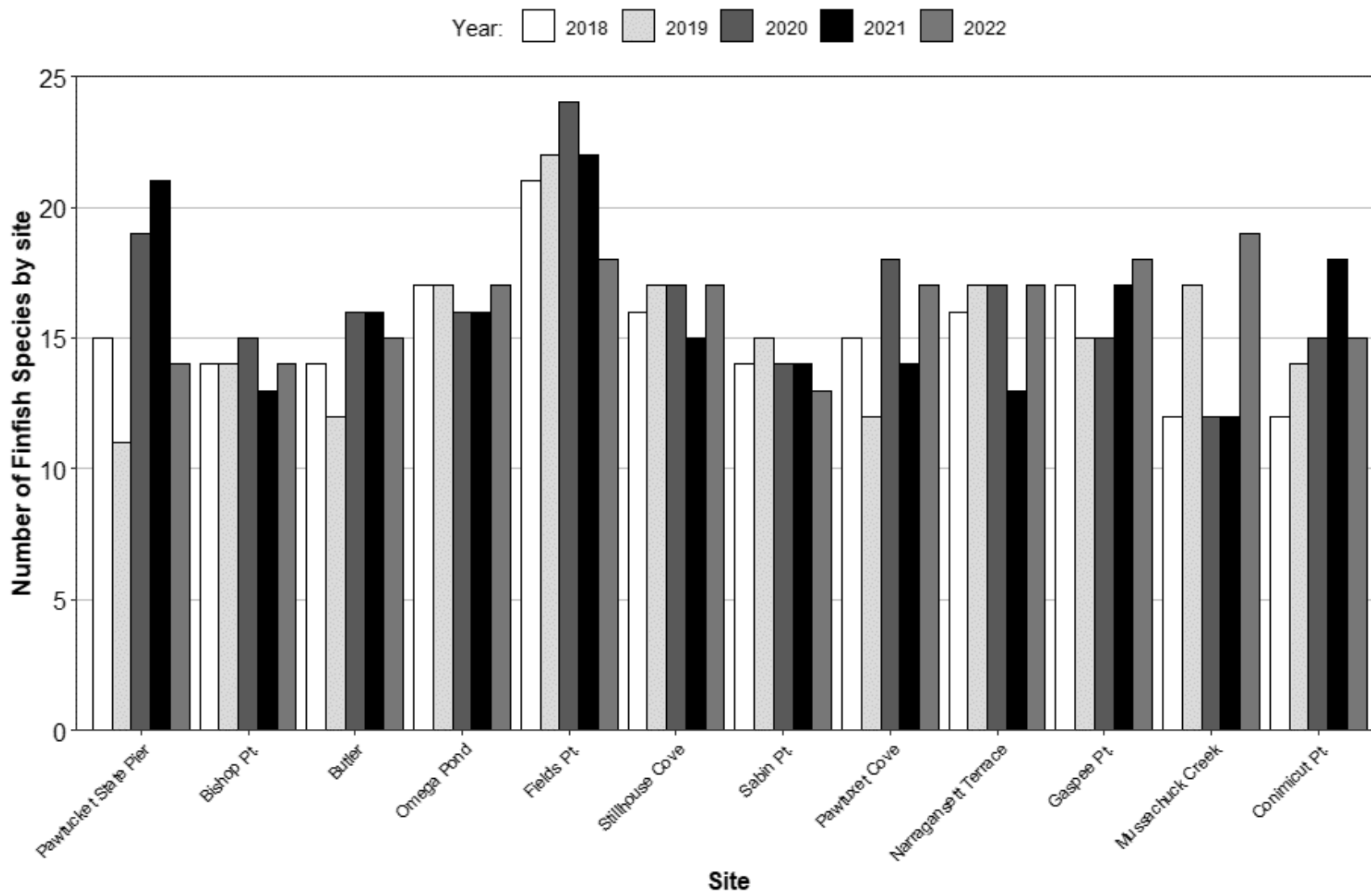
# APPENDIX

Mean Shannon diversity across sites in 2018-2022 beach seines.



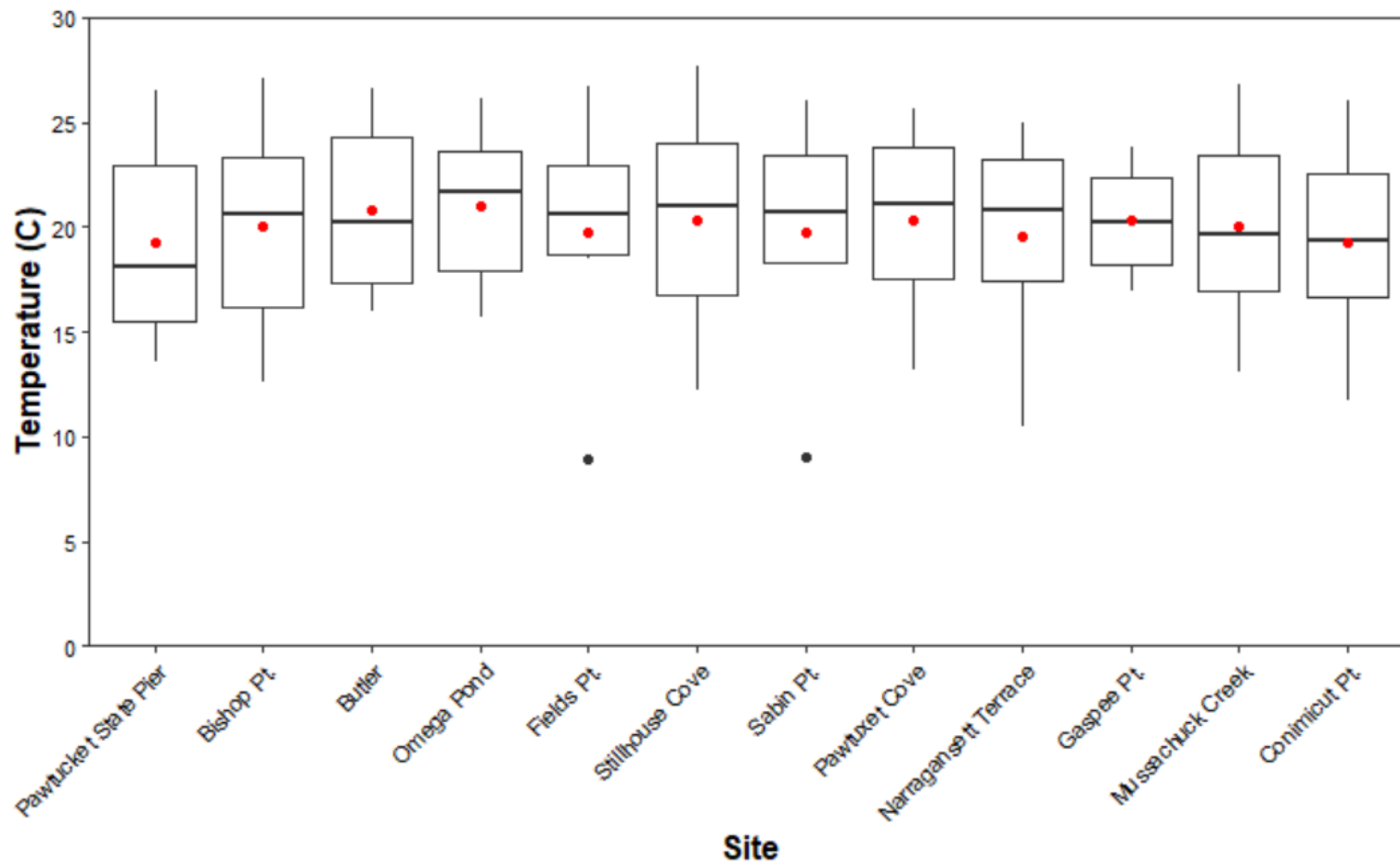
# APPENDIX

Cumulative number of finfish species by site in 2018-2022 beach seines.



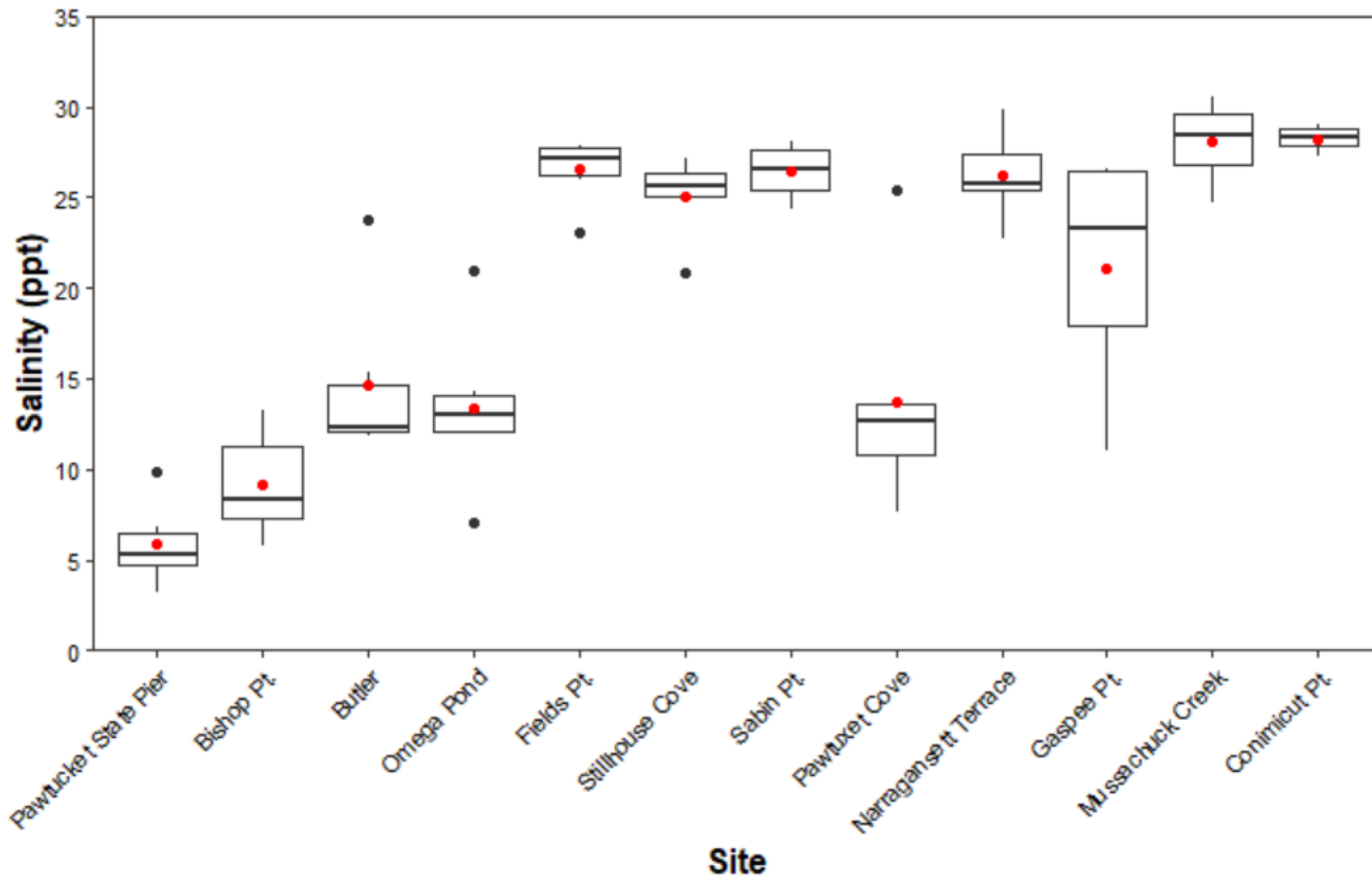
# APPENDIX

Boxplot of temperature (C) recorded by handheld YSI across all seine stations in 2022 at the time of sample (red dot indicates mean).



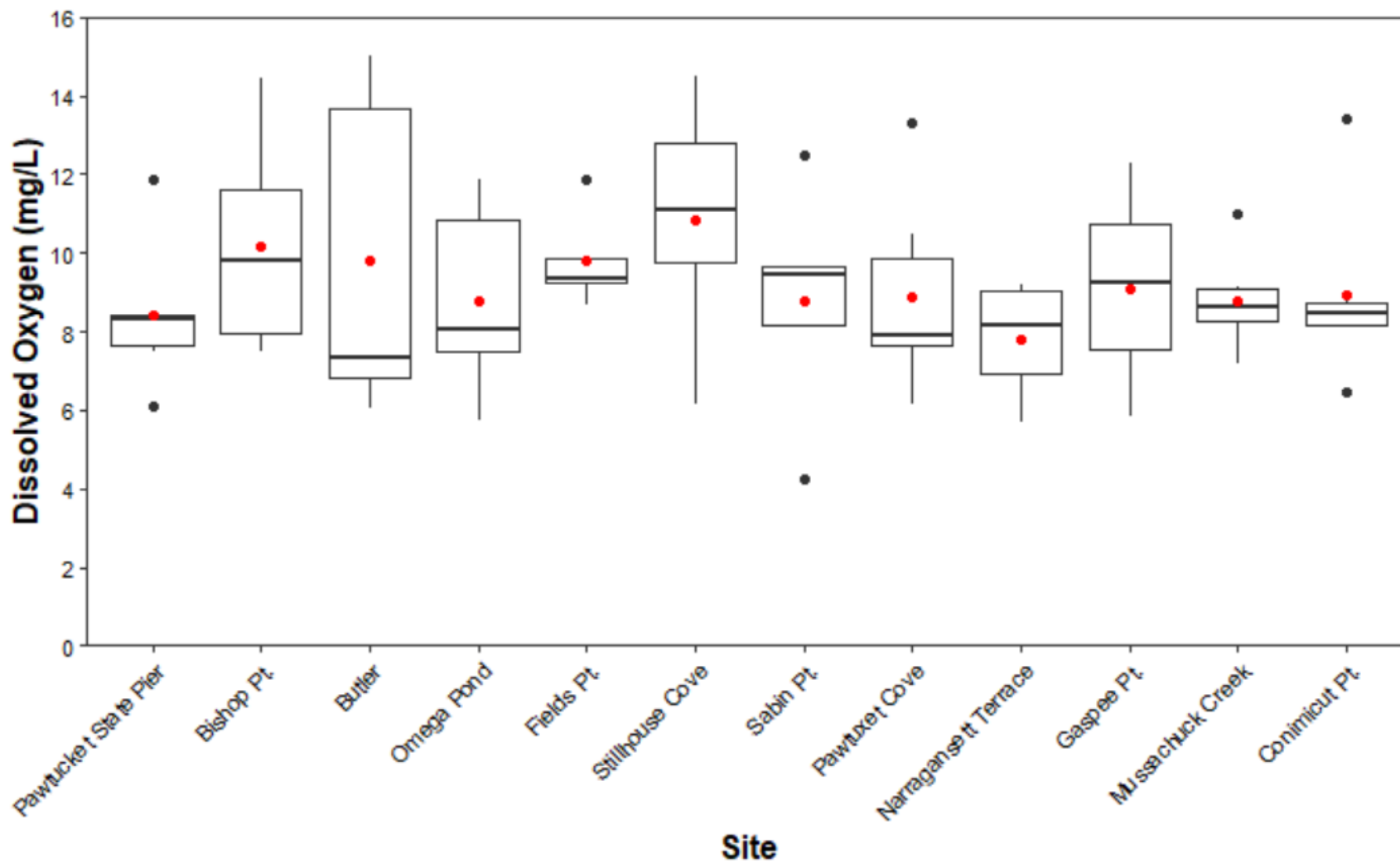
# APPENDIX

Boxplot of salinity (ppt) recorded by handheld YSI across all seine stations in 2022 at the time of sample (red dot indicates mean).



## APPENDIX

Boxplot of dissolved oxygen (mg/L) recorded by handheld YSI across all seine stations in 2022 at the time of sample (red dot indicates mean).





# Sportfish Assessment and Management in Rhode Island Waters

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**STATE:** Rhode Island

**PROJECT NUMBER:** F-61-R

**SEGMENT NUMBER:** 21

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

**PERIOD COVERED:** January 1, 2022 – December 31, 2022

**JOB NUMBER 8 TITLE:** Assessment of Recreationally Important Finfish Stocks in Rhode Island Waters

During this period, several stock assessments for recreationally significant finfish species were conducted that RI staff participated in, either as stock assessment committee participants or by contributing data that were derived from surveys funded by the sportfish restoration grant to the stock assessment process. The project leaders participated at the Atlantic States Marine Fisheries Commission's (ASMFC) meetings relative to the management of recreationally important coastal stocks. They also participated in the National Oceanographic and Atmospheric Administration (NOAA) stock assessment process for species under their jurisdiction by contributing data from jobs listed in this grant report, participating in stock assessment subcommittees, or via membership in the Scientific and Statistical Committee of the New England Fishery Management Council. The status of the most important recreationally caught species in Rhode Island were presented in the annual finfish sector management plan. The following information by species highlights some of the major contributions during this period.

## **1. SUMMER FLOUNDER**

A management track stock assessment for summer flounder was completed in the summer of 2021. This assessment used the same methods and data as the 2019 benchmark assessment, with updated commercial and recreational catch data and research survey indices through 2019. The 2019 benchmark assessment process included multiple modeling frameworks such as sex specific and state-space models. The main tasks performed by staff were to gather both catch and fishery independent information from previous years and stratify that information by age based on aging information from the NOAA trawl survey. RI contributed its Division of Marine Fisheries trawl survey data (see job number 2 from this grant) and the University of Rhode Island Trawl Survey information (see job number 14 from this grant) to the assessment. Staff were active members of the benchmark stock assessment working group and participated in meetings where the assessment information was released. Additionally, the RI participant on this working group developed unique ways for combining survey indices, and ran multiple alternative assessment runs with this combined survey information.

The Atlantic States Marine Fisheries Commission and Mid-Atlantic Fishery Management Council developed a draft Framework/Addendum to develop harvest control rules for the summer flounder, scup, black sea bass, and bluefish fisheries. As part of this initiative, staff of the Rhode Island Department of Environmental Management (RIDEM) worked on models that were considered for use in predicting recreational harvest to set management measures.

Summer flounder 2021 management track assessment:

[https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/60ee366302e0767984f30a25/1626224228229/c\\_2021\\_summer\\_flounder\\_MTA\\_report.pdf](https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/60ee366302e0767984f30a25/1626224228229/c_2021_summer_flounder_MTA_report.pdf)

## **2. STRIPED BASS**

The 2022 stock assessment update for Atlantic striped bass found that the stock is overfished but overfishing is no longer occurring relative to the updated biological reference points (ASMFC, 2022). Female spawning stock biomass in 2021 was estimated to be 143 million pounds, below both the SSB target and SSB threshold, 235 million pounds and 188 million pounds respectively. SSB has been declining since 2003 and has been below the threshold since 2013. F in 2021 was estimated to be 0.14, below both F target and F threshold, 0.17 and 0.20 respectively.

Staff also spent a considerable amount of time in 2022 on the striped bass plan development team (PDT) working on Amendment 7 to the Atlantic Striped Bass Fishery Management Plan and Draft Addendum I to Amendment 7. Amendment 7 was adopted by the Board in May 2022 and Draft Addendum I is still in development. Amendment 7 addressed management triggers, recreational release mortality, stock rebuilding, and conservation equivalency. Draft Addendum I addresses commercial quota transfers. The Board has requested updated stock projections under different scenarios of fishing mortality and quota utilization to be presented in May 2023, at which time they are expected to take final action on the Draft Addendum.

Other work on striped stock assessments in 2022 included providing biological data and commercial catch-at-age data to the Chesapeake Bay Laboratory (CBL). The CBL is working on a migration model for striped bass and DMF staff have been collaborating on those efforts which are expected to continue in 2023.

2022 Striped bass update assessment:

[https://asmfc.org/uploads/file/63cb200fAtlStripedBassAssessmentUpdate\\_Nov2022.pdf](https://asmfc.org/uploads/file/63cb200fAtlStripedBassAssessmentUpdate_Nov2022.pdf)

## **3. ATLANTIC MENHADEN AND MULTISPECIES MODELS**

The ASMFC completed a stock assessment update for the coastwide stock of Atlantic menhaden in 2022. This assessment, which included survey and fishery data through 2021, updated the 2020 benchmark stock assessment for the species. The Atlantic

menhaden stock is assessed with a statistical catch at age model called BAM (Beaufort Assessment Model). The main tasks for the assessment were to gather both catch and fishery independent information from previous years and stratify that information by age based on aging information from the NOAA menhaden sampling program, which RI contributed locally caught samples to. RI contributed its Division of Marine Fisheries seine survey data (see job number 4 from this grant) and its trawl survey data (jobs 1 and 2 from this report), collecting the information and processing it for the assessment. Staff also participated in meetings where the assessment information was reviewed and served as active members of the stock assessment sub-committee.

In addition to the single-species menhaden assessment, a series of multispecies models were produced for peer review along with the 2020 assessment. These models included an Ecopath with Ecosim model, a Steele-Henderson multispecies surplus production model, a Bayesian time-varying surplus production model, and RI staff have created a multispecies statistical catch-at-age model (MSSCAA). The MSSCAA model features menhaden, striped bass, bluefish, weakfish, and scup as the modeled species, all recreationally important species. The goal for these models was to incorporate more ecosystem and trophic interaction information into the assessment process, and to create ecological reference points, which were ultimately accepted for use in management by the Atlantic Menhaden Management Board. These ecological reference points are currently used to guide harvest limits for the fishery and will be updated during the next benchmark assessment in 2025.

Atlantic menhaden 2021 single species stock assessment update report:

[http://www.asafc.org/uploads/file/63d289bc2022AtlanticMenhadenStockAssessmentUpdate\\_TOR\\_Report.pdf](http://www.asafc.org/uploads/file/63d289bc2022AtlanticMenhadenStockAssessmentUpdate_TOR_Report.pdf)

Atlantic menhaden 2019 ecological reference point assessment:

[http://www.asafc.org/uploads/file/5e4c4064AtlMenhadenERPAssmt\\_PeerReviewReports.pdf](http://www.asafc.org/uploads/file/5e4c4064AtlMenhadenERPAssmt_PeerReviewReports.pdf)

### **3. BLACK SEA BASS**

An operational assessment for black sea bass was completed in the summer of 2021. This assessment used the same methods and data as the 2019 operational assessment, with updated commercial and recreational catch data and research survey indices through 2019. Spatial statistical stock assessment models (separate northern and southern stocks) were developed in the 2016 benchmark assessment and have been used in the updates and operational assessments since.

Beginning in August of 2021, a research track stock assessment has been under way for black sea bass and is expected to be completed in 2023. For this assessment, new datasets are being evaluated for their utility to inform or be used in stock assessment models for the species. Rhode Island DEM staff contributed trawl survey (see job 2 from this grant) and seine survey data (see jobs 3 and 4) to be evaluated along with age and growth data

(job 9) for use in the assessment. In the future, RIDEM DMF hopes to contribute new ventless pot survey information to the assessment (job 12).

As mentioned above for summer flounder, RIDEM staff contributed to the Atlantic States Marine Fisheries Commission and Mid-Atlantic Fishery Management Council's process of developing harvest control rules for the black bass fishery as part of a greater recreational reform initiative. Rhode Island staff spent considerable time contributing to the ongoing development of recreational black sea bass harvest estimation models to be considered for use in potential management procedures.

Black sea bass 2021 operational assessment:

[https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/60f03955e00eb31d7cf06ab7/1626356053324/c\\_BSB\\_Management+Track+Assessment\\_2021.pdf](https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/60f03955e00eb31d7cf06ab7/1626356053324/c_BSB_Management+Track+Assessment_2021.pdf)

## **5. SCUP**

A management track stock assessment for scup was completed in the summer of 2021. This assessment used the same method (statistical catch-at-age model) and data as the 2019 operational assessment, with updated commercial and recreational catch data and research survey indices through 2019. The main tasks were to gather both catch and fishery-independent information from previous years and stratify that information by age based on aging information that is collected by NOAA. RI contributes its Division of Marine Fisheries trawl survey data (see jobs 1 and 2 from this document) and the University of Rhode Island Trawl Survey information (see job 14 from this grant) and hopes to contribute the new ventless pot survey info in the future to the assessment (job 12). Staff collects the information and processes it for the assessment. Staff participated in several meetings where the assessment information was reviewed, with additional responsibilities for developing management analyses after the assessment was completed.

Scup 2021 management track stock assessment:

[https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/60ee353e114e6b7b7de66ad7/1626223937644/c\\_2021\\_scup\\_MTA\\_report.pdf](https://static1.squarespace.com/static/511cdc7fe4b00307a2628ac6/t/60ee353e114e6b7b7de66ad7/1626223937644/c_2021_scup_MTA_report.pdf)

## **6. BLUEFISH**

An operational stock assessment was conducted by the Northeast Fisheries Science Center (NEFSC) in 2021. The assessment estimated spawning stock biomass (SSB) in 2019 to be 95,742 MT, which is less than the SSB threshold (100,865 MT) indicating the stock is overfished. Fishing mortality in 2019 was estimated to be 0.172, below the Fthreshold, indicating the stock is not experiencing overfishing (Fmsy proxy = F35%SPR = 0.181) (Northeast Fisheries Science Center (NEFSC) 2020).

In 2022, DMF staff contributed data through 2021 for the 2022 Bluefish Research Track Assessment. Data included recreational release length-frequency data, age and growth port sampling data, young-of-year (YOY) abundance index data from the fall component of the RI Seasonal Trawl Survey, and YOY abundance index data from the Narragansett

Bay Juvenile Finfish Seine Survey. The assessment was peer reviewed in December of 2022 and management action is expected to take place later in 2023.

## **7. TAUTOG**

A stock assessment update was completed in 2021 and approved for management use using the same methodology as the 2015 benchmark stock assessment and the 2017 update. The assessment update uses the Age Structured Assessment Program v. 3.0.17, part of the NOAA Fisheries Toolbox for the four management regions coastwide (RI is in a region with Massachusetts, MARI). Data from 2016-2020 was added, and the newly calibrated MRIP data was included in the update. The main tasks were to gather both catch and fishery independent information from the previous years for and stratify that information by age based on aging information that was collected in each state, and which RI contributed locally caught samples to. RI staff served on the stock assessment subcommittee and provided support in the main tasks and ensuring the model was successfully completed. RI contributed 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.

Tautog 2021 stock assessment update:

[http://www.asmfc.org/uploads/file/618584cc2021TautogRegionalStockAssessmentUpdate\\_WithAppendices.pdf](http://www.asmfc.org/uploads/file/618584cc2021TautogRegionalStockAssessmentUpdate_WithAppendices.pdf)

## **8. WINTER FLOUNDER**

A management track stock assessment for the Southern New England/Mid-Atlantic (SNE/MA) winter flounder stock was completed in 2022. This assessment revises the 2011 benchmark stock assessment that was peer reviewed at the SAW52 meeting (<http://www.asmfc.org/uploads/file/parta.pdf>). This assessment passed peer review and was previously updated through operational assessments for management use in 2015, 2017, and 2020. The 2022 assessment indicates the SNE/MA stock of winter flounder is not overfished and not experiencing overfishing relative to the updated biological reference points defined in the assessment. This is a change in stock status compared to previous assessments and is due to a change in the years of recruitment estimates used to estimate biological reference points. Instead of drawing upon the entire time series of recruitment estimates, the projections now only use recruitment estimates from the past 20 years (2002-2021). The winter flounder stock is most likely not capable of achieving the high levels of recruitment prior to 2000; therefore, using a truncated recruitment time series of only the past 20 years better reflects the current state of the stock.

During this grant period, the main tasks for RI were to gather both catch and fishery independent information and stratify that information by age based on aging information from the NMFS trawl survey. RI contributed its trawl survey data (see job numbers 1 and 2 from this grant) as well as seine survey data (see job number 4 from this grant) to the assessment. Staff collected the requested information and age stratified it for the

assessment. Staff also participated in several meetings where the assessment information was released, and staff were active members of New England Fisheries Management Council Scientific and Statistical Committee that reviewed all the updated stock assessment information including data and research on winter flounder. In addition, staff were active participants in the NEFMC Groundfish Plan Development Team and ASMFC winter flounder TC that discussed both federal and state water management measures for the SNE/MA winter flounder stock.

Winter flounder 2022 management track stock assessment update report:  
[http://www.asafc.org/uploads/file/63d6c2f85\\_2022\\_FLW\\_SNEMA\\_RPT.pdf](http://www.asafc.org/uploads/file/63d6c2f85_2022_FLW_SNEMA_RPT.pdf)

## **9. WEAKFISH**

Historically, weakfish had not had an approved assessment for many years and management had long been based on external, non-analytical indicators. In 2016, a full benchmark assessment was performed and was peer reviewed which switched to a statistical catch at age modeling framework that used Bayesian statistical applications to account for time varying natural mortality, which is unique amongst the many sportfish species assessments that RI participates in. Other models were also tested, including a standard statistical catch at age model (using the ASAP software package), but the Bayesian model was selected as the preferred model by the assessment team. The main tasks associated with the assessment were to gather both catch and fishery independent information and stratify that information by 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 participated in meetings where the assessment information is released. This model has allowed for an ability to get back to better informed management processes for this species. An update assessment was conducted in 2019, for which staff provided data and analytical assistance.

Weakfish 2019 stock assessment update:  
<http://www.asafc.org/uploads/file/5de7fc7c2019WeakfishAssessmentUpdate.pdf>

## **10. SPINY DOGFISH**

In 2022, staff participated in the research track stock assessment for spiny dogfish, often a recreationally intercepted species by Rhode Island anglers. The assessment's goal was to construct a new data-rich assessment model for use in guiding future management advice for the Northwest Atlantic spiny dogfish stock. One result of the research track stock assessment was the previously used model (the stochastic estimator model) was replaced with a new length-based, data-rich assessment model framework, Stock Synthesis (v3). Staff helped in building this model and preparing for it to be peer-reviewed in December 2022. Also, in support of the assessment, several analyses were conducted by staff to meet the assessment's Terms of Reference, such as understanding environmental drivers on the abundance, distribution, and life history rates. Additional work was done to understand the efficacy of fishery-dependent data to infer population

fluctuations. The assessment passed peer-reviewed, and these new science and modeling tools to be utilized in the next management track assessment to guide future management of the stock.



**ASSESSMENT OF RECREATIONALLY IMPORTANT  
FINFISH STOCKS IN RHODE ISLAND COASTAL WATERS**

**Age and Growth Study**

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March 2023

## PERFORMANCE REPORT

**STATE:** Rhode Island

**PROJECT NUMBER:** F-61-R

**SEGMENT NUMBER:** 22

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

**PERIOD COVERED:** January 1, 2022 – December 31, 2022

**JOB NUMBER AND TITLE:** 9, Age and Growth Study

**JOB OBJECTIVE:** To collect age, growth, diet composition, and maturity 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 stock assessments and 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 collect, or exceed, the target sample numbers for the majority of species in 2022, however in some cases fell short on target sample numbers due to the availability of fish. Investigators had difficulty in obtaining samples for certain species, particularly bluefish, summer flounder, and winter flounder due to the dynamics of the fisheries and the availability of fish. Work to age the primary ageing structures collected in all years is complete except for tautog. Staff attended the 2023 ASMFC QA/QC Ageing Workshop from 3/7/23 – 3/9/23 where it was decided to no longer use operculum as the primary ageing structure for tautog. As a result, staff now have to process otoliths and spines from 2022 and to complete one year of side-by-side structure comparisons before switching exclusively to spines moving forward.

In addition to the collection of age and growth data, investigators continued the collection of stomach content, sex, and maturity stage data from target species. This data was collected through collaboration with investigators on the Rhode Island Division of Marine Fisheries (RIDMF) Monthly and Seasonal trawl surveys (Jobs 1 and 2), RIDMF Narragansett Bay Juvenile Finfish Beach Seine survey (Job 4), RIDMF Fyke Net survey (Job 10), commercial gillnetters, commercial otter trawlers, commercial hook & line, and recreational hook and line fishers.

**TARGET DATE:** December 31, 2022

**STATUS OF PROJECT:** On schedule

**SIGNIFICANT DEVIATIONS:** For bluefish, only 34 of the required 100 samples were collected. For summer flounder, only 71 of the targeted 100 samples were collected. For winter flounder, only 29 of the 40 targeted samples were collected.

**RECOMMENDATIONS:** Move into the next project segment and continue data collection in 2023.

**REMARKS:** N/A

## **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, the diet composition of finfish has become increasingly important in understanding the age and growth of a population. The 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 multi-species modeling approaches 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. Most recently, ASMFC adopted an ecosystem-based management approach for assessing Atlantic menhaden. The data collected in this study will help contribute to the aforementioned efforts.

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 as well as the NorthEast Area Monitoring and Assessment Program (NEAMAP), which do not sample within 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 and ecosystem-based modeling approaches are further developed. Additionally, this study satisfies the requirements of ASMFC Fishery Management Plans (FMP's) for 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 the collection of both scale and otolith samples for ageing from most species, except for weakfish and bluefish for which only otolith samples were taken. For tautog, opercula, otoliths, and the first pectoral-fin spine were collected (no scales).

## **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 December of 2022. Data collected included lengths, weights, and the appropriate age structure for the specific species (i.e., scale, otolith, operculum, pelvic spine). 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 including various finfish dealers, recreational anglers, commercial gillnetters, commercial otter trawlers, commercial hook & line fishers, and RIDMF surveys (otter trawl, fyke net, and fish pot) (Table 3).

Diet composition data was collected for high priority species by excising fish stomachs from fish collected during the RIDMF seasonal and monthly bottom trawl surveys, from fish racks and whole fish collected during port sampling, or fish racks and whole fish which were donated. For each species, the target number of stomachs to be examined is 40 (Table 4). Additional data collected from these samples included length, weight (if whole fish available), sex, maturity, and age structures. 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 Microsoft Access database.

### Black sea bass

For 2022, a total of 56 black sea bass age samples have been processed to date from multiple sources including the RIDMF otter trawl survey, RIDMF finfish ventless trap survey, and the Commercial Fisheries Research Foundation (CFRF) (Table 2). There are at least 44 black sea bass samples waiting to be processed, which would bring the total number of age structures collected to at least 100 and would meet the minimum requirement for this species. This deficiency resulted from the staff person assigned to this project being assigned additional responsibilities that consumed the time normally spent on sample processing.

Currently, otoliths remain the preferred method for ageing black sea bass when they are available for extraction. Both scales and otoliths were collected from all black sea bass sampled in 2022 with only otoliths from RIDMF samples being aged. Black sea bass samples collected ranged in size from 6.4-20.5 inches (16.2-52.0 cm) total length and 3 – 12 years old (Figure 1). Age samples collected as part of the collaboration between RIDMF and CFRF have been sent to the Virginia Institute of Marine Science (VIMS) for processing and ageing.

Stomach content and maturity stage data were collected from 49 black sea bass; stomach contents included prey items from 8 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Black sea bass stomach contents were dominated by crustaceans (55.5%), cephalopod molluscs (16.8%), and finfish (11.8%); negligible amounts of algae, bivalve molluscs, gastropod molluscs, and polychaetes accounted for 0.8%; “unidentifiable” contents accounted for 15.1%. Removal of “unidentifiable” contents from the analysis resulted in crustaceans accounting for 65.4%, cephalopod molluscs for 19.8%, and finfish for 13.9%; negligible amounts of algae, bivalve molluscs, gastropod molluscs, and polychaetes accounted for 0.9% (Figure 9, Table 5).

### Bluefish

The ASMFC requires that a minimum of 100 bluefish age samples be collected annually by the state of Rhode Island. In 2022, age samples were collected from only 34 bluefish. Bluefish samples ranged in fork length from 12.8-29.8 inches (32.5-75.7 cm) and 1-7 years old (Figure 2).

Stomach content and maturity stage data were collected from 34 bluefish; stomach contents included prey items from 2 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Of the bluefish stomachs examined in 2022, identifiable stomach contents encountered were finfish (87.8%) and cephalopod molluscs (2.6%); “unidentifiable” contents accounted for 9.6%.

Removal of “unidentifiable” contents from the analysis resulted in finfish accounting for 97.1% and cephalopod molluscs for 2.9% (Figure 9, Table 5).

### Menhaden

A total of 48 Atlantic menhaden age samples were collected in 2022, all from the RIDMF otter trawl survey and commercial otter trawls (Table 2). Samples can only be collected from commercial purse seine operations when the Narragansett Bay menhaden management area is open to commercial fishing. In 2022, the menhaden management area opened briefly for a single day in Mid-May and 11 weeks from August through October. Landings during these openings were minimal as all menhaden were small and not commercially marketable making obtaining samples difficult. As a result, bait samples were collected from commercial otter trawl and supplemented with samples from the DMF trawl survey. Menhaden samples ranged in fork length from 9.3-11.8 inches (23.7-30.0 cm). Age samples will be sent to the NOAA Fisheries Beaufort Laboratory for processing and ageing. A menhaden ageing workshop is planned for November 2023 to discuss ageing protocols. It is anticipated that RI will take over ageing of their menhaden samples after the workshop.

Maturity stage data were collected from 48 fish. Due to the fact that menhaden are filter feeders, all stomach contents encountered in previous years of this study were liquefied, with prey item(s) unable to be identified and classified. Due to this, no menhaden stomachs were examined during 2022. Generally, menhaden stomach contents should reflect the dominant planktonic species present at the time of sample collection.

### Scup

In 2022, a total of 108 scup age samples were collected exclusively from fish caught by the RIDMF otter trawl survey (Table 2). Scup samples ranged in fork length from 8.7-14.3 inches (22.2-36.2 cm) and age from 4-14 years old (Figure 3).

Stomach content and maturity stage data were collected from 43 scup. Stomach contents included prey items from 8 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Identifiable stomach contents included cephalopod molluscs (27.1%), finfish (17.1%), crustaceans (11.7%), polychaetes (5.0%), gastropod molluscs (3.9%), sipunculids (2.7%), and algae (0.9%); “unidentifiable” contents accounted for 28.7%. Removal of “unidentifiable” contents from the analysis resulted in cephalopod molluscs accounting for 38.0%, finfish for 24.0%, crustaceans for 16.4%, polychaetes for 7.1%, gastropod molluscs for 5.4%, sipunculids for 3.8%, and algae for 1.3% (Figure 9, Table 5).

### Spiny Dogfish

Spiny dogfish are not routinely sampled as they are not frequently encountered on the RIDMF otter trawl survey. No spiny dogfish were sampled in 2022.

### Striped Bass

A total of 308 striped bass age samples were collected in 2022. Although otoliths remain the primary ageing structure, scales are frequently collected from commercial samples when staff are unable to collect otoliths due to the damage it would cause to the fish. 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. In recent years there have been a very limited number of floating fish traps in operation making obtaining striped bass samples from this fishery difficult. A total of 186 samples were obtained from the general category fishery and samples from floating fish traps, for a total of 276 samples. Staff supplemented traditional sampling by collecting a total of 32 striped bass age samples from the RIDMF otter trawl survey (n=15) and fyke net (n=17) surveys. These samples were generally below legal minimum size(s) but helped to expand the length-frequency distribution sampled. Striped bass sampled ranged from 12.9-50.0 inches fork length (32.7-127.0 cm) and 2-22 years old (Figure 4).

Stomach content and maturity stage data were collected from 32 striped bass. Stomach contents included prey items from 6 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Identifiable stomach contents were dominated by finfish (61.6%) and crustaceans (25%), with small quantities of polychaetes (1.2%), algae (0.12%), aquatic plants (0.04%), and cephalopod molluscs (0.02%); “unidentifiable” contents accounted for 12.1%. Removal of “unidentifiable” contents from the analysis resulted in finfish accounting for 70.0% and crustaceans accounting for 28.4%, with small quantities of polychaetes (1.3%), algae (0.14%), aquatic plants (0.05%), and cephalopod molluscs for (0.03%) (Figure 9, Table 5).

#### Summer Flounder

A total of 72 summer flounder scale and otolith samples were collected in 2022, all from fish caught by the RIDMF otter trawl survey. Summer flounder samples collected varied in size from 11.5-25.0 inches (29.2-63.6 cm) total length and 1-6 years old (Figure 5).

Stomach content and maturity stage data were collected from 47 summer flounder. Stomach contents included prey items from 5 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Identifiable stomach contents were dominated by finfish (58.1%) and cephalopod molluscs (15.3%), with negligible amounts of algae (0.02%), crustaceans (0.15%), and bivalve molluscs (0.09%); “unidentifiable” contents accounted for nearly 26.4%. Removal of “unidentifiable” contents from the analysis resulted in finfish accounting for 78.9%, cephalopod molluscs for 20.8%, algae for 0.02%, crustaceans for 0.2%, and bivalve molluscs for 0.09% (Figure 9, Table 5).

#### Tautog

A total of 227 tautog age samples were collected in 2022. Although the primary ageing structure at this time remains the opercula, otoliths and pelvic spines have also been collected as secondary structures. Samples were primarily collected from the recreational hook and line fishery (n=181) with additional samples obtained from the RIDMF otter trawl survey (n=39), and recreational spear fishery (n=7). Tautog samples are typically collected in the fall months when the party and charter boat vessels are targeting them. The ability to obtain samples during this period of time can be quite variable due to weather conditions such as strong winds and high seas. Tautog samples collected ranged from 12.9-28 inches (32.7-71.1 cm) total length.

Stomach content and maturity stage data were collected from 42 tautog in 2022. Stomach contents included prey items from 6 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Identifiable tautog diet was primarily comprised of crustaceans (36.4%), bivalve molluscs (32.2%), and gastropod molluscs (8.3%), with a small quantity of maxillopods (0.4%), algae (0.1%), and sand/rocks (0.01%) also observed; “unidentifiable” contents accounted for 22.4%. Removal of “unidentifiable” contents from the analysis resulted in crustaceans accounting for 47.0%, bivalve molluscs for 41.5%, and gastropod molluscs for 10.8%, with a small quantity of maxillopods (0.5%), algae (0.2%), and sand/rocks (0.02%) (Figure 9, Table 5).

In March 2023 staff attended the ASMFC QA/QC Ageing workshop where it was decided that operculum are no longer the preferred structure for tautog ageing. All states that age tautog were encouraged to switch to sectioned otoliths or sectioned spines. As sectioned spines are a new ageing structure, states must conduct one year of side-by-side otolith and spine readings before switching completely to spines. Staff will continue to work on sectioning otoliths and spines collected in 2022 to satisfy this requirement. For 2023 and beyond, staff will switch to sectioned spines as the preferred ageing structure and no longer collect operculum and otoliths.

### Weakfish

Rhode Island is required by the ASMFC to collect three age structures and 6 lengths per metric ton of weakfish landed commercially in the state. In 2022, this would have resulted in a sampling target of 43 fish lengths and 21 ages. The weakfish stock assessment sub-committee and management board have requested that length samples come from the commercial fishery as these data are used in developing the commercial age-length keys. In recent years, weakfish have become scarce in RI, which has resulted in extreme difficulty in obtaining fishery-dependent samples. Investigators continue to attempt to purchase fish directly from seafood dealers at market value to ensure that they can obtain samples, however strong market demand and limited supply during 2021 prevented the availability of this species for sampling. In 2022, a total of 44 weakfish length and otolith samples were collected, with 34 fishery-dependent samples collected. Weakfish collected by the fishery-independent RIDMF otter trawl (n=10) consisted of 3 sub-legal sized fish and 7 legal-sized fish. Weakfish sampled ranged from 9.7-28.3 inches (24.7-71.8 cm) total length and were 1-5 years old (Figure 6).

Stomach content and maturity stage data were collected from 44 weakfish. Stomach contents included prey items from 4 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Of the weakfish stomachs examined in 2022, identifiable stomach contents were dominated by finfish (59.0%) and cephalopod molluscs (19.8%), with minor contributions from crustaceans (1.3%) and algae (0.3%); “unidentifiable” contents accounted for 19.7%. Removal of “unidentifiable” contents from the analysis resulted in finfish accounting for 73.5%, cephalopod molluscs for 24.6%, crustaceans for 1.6%, and algae for 0.4% (Figure 9, Table 5).

### Winter Flounder

A total of 29 winter flounder scale and otolith samples were collected in 2022. These samples were collected entirely by RIDMF staff on board the RIDMF otter trawl survey. Winter flounder

samples collected varied in size from 10.2-17.8 inches (26.0-45.1 cm) total length and 2-10 years old (Figure 7).

Stomach content and maturity stage data were collected from 29 winter flounder. Stomach contents included prey items from 7 taxonomic groups (Table 3). The proportional contribution of all stomach contents encountered in 2022 is shown in Figure 8 and summarized in Table 4. Of the winter flounder stomachs examined in 2022, identifiable stomach contents were dominated by cnidarians (59.2%), polychaetes (13.7%), and crustaceans (6.6%), with minor amounts of algae (2.1%), bivalve molluscs (1.0%), gastropod molluscs (0.4%), and sipunculids (0.08%); “unidentifiable” contents accounted for 17.0%. Removal of “unidentifiable” contents from the analysis resulted in stomach contents being dominated by cnidarians (71.3%), polychaetes (16.6%), and crustaceans (7.9%), with minor amounts of algae (2.5%), bivalve molluscs (1.2%), gastropod molluscs (0.5%), and sipunculids (0.09%) (Figure 9, Table 5).

## **SUMMARY**

In 2022 investigators were able to meet, or exceed, the target age structure sample numbers for scup and tautog, while under-achieving target sample numbers for bluefish (34/100), summer flounder (72/100), and winter flounder (29/40). In the cases where the sample targets were not achieved, this was due to the dynamics of the fisheries, inclement weather, and availability of fish. Processing and ageing of all hard parts is complete for 2022 except for tautog. In 2023, 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. Staff will continue to participate in ASMFC ageing workshops as they occur in 2023.



**FIGURES**

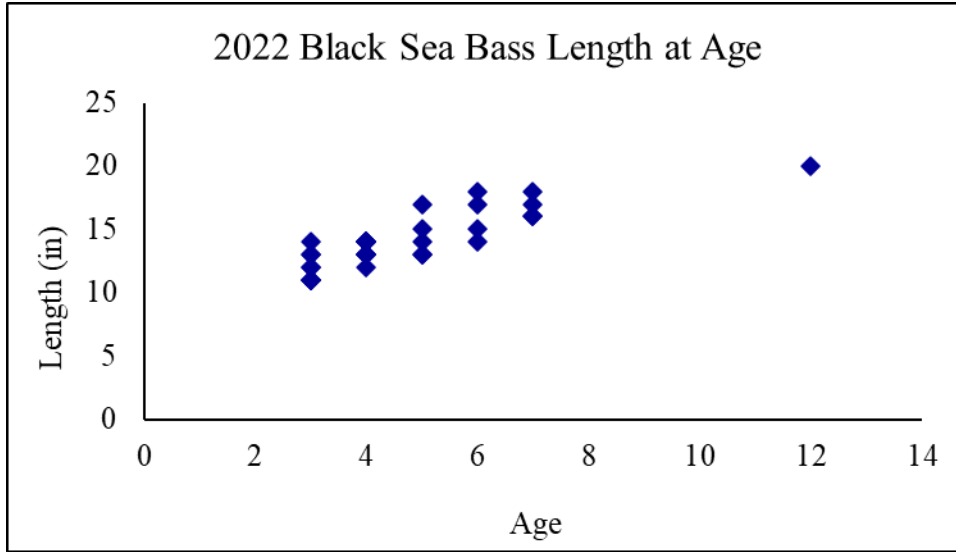


Figure 1. Black sea bass age at length.

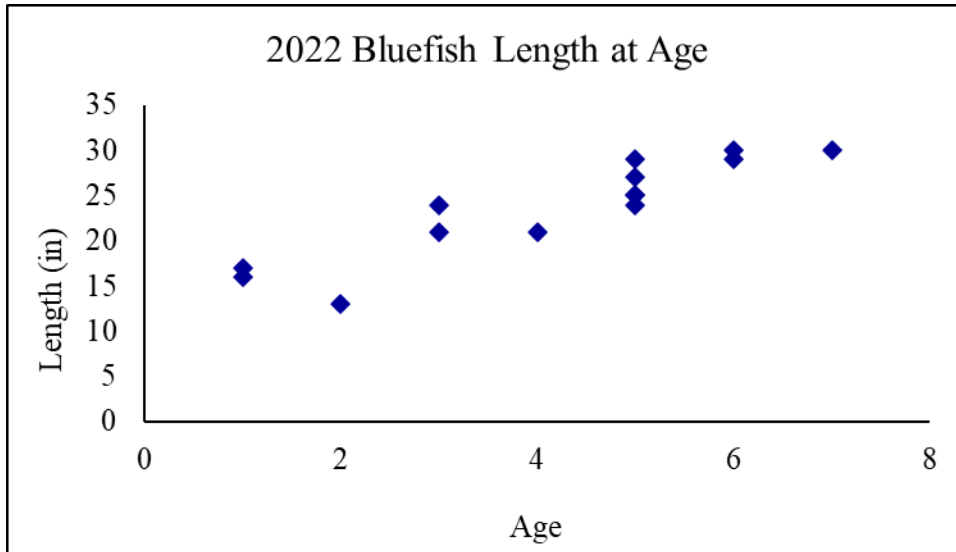


Figure 2. Bluefish age at length.

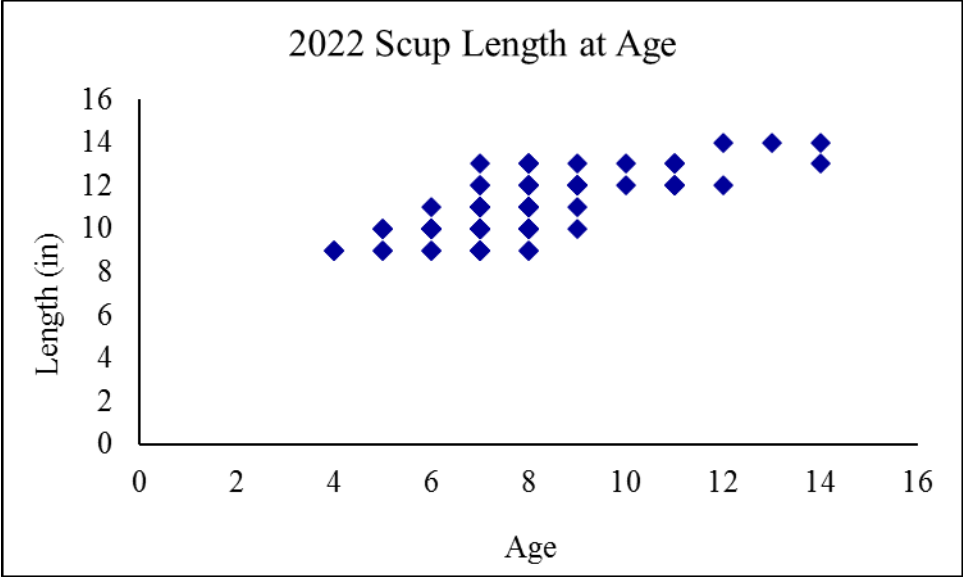


Figure 3. Scup age at length.

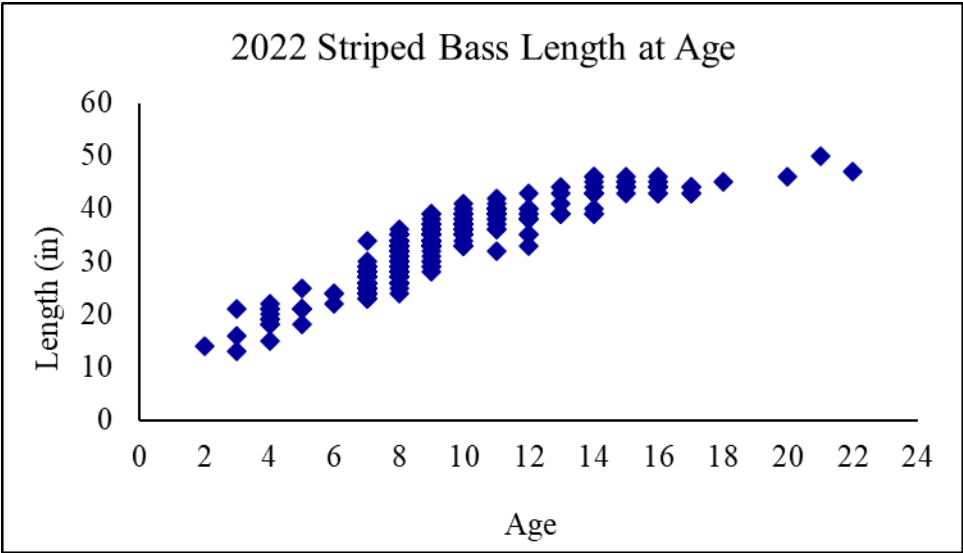


Figure 4. Striped bass age at length.

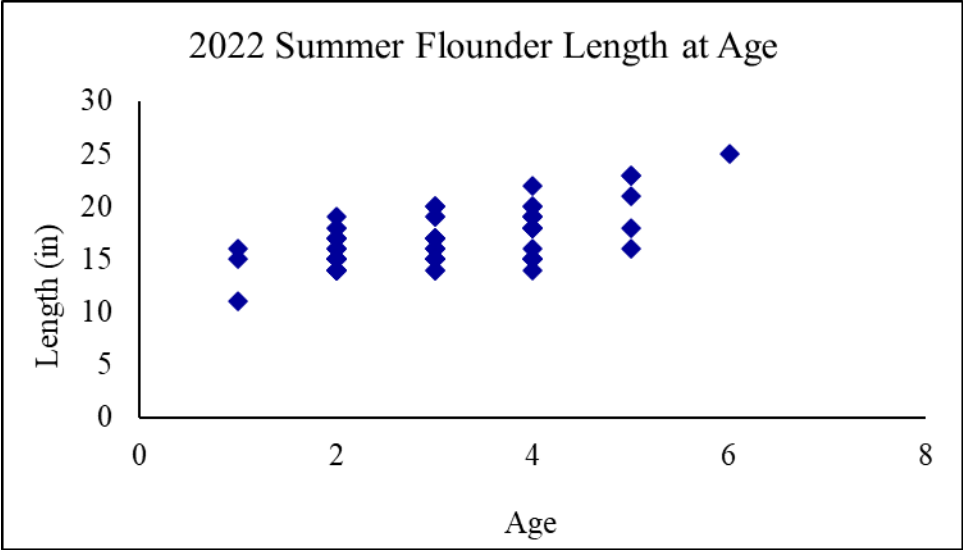


Figure 5. Summer flounder age at length.

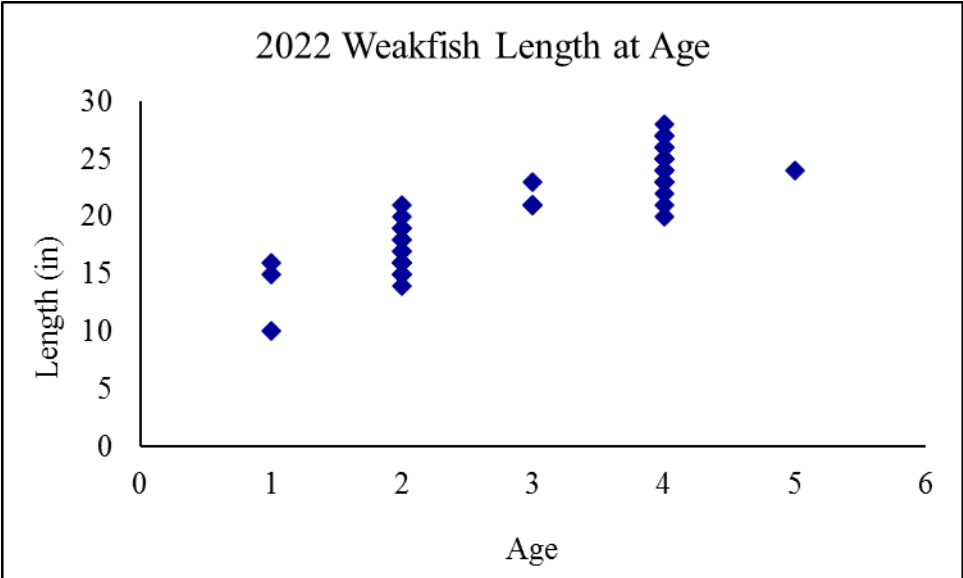


Figure 6. Weakfish age at length.

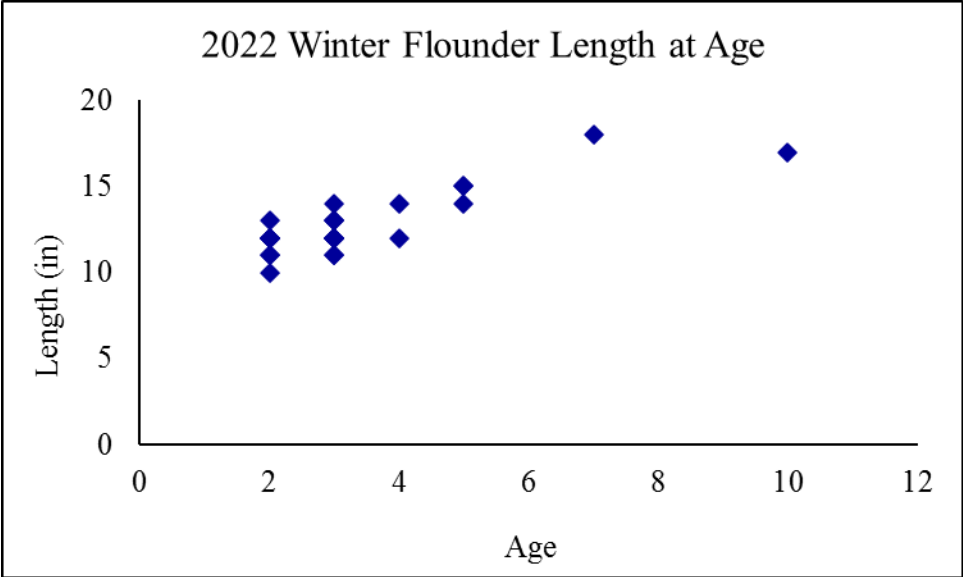


Figure 7. Winter flounder age at length.

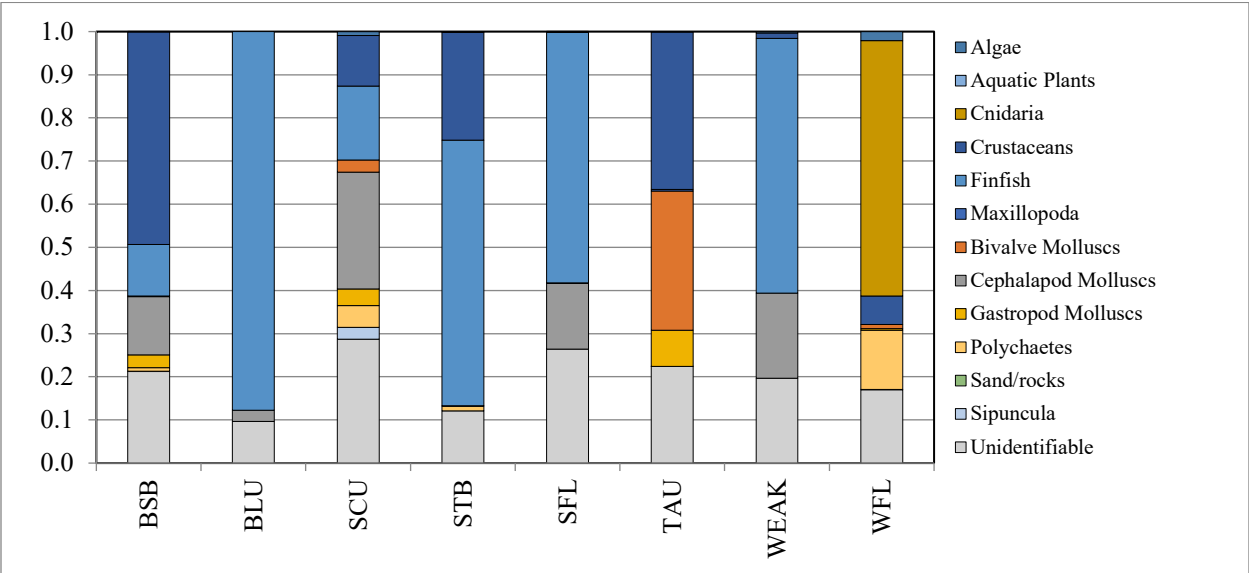


Figure 8. 2022 Proportional contribution of all stomach content types by species.

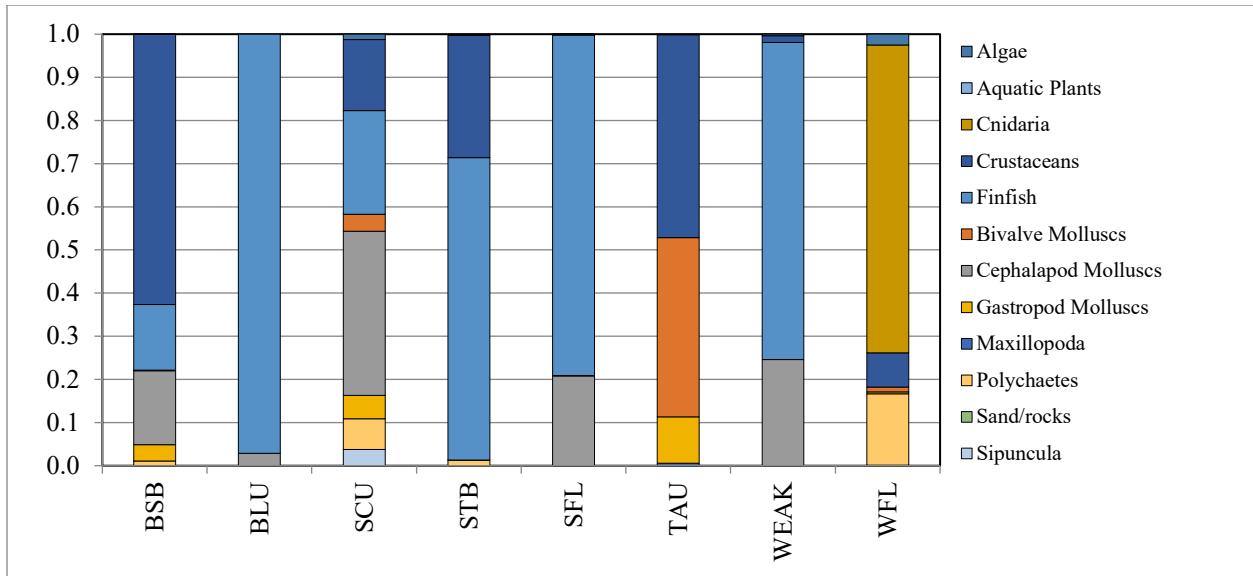


Figure 9. 2022 Proportional contribution of stomach content types by species; “unidentifiable” contents not included.

## TABLES

Table 1. Number of ageing structures collected by species in 2022.

Common name	Ageing structure(s)	Target number of ageing structures	Number of ageing structures collected
Black sea bass	Scale, Otolith	100	56 scale, 56 otolith
Bluefish***	Otolith	100	34 otolith
Menhaden***	Scale, Otolith	100	48 scale, 48 otolith
Scup	Scale, Otolith	100	108 scale, 108 otolith
Striped bass	Scale, Otolith	150 fish/gear type**	308 scale, 32 otolith
Summer Flounder	Scale, Otolith	100	72 scale, 72 otolith
Tautog***	Operculum, Otolith, 1 <sup>st</sup> pelvic	200	227 operculum, 227 otolith, 227 pelvic spines
Weakfish***	Otolith	3 fish aged per metric ton landed*	44 otoliths
Winter Flounder	Scale, Otolith	NA	28 scale, 28 otolith

\*Per ASMFC FMP requirements, ages required for 2022

\*\*Gear types include floating fish trap and general category

\*\*\*Required by ASMFC

Table 2. Gear type sampled for each species collected in 2022 (FFT=Floating Fish trap).

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

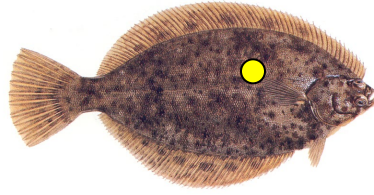
Table 3. 2022 Summary of stomach content sampling by species (\* Sand/rocks and “unidentifiable” stomach contents not included in number of prey taxa).

SPECIES	Target # Stomachs	# Stomachs sampled	# PREY TAXA*
Black Sea Bass	40	49	8
Bluefish	40	26	2
Scup	40	43	8
Striped Bass	40	32	6
Summer Flounder	40	47	5
Tautog	40	42	6
Weakfish	40	31	4
Winter Flounder	40	29	7



Nemertea	0	0	0	0	0	0	0	0
Platyhelminthes	0	0	0	0	0	0	0	0
Polychaetes	0.1000	0	0.0708	0.0132	0	0	0	0.1655
Porifera	0	0	0	0	0	0	0	0
Sand/rocks *	0	0	0	0	0	0.0002	0	0
Sipuncula	0	0	0.0379	0	0	0	0	0.0009
Urochordata	0	0	0	0	0	0	0	0





## **Assessment of Recreationally Important Finfish Stocks in Rhode Island Coastal Waters**

### **Winter Flounder Spawning Stock Biomass Survey**

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Federal Aid in Sportfish Restoration  
F-61-22

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, 2022 – December 31, 2022

Job Number and Title: Job X – Winter Flounder 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 to report.

### **Summary:**

In 1999, the Rhode Island (RI) Coastal Ponds Project was expanded to support an adult winter flounder (*Pseudopleuronectes americanus*) 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 RI south shore coastal ponds. It was determined that 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 up and running.

The survey runs from approximately January through April annually. Fyke net 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 eighteen stations where data has been collected over the course of the survey, with seven found in Point Judith Pond, four in Potter Pond, and seven in Ninigret Pond (also known as Charlestown Pond). A few additional scoping locations were surveyed briefly in Ninigret and Point Judith Pond in 2021 and 2022.

### **Additional Research:**

In 2012, the Ninigret Pond system was added to the survey. As adult winter flounder abundance in the Point Judith system declined to all-time lows, the adjacent Ninigret Pond was surveyed from the 2012 through the 2015 sampling year. During this period, RI Coastal Trawl Survey data (Spring Survey) showed a sharp increase in winter flounder relative abundance in the Block Island Sound area. This initially appeared to be similar to the trend seen in the Ninigret Pond system. However, in subsequent years, winter flounder catch per unit effort (CPUE) in the Spring Trawl Survey has declined and shown an overall downward trend throughout the time series. If, through this continuation of the multiple sampling areas, Point Judith Pond 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 Ninigret Pond sampling, that is now missing from the Point Judith Pond survey due to the inability to catch enough fish to effectively tag a large enough portion of the population to expect tag returns. The Environmental Protection Agency initially partnered in this project on Ninigret Pond and collected data for four winter survey seasons (2012-2015). Ninigret Pond was again added as a system to the survey again in 2019 and will continue to be sampled moving forward.

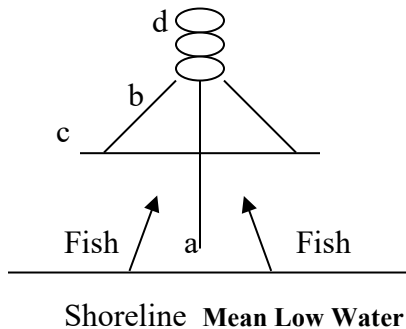
Beginning in 2022 a passive acoustic tag monitoring project was initiated in Ninigret Pond. An array of 13 acoustic receivers was deployed throughout Ninigret Pond to detect locations and movements of tagged winter flounder and any other tagged species that may enter the pond. A total of 25 winter flounder were tagged with acoustic tags in 2022.

**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 referred to as a 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. Adult winter flounder are tagged using Peterson Disk Tags or Vemco V13 acoustic tags.

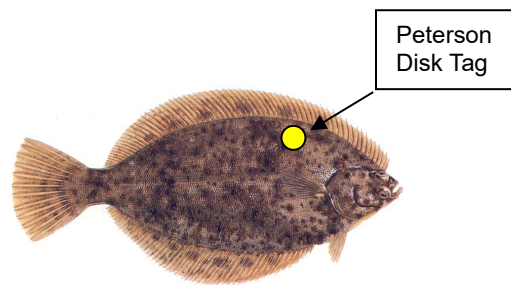
Net dimensions:

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



Station water profile:

- Dissolved oxygen - mg/l
- Salinity - ppt
- Temperature - degree C



**Fieldwork:**

In 2022 two to three nets were concurrently set in Point Judith/Potter Pond and two to three nets were set concurrently in Ninigret Pond, for a total of four to six concurrently set nets among the three systems. A total of 91 fyke net sets were conducted in 2022. Nets were tended every two to seven days depending on the anticipated 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. Tagging and recapture data is presented in Tables 1-3.

### **Fisheries:**

Winter flounder were historically a commercially and recreationally important species to the State of Rhode Island. From 1999-2021, commercial landings of winter flounder in Rhode Island averaged 280 metric tons and an average value of just below one million dollars annually (Table 4, Figure 1). Throughout the time series, landings have shown an overall downward trend. Recreational harvest as monitored through NOAA Fisheries' Marine Recreational Information Program (MRIP) has declined rapidly throughout the period and remains extremely low through 2022 (Table 5, Figure 2) (NMFS 2021 commercial landings query and MRIP database through 2021/2022). While an increase in recreational catch was seen in 2021, this value carries a very high PSE. Note that due to the rarity of the MRIP Access Point Angler Intercept Survey encountering anglers who have captured winter flounder since 2005, the percent standard error (PSE) for these data points is commonly very high (Table 5).

The Northeast Fisheries Science Center and Atlantic States Marine Fisheries Commission 2022 SNE/MA management track stock assessment update report indicates the stock is not overfished and overfishing is not occurring (NOAA 2022). This is a change in stock status compared to previous assessments and is due to a change in the years of recruitment estimates used to estimate biological reference points. Instead of drawing upon the entire time series of recruitment estimates, the projections now only use recruitment estimates from the past 20 years (2002-2021). The SNE/MA winter flounder stock is most likely not capable of achieving the high levels of recruitment prior to 2000; therefore, using a truncated recruitment time series of only the past 20 years better reflects the current state of the stock. Spawning stock biomass in 2021 was estimated to be 3,353 metric tons, which is 101% of the biomass target and 202% of the biomass threshold. The 2022 fishing mortality was estimated to be 0.061 which is 23% of the overfishing threshold.

### **Spawning Behavior:**

Winter flounder enter the RI south shore coastal pond systems to spawn in the early part of winter (typically in November) and engage in spawning activity from approximately December 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. Figure 3 displays the ratios of spawning stages of winter flounder captured from 1999-2022 by month.

Sex ratios throughout the time series tend to skew slightly female dominant (Figure 4). Many decades ago similar observations were made in Green Hill Pond, a neighboring coastal pond (Saila 1961), and in Narragansett Bay (Saila 1962). Note that ‘unknown’ fish in this figure refers to those individuals that were too young to sex.

### **Results:**

A total of 91 fyke net sets were conducted in 2022 (Tables 1-3). The total number of winter flounder sampled during the 2022 survey was 192. This was a 14% decrease of total catch from the 2021 survey. Sizes ranged from 14.1 cm to 49.6 cm in 2022 (Figure 5). The CPUE across all ponds in 2022 was 2.1 fish/net haul. 2022 adult winter flounder CPUE in Point Judith Pond was 0.33 fish per net haul (Figure 6). This value is well below the time series high of 27.2 in 1999, as well as below the time series median. The catch rates in Point Judith Pond have shown a downward trend throughout the time series. 2022 adult winter flounder CPUE in Potter Pond was 1.7 fish per net haul (Figure 7). This value is near the time series median. 2022 winter flounder CPUE in Ninigret Pond was 2.6 fish per net haul (Figure 8).

In 2022, a total of 12 mature fish were tagged in Potter Pond 93 tagged in Ninigret Pond, and 2 fish were tagged within Point Judith Pond. Seven tagged winter flounder were recaptured in 2022 by both research surveys and commercial harvesters. In addition to the Peterson disc tags, 25 Vemco V13 acoustic tags were mounted on winter flounder in Ninigret Pond. All 25 of these individuals were monitored throughout the season on the acoustic receiver array. Tagged fish utilized all parts of Ninigret Pond including the far west basin. The majority of acoustic tagged fish exited the Ninigret Pond Breachway in May, though two fish appear to have remained resident in the general area through the summer of 2022 (Figure 9).

### **Discussion:**

Low catch rates in all systems surveyed have been observed in the recent decade of the adult coastal pond survey. CPUE trends indicate that despite both commercial and recreational harvest limits put in place to reduce mortality, localized coastal pond winter flounder populations are not recovering. Continued sampling in the Point Judith Pond, Potter Pond, and Ninigret Pond systems is necessary to monitor these trends. Increased sampling effort conducted in 2022 revealed similar population trends to those seen in the past few years. More winter flounder were tagged in 2021 than in the previous five years combined; tag return rates increased accordingly with the most tag returns in 2022 since 2015.

### **Recommendations:**

Continuation of all adult winter flounder work statewide in order to make accurate connections between coastal ponds, Narragansett Bay, and Rhode Island/Block Island Sound winter flounder stocks is necessary. In addition, the acoustic tagging survey in the Ninigret Pond System will be continued in 2023 in order to track local adult winter flounder abundance and use the catch as a source of taggable animals to gain information on population size, mortality, and year class structure. The importance of returning tag data from the commercial trawl/gill net fleet in Rhode Island Sound and Block Island Sound should be stressed in order to facilitate continued reporting of recaptured fish. Utilization of the Division’s Marine Fisheries listserv is recommended to alert commercial and recreational anglers to the continued efforts of this survey. The addition of staff in 2019 successfully alleviated all issues that have led to reduced sampling effort in recent years.

Due to moratoriums on commercial and recreational fishing in Point Judith Pond and Potter Pond, it is recommended that additional effort be placed in Ninigret Pond and potentially another system moving forward to increase the likelihood of tag returns for fish within those systems. Additionally, the past several years has seen higher mortality rates of winter flounder within fyke nets in Point Judith Pond compared with the other sampled systems. This is likely due to predation by seals and otters. In an effort to reduce survey related mortalities, sampling effort will be significantly reduced in Point Judith Pond moving forward.

### **References:**

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

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

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**Table 1 – Winter flounder tagging/recapture totals in Point Judith Pond by year. Number recaptured indicates the number of tagged fish that were recaptured in that year, regardless of what year that tagged fish had been released.**

<b>Year</b>	<b>Number of fyke sets</b>	<b>Number caught</b>	<b>Number tagged</b>	<b>Number recaptured</b>
1999	57	1297	329	38
2000	14	350	189	27
2001	22	540	354	50
2002	27	282	165	7
2003	27	160	87	4
2004	23	102	64	12
2005	27	252	116	5
2006	44	410	89	6
2007	31	121	35	3
2008	19	39	14	0
2009	26	62	0	0
2010	24	85	21	0
2011	23	60	5	0
2012	16	32	11	0
2013	14	12	0	0
2014	14	11	1	0
2015	7	10	4	0
2016	11	6	1	0
2017	1	0	0	0
2018	3	0	0	0
2019	12	8	0	0
2020	33	53	3	0
2021	20	9	3	0
2022	9	3	2	1
<b>Total</b>	<b>504</b>	<b>3904</b>	<b>1493</b>	<b>153</b>

**Table 2 – Winter flounder tagging/recapture totals in Potter Pond by year. Number recaptured indicates the number of tagged fish that were recaptured in that year, regardless of what year that tagged fish had been released.**

Year	Number of fyke sets	Number caught	Number tagged	Number recaptured
1999	0	0	0	0
2000	10	67	13	2
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	0	0	0	0
2011	2	8	6	0
2012	5	9	3	0
2013	5	10	5	0
2014	3	3	2	0
2015	7	46	10	0
2016	2	8	1	0
2017	3	8	2	0
2018	3	35	5	0
2019	4	5	4	0
2020	14	14	8	2
2021	36	92	35	0
2022	29	49	12	0
<b>Total</b>	<b>123</b>	<b>354</b>	<b>106</b>	<b>4</b>

**Table 3- Winter flounder tagging/recapture totals in Ninigret Pond by year. Number recaptured indicates the number of tagged fish that were recaptured in that year, regardless of what year that tagged fish had been released.**

Year	Number of fyke sets	Number caught	Number tagged	Number recaptured
2012	19	113	98	10
2013	21	146	109	11
2014	14	33	33	4
2015	16	143	67	4
2016	0	0	0	0
2017	0	0	0	0
2018	0	0	0	0
2019	5	34	17	0
2020	16	103	6	3
2021	40	121	79	0
2022	53	140	87	7
<b>Total</b>	<b>184</b>	<b>833</b>	<b>496</b>	<b>39</b>

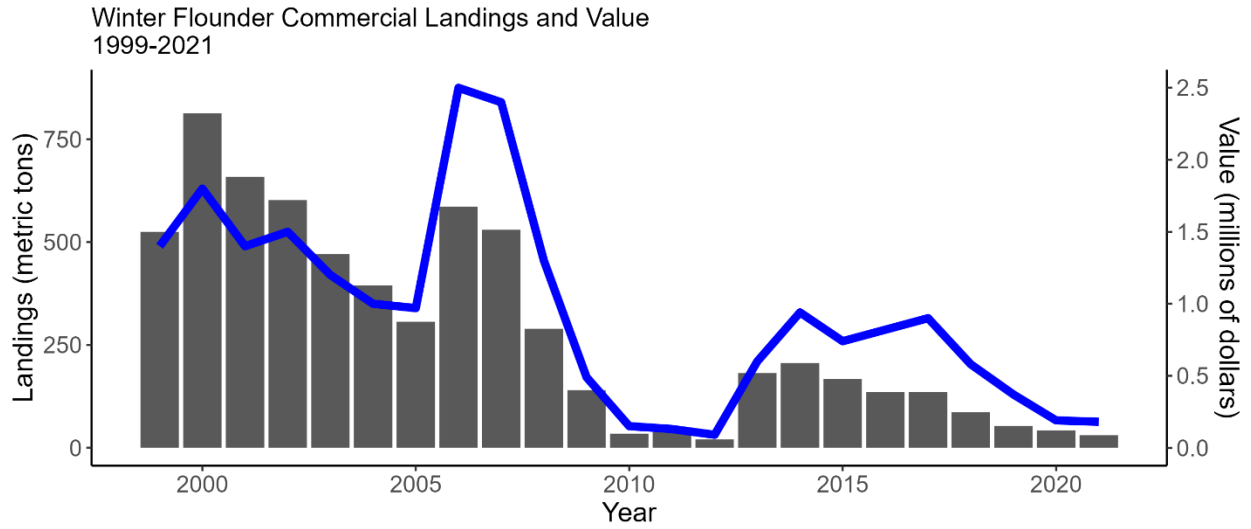


**Table 4 - Commercial landings and value of winter flounder in Rhode Island by year.**

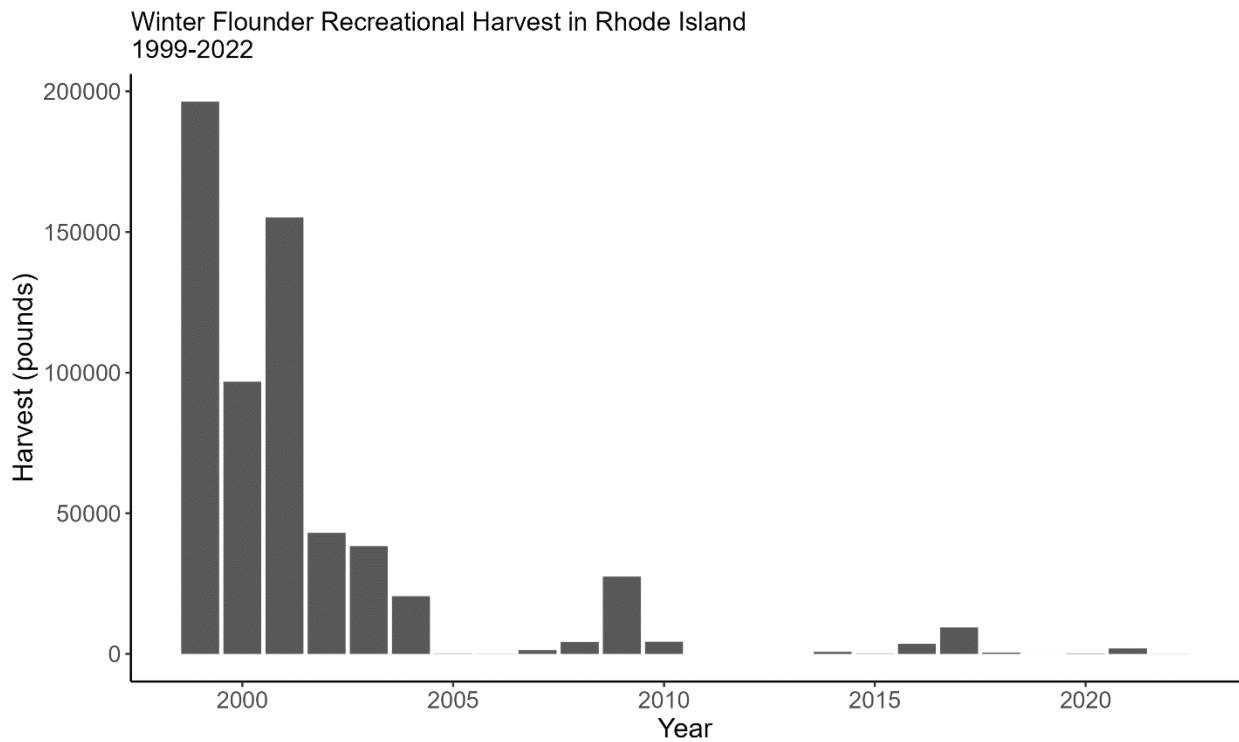
<b>Year</b>	<b>Landings (metric tons)</b>	<b>Value (millions of dollars)</b>
1999	525	1.4
2000	813.1	1.8
2001	658.5	1.4
2002	602	1.5
2003	470.6	1.2
2004	394.5	1
2005	306.4	0.97
2006	586.4	2.5
2007	530.1	2.4
2008	289.3	1.3
2009	140.2	0.49
2010	34.1	0.15
2011	37.9	0.13
2012	20.1	0.09
2013	181.7	0.6
2014	206.2	0.94
2015	167.4	0.74
2016	135.7	0.82
2017	135.8	0.9
2018	86.7	0.58
2019	53.1	0.37
2020	41.9	0.19
2021	30.6	0.18
<b>Average</b>	<b>280.3</b>	<b>0.94</b>

**Table 5 - MRIP Estimated Recreational Harvest for winter flounder in Rhode Island. Results from this query for 1999-2022 contain estimates resulting from the full application of both the Access Point Angler Intercept Survey (APAIS) and Fishing Effort Survey (FES) calibration. PSE values greater than 50 are highlighted red and indicate a very imprecise estimate. Results display harvest (Type A + B1). Values from 2020 are 100% contributed from imputed data. Values from 2022 are preliminary and subject to change.**

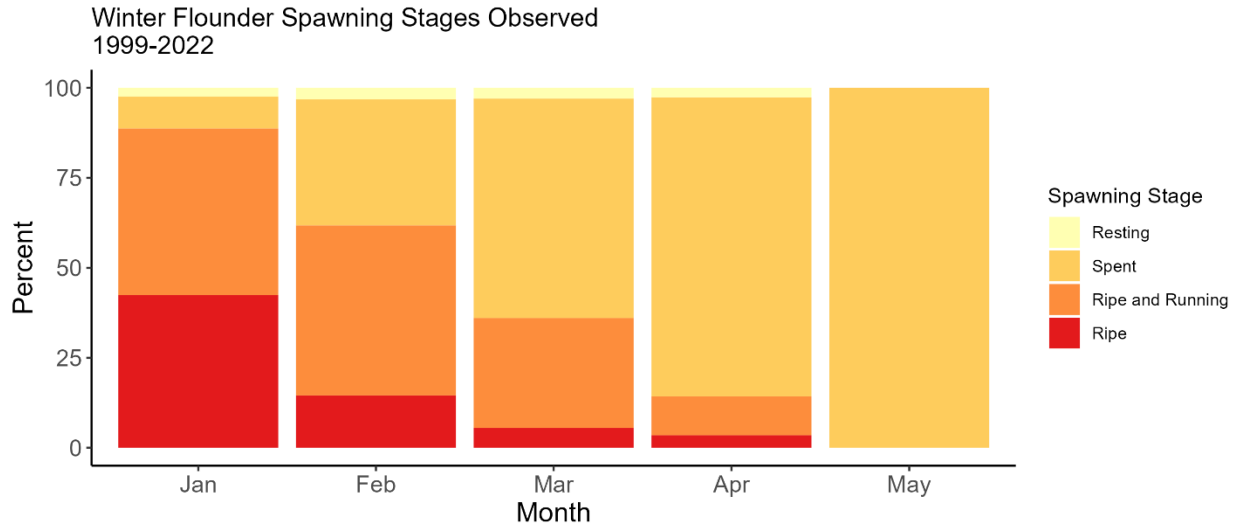
Estimate Status	Year	Common Name	Harvest (A+B1) Total Weight (lb)	PSE
FINAL	1999	WINTER FLOUNDER	196,351	25
FINAL	2000	WINTER FLOUNDER	96,789	30.7
FINAL	2001	WINTER FLOUNDER	155,171	31.6
FINAL	2002	WINTER FLOUNDER	43,058	29
FINAL	2003	WINTER FLOUNDER	38,300	49.1
FINAL	2004	WINTER FLOUNDER	20,544	47.5
FINAL	2005	WINTER FLOUNDER	103	61.5
FINAL	2006	WINTER FLOUNDER	65	73.5
FINAL	2007	WINTER FLOUNDER	1,321	99.1
FINAL	2008	WINTER FLOUNDER	4,219	105.6
FINAL	2009	WINTER FLOUNDER	27,455	79.3
FINAL	2010	WINTER FLOUNDER	4,342	106.3
FINAL	2014	WINTER FLOUNDER	713	94
FINAL	2015	WINTER FLOUNDER	91	102.5
FINAL	2016	WINTER FLOUNDER	3,520	96.2
FINAL	2017	WINTER FLOUNDER	9,419	105.7
FINAL	2018	WINTER FLOUNDER	453	68.6
FINAL	2019	WINTER FLOUNDER	4	99.3
FINAL	2020	WINTER FLOUNDER	143	64.2
FINAL	2021	WINTER FLOUNDER	1,952	92.2
PRELIMINARY	2022	WINTER FLOUNDER	45	101.9



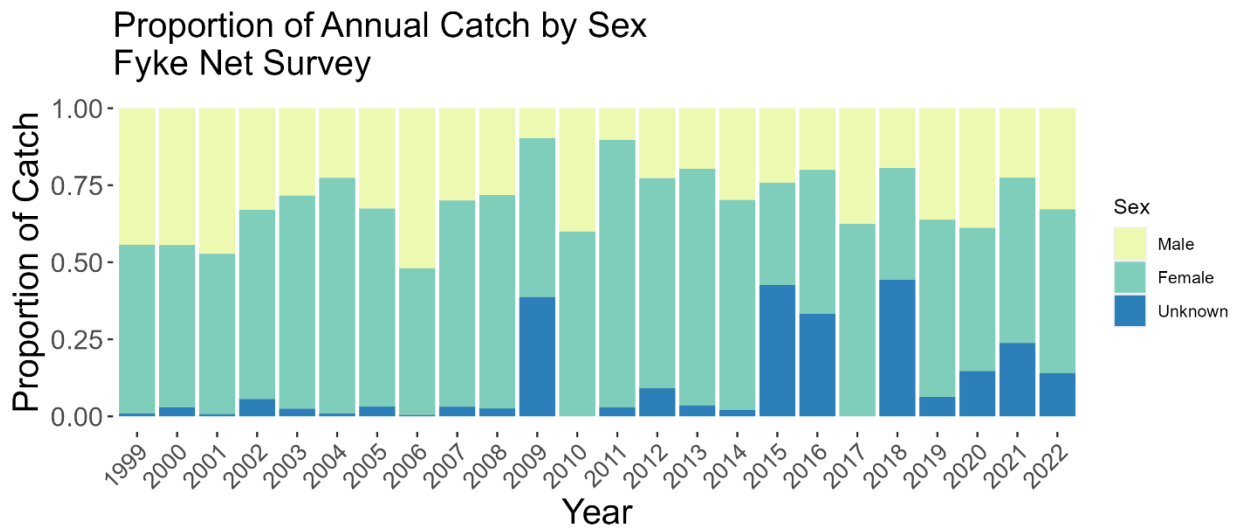
**Figure 1 – Winter flounder commercial landings from 1999-2021. Grey bars indicate landings (mt) and the blue line indicates value (millions of dollars).**



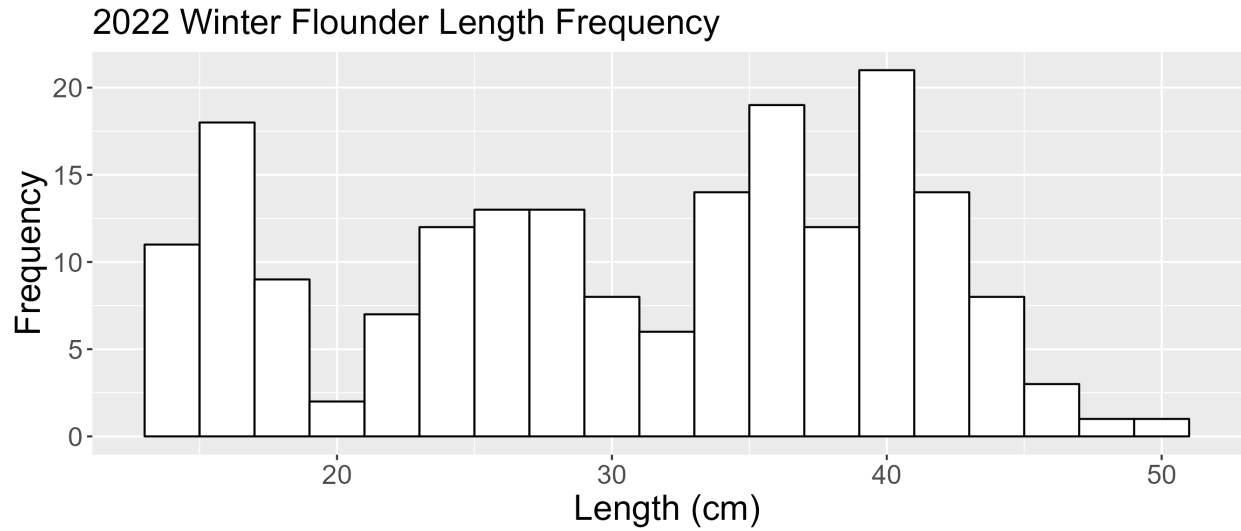
**Figure 2 – Winter flounder recreational harvest (Type A + B1 lbs) from 1999 to 2022. Note that 2022 data is preliminary.**



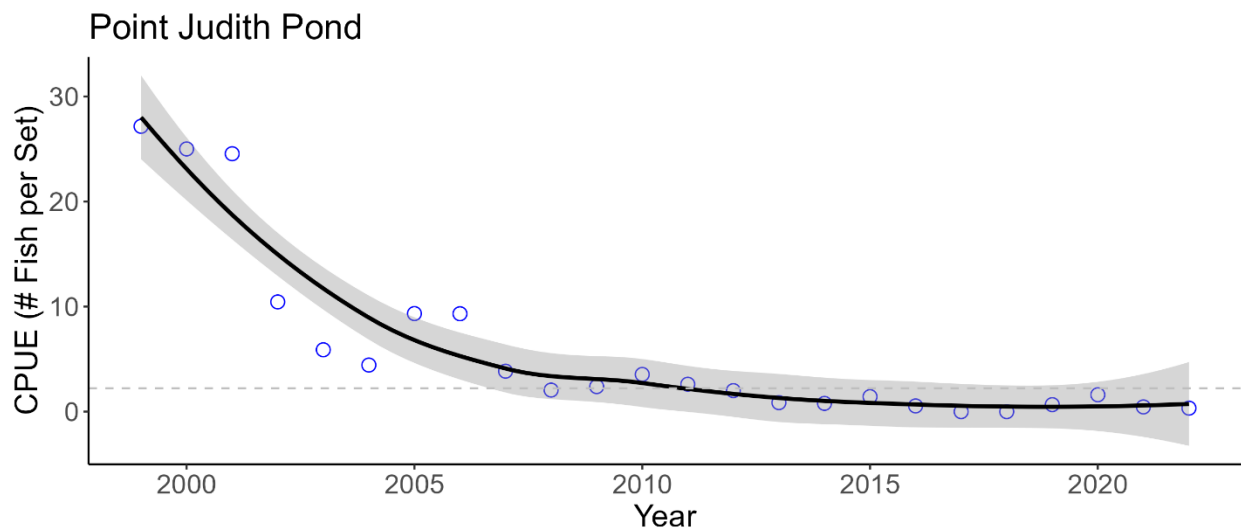
**Figure 3 – Winter flounder spawning stages observed by month from 1999-2022 across all surveyed coastal ponds.**



**Figure 4 – Winter flounder male to female ratio from 1999-2022 across all three surveyed coastal ponds.**



**Figure 5 – Winter flounder length-frequency for 2022 survey across all sampled coastal ponds.**



**Figure 6 - WFL smoothed abundance index for Point Judith Pond. Gray dashed line is time series median; black line is time series Loess regression fit; and gray shaded area is the approximate 95% confidence limits for Loess regression fit.**

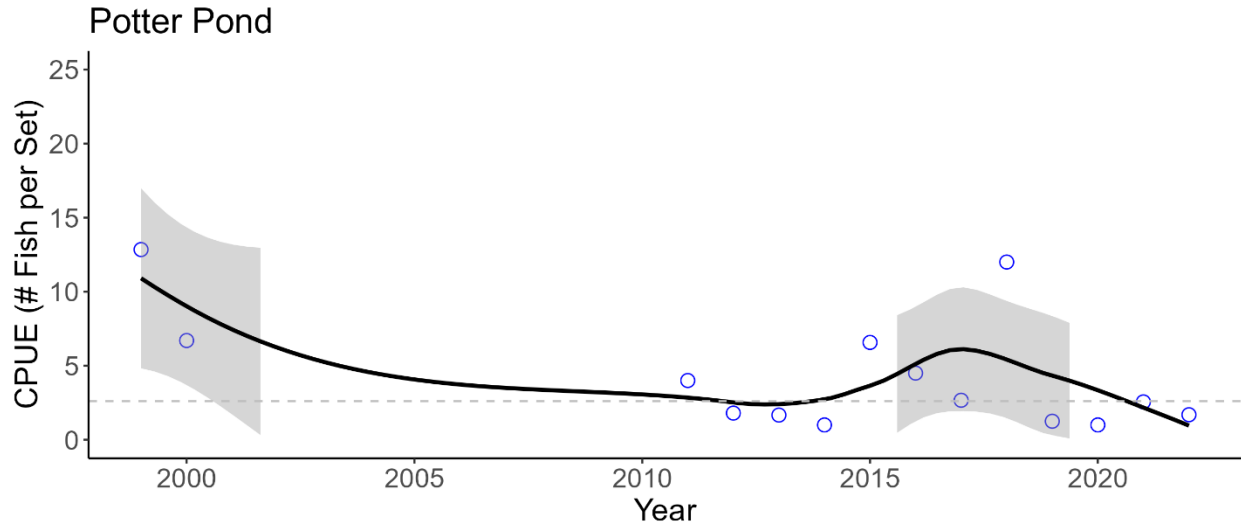


Figure 7 – Winter flounder smoothed abundance index for Potter Pond. Gray dashed line is time series median; black line is time series Loess regression fit; and gray shaded area is the approximate 95% confidence limits for Loess regression fit.

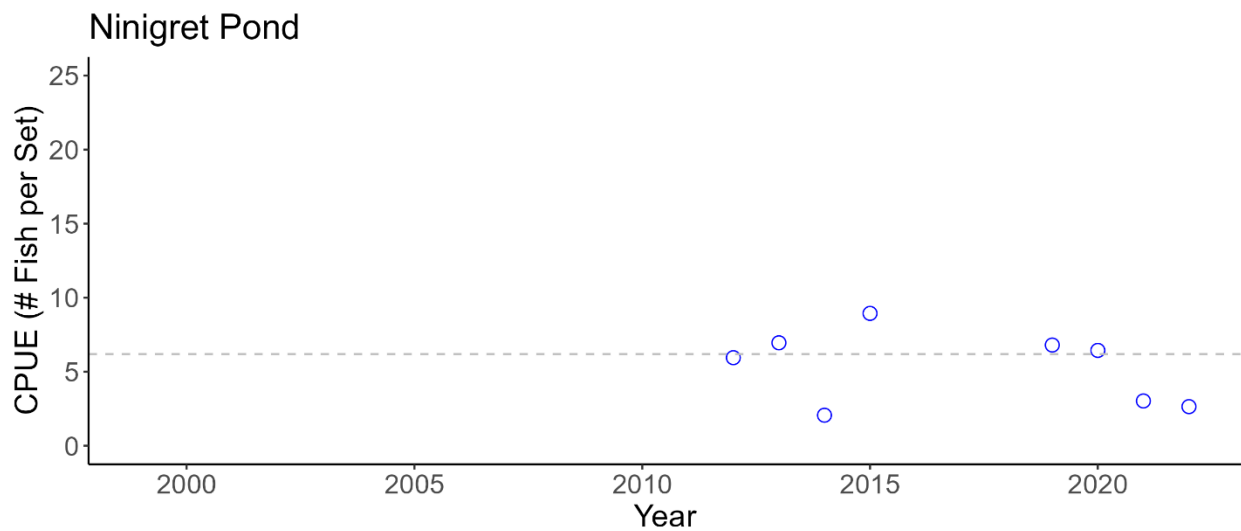
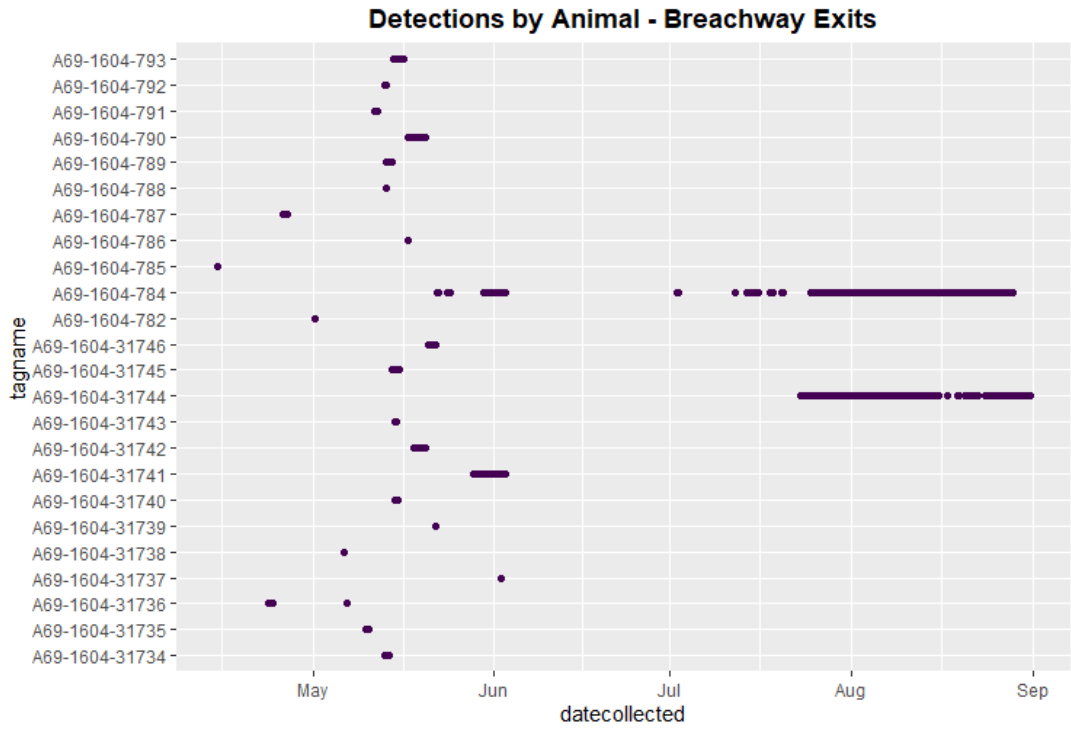


Figure 8 – Winter flounder smoothed abundance index for Ninigret Pond. Gray dashed line is time series median.



**Figure 9 – Acoustic pings of winter flounder at the Ninigret Pond Breachway entrance/exit during the first half of 2022.**

Narragansett Bay Atlantic Menhaden Monitoring Program

Nicole Lengyel Costa

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**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, 2022 – December 31, 2022

**JOB NUMBER 11 TITLE:** Narragansett Bay Atlantic Menhaden Monitoring Program

**JOB OBJECTIVE:** Continue administering an Atlantic menhaden monitoring program in Narragansett Bay that uses sentinel fishery observations (information of landings from floating fish traps), abundance information from spotter flights (with a trained spotter pilot), removal information by tracking fishery landings, and a mathematical model (Depletion Model for Open Systems; see Gibson, 2007) to monitor the biomass 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, 2017). 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.

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 Department of Environmental Management Division of Marine Fisheries (Division) administers a menhaden monitoring program in Narragansett Bay. The program collectively uses sentinel fishery observations (floating fish trap data), spotter flight information with a trained spotter pilot, 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 2022

**SIGNIFICANT DEVIATIONS:** No significant deviations.

**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.

**REMARKS:** Biomass 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 management structure maintains 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. Beginning in 2015, DEM adopted a regulation that opens the fishery annually on September 1<sup>st</sup> in the lower portion of Narragansett Bay at a reduced possession limit, despite the level of biomass present in the Bay. This opening is contingent upon the state having unharvested state quota remaining or having opted into the Episodic Event Set Aside program through ASMFC.

**METHODS, RESULTS & DISCUSSION:** The program consists of three main elements: collection of fishery landings information through call in and logbook requirements, field work (spotter flights and biological sampling), and computer modeling work. DEM regulations require that commercial vessels fishing for menhaden in Narragansett Bay report their catches to Division staff daily. All RI licensed commercial harvesters, including floating fish trap and purse seine operators, are required to file logbook reports monthly with the Division that details daily fishing activities.

Each year the Division contracts a trained spotter pilot to make biomass estimates of menhaden in Narragansett Bay. When in the air, the pilot records counts of menhaden schools observed, the estimated weight within the schools, and the location of the schools.

Each year biological port samples are collected from commercial purse seine operations, floating fish traps that operate in state waters outside of the menhaden management area, or from the Divisions trawl survey (Jobs 1 and 2 of this grant). Sampling includes length frequencies, body weights, and collecting scales and otoliths for age determination (see Age and Growth Study, Job 9 of this F-61R grant progress report).

Collectively, these sources of information are analyzed using the theory of depletion estimation as applied to open populations. All of the aforementioned information is centrally collected and used in a computer modeling approach that allows the Division to monitor the abundance of menhaden in Narragansett Bay. The existing regulatory framework governing state waters allows the Division to use the output from the mathematical modeling approach to set a number of fishing activity parameters including a static amount of fish needed to be present to allow commercial fishing to commence, thus protecting recreational and ecological interests if only a small population enters the Bay. The framework also authorizes 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. The Divisions ability to close the fishery when the standing population of menhaden in Narragansett Bay drops back below the threshold level of fish helps to maintain a portion of the population for recreational fishermen and ecological services. This program also allows the Division to accurately track the state quota and provides justification for Rhode Island to participate in the Episodic Event Set Aside Program.

#### 2022 Fishery Data

In 2022, biomass within the management area reached the minimum 2 million pound threshold in mid-May and the commercial menhaden fishery inside the management opened at 120,000 pounds per vessel per day for a single day on May 16, 2022. The management area subsequently reopened on August 9, 2022, when biomass again reached the minimum 2 million pound threshold. Fishermen reported that menhaden in the menhaden management area were small in size and not marketable. The management area remained open through October when it closed on October 24, 2023, once biomass dropped below the 1.5 million pound threshold. State waters outside of the management area remained open throughout the year. RI did not harvest it's full quota in 2022 and transferred a portion of it to other states. A total of 44 contractor spotter flights were completed in 2022 to accurately monitor biomass levels of menhaden within the management area (Figure 1).

**SUMMARY:** The menhaden monitoring program in Narragansett Bay opened for 1 day in May and approximately eleven weeks from August through October during the 2022 fishing year as a result of high menhaden biomass. RI did not fully harvest its initial 2022 commercial quota allocation and transferred a portion to other states. Total landings for RI from all sources totaled approximately 617,000 pounds.

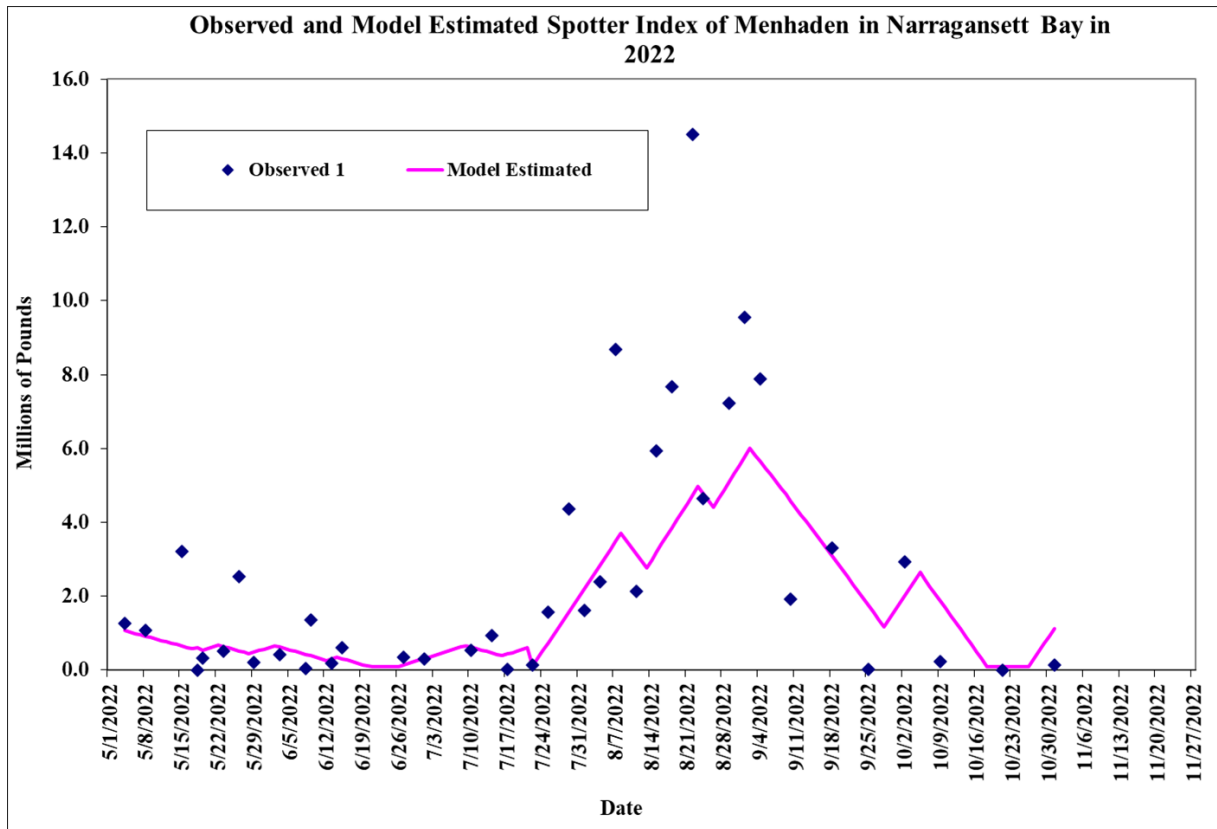


Figure 1. Predicted spotter pilot estimates and observed biomass in Narragansett Bay in 2022.

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ASMFC

# **Narragansett Bay Ventless Fish Pot Multi-Species Monitoring and Assessment Program**

## **Ventless Fish Pot Survey**

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Federal Aid in Sportfish Restoration  
F-61-22

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, 2022 – December 31, 2022

Job Number Job XII - Narragansett Bay Ventless Fish Pot Multi-Species Monitoring and Assessment Program

Job Objective: To assess and standardize a time series of relative abundance for structure-oriented finfish (scup, black sea bass, and tautog) in Narragansett Bay. Additional collection of age, weight at length, and other biological information for these species.

Significant Deviations: 2022 represented the second year of a new long-term ventless fish pot multi-species monitoring and assessment program. Only a subset of survey months, April through August, was sampled in 2022 due to vessel issues.

### **Summary:**

Finfish species that associate with bottom structure while in nearshore ecosystems may have relatively low catchability in traditional bottom trawl gear. As such, traditional fisheries-independent survey designs are often imperfect in assessing the relative abundance of structure-oriented marine species due to their inability to sample such habitats. Various stock assessments for structure-oriented fish including scup (NEFSC 2002) and black sea bass (NEFSC 2011) have recommended exploring alternatives to trawl surveys to provide better analytical assessment data for these species. Additionally, working groups such as the Northeast Data Poor Stocks Working Group (NEFSC 2008, Shepard 2008, Terceiro 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, each of which is an important recreational finfish in Rhode Island waters, tend to associate with bottom structure for a large portion of the year and as a result have low catchability in traditional bottom trawl surveys.

To address this concern, the Rhode Island Division of Marine Fisheries (RIDMF) conducted an exploratory ventless fish pot (referred to alternately as ‘pots’ and ‘traps’ throughout and colloquially) survey in Narragansett Bay from 2013 through 2016 and again in 2019. Based on data gathered during the exploratory survey RIDMF designed a standardized monitoring and assessment survey of recreationally important finfish utilizing ventless fish pot gear and began the survey in 2021. The goal of this survey program is to assess and standardize a time series of relative abundance for structure-oriented finfish in Rhode Island state waters, particularly black sea bass, tautog, and scup. Relative abundance indices derived from this survey will ideally be integrated into both local and coastwide assessments for the target species and will supplement state and regional trawl survey abundance indices.

While a fish pot survey allows for monitoring species entire habitat range (i.e. unstructured and structured [hard] bottom), several survey design decisions can influence catch

rates including directed placement on bottom type, pot design, soak time, and bait. These confounding factors on catch rates for recreationally significant finfish species for Rhode Island were evaluated in the summer and fall of 2019 through a directed study. The goal of this exploratory survey was to determine if there is a gear/soak time/bait combination that best maximizes catch for important finfish species while still providing a replicable methodology moving forward. Data from this 2019 study was used to inform the design of this long-term fish pot survey within Rhode Island state waters, and perhaps serve as a template for future efforts within other regions of these species' stock bounds.

### **Fisheries:**

Black sea bass, tautog, and scup are commercially and recreationally important species in RI. Summaries of RI commercial landings and values are found in Tables 1 through 3 and summaries of recreational harvest of each species are found in Tables 4 through 6. Throughout the time series, landings have shown generally stable (scup, tautog) or slightly increasing (black sea bass) trends for each of these species.

The Atlantic States Marine Fisheries Commission (ASMFC) 2021 black sea bass northern stock operational stock assessment indicates the stock was not overfished and overfishing was not occurring in 2019 relative to reference points (ASMFC 2021a). Starting in 2007, spawning stock biomass (SSB) increased rapidly and reached a peak in 2014 at over 76 million pounds, then decreased slightly. In 2019 SSB was estimated at 65.63 million pounds, 2.1 times the updated biomass target of 31.84 million pounds. (ASMFC 2021a).

Based on the 2021 tautog ASMFC stock assessment update, the Massachusetts-Rhode Island stock of tautog is not overfished and overfishing is not occurring (ASMFC 2021b). A 3-year average  $F$  is 0.23 which is below the target  $F$  of 0.28. Spawning stock biomass in 2020 was estimated to be 14.9 million pounds, above the target spawning stock biomass of 10.09 million pounds. Similarly, for scup the 2021 management track stock assessment update indicated the stock is considered rebuilt and not experiencing overfishing, with 2019 SSB estimated at 389 million pounds, about two times the SSB target of 198 million pounds (ASMFC 2021c).

### **Methods and Materials:**

Seven subareas are sampled within RI state waters: the Providence River including portions of the Upper Bay/Greenwich Bay, West Passage, East Passage, Mount Hope Bay including portions of the Upper Bay, Sakonnet River including the area from Land's End to Sakonnet Point, eastern RI Sound and western RI Sound (Figure 1). Each area is subdivided into 0.5-degree latitude and longitude squares and numbered; each respective grid cell is referred to as a 'station'. Investigators located areas of structured hard bottom (e.g., rocky outcropping, boulders/large cobble, wreck, bridge abutments, pilings) within each station when possible. The specific locations of structure were noted in the stations containing structural elements. At the start of each year three sampling stations are selected within each subarea and those stations are sampled May through October through the year (Figure 2). The RI Sound stations are also sampled in April. Each of the stations within a subarea are further stratified by depth with a 'shallow', 'deep', and 'fixed' are sampled within each subarea. 'Fixed' stations are sampled in the same location across all years. 'Shallow' and 'deep' stations are randomly selected each year.

In 2022 the survey was conducted monthly April to August. Traps fished are unvented black sea bass pots (43.5" x 23" x 6") constructed of 1.5" x 1.5" coated wire mesh, single mesh entry head, and single mesh inverted parlor nozzle. Baited (frozen clam bellies) trawls of five

traps are fished for an overnight soak (~24 hours) at each sampling station. After the 24-hour soak the trap sets were hauled, the catch processed, and gear either reset at a new station or removed from the water.

Upon hauling trap trawls, the catch is sorted by species. Finfish are measured to the nearest millimeter, fork length (FL) or total length (TL) as species appropriate. Invertebrates are measured using a species-specific appropriate metric or counted. Water temperature and salinity are collected using loggers on each trawl. Major and minor bottom types present at each sampling station are noted each month based on data from an onboard Furuno transducer.

## **Results:**

In 2022 a total of 93 trawl sets were sampled, totaling 465 individual fish pots set and processed. Twenty-two unique fish and invertebrate species were collected in 2022 with 1,560 fish and 3,273 invertebrates caught. Black sea bass was the most caught fish species with 839 individuals trapped (53% of fish catch) (Table 7). Scup were the second most caught fish species (502 individuals, 32% of fish catch) followed by cunner (92 individuals, 6% of total catch). These three species together accounted for over 91% of the total finfish catch. Spider crabs were the most frequently caught invertebrate representing over 80% of the total invertebrate catch (Table 8). American lobster were the second most frequently caught invertebrate species.

Across the timeseries black sea bass were caught in greatest abundance over structured bottom, while tautog and scup were caught in similar abundance over structured and unstructured bottom types (Figure 3). In general, black sea bass were caught in greater abundances at cooler bottom temperatures (10-14C) compared with scup (20-25C) (Figure 4). Likewise, black sea bass were caught in greatest abundances at moderate depths (50-75ft) compared with scup which were most common at shallow sampled depths (0-24ft) (Figure 5). Likely interrelated with depth and bottom temperature, black sea bass were caught in greatest abundance at more southern latitudes samples while scup were most common in the Upper Bay (Figure 6).

## **Discussion:**

Results from 2022, the second year of the new long-term ventless pot multi-species monitoring and assessment program, indicate that fish pots effectively target the three species of interest for this job; black sea bass, tautog, and scup as well as several other species of interest including cunner and conger eel. Based on the continued importance of these species to RI, both recreationally and commercially, it is critical that these species be accurately assessed. Compared with the earlier exploratory studies, this expanded and modified survey design will better allow this project to meet its goals. These goals include:

- Collect fishery independent data to provide a relative index of abundance for species that may not be fully sampled by RIDMF bottom trawl.
  - Collected data to be used in state and federal stock assessments and management.
- Provide relatively high-density spatiotemporal coverage of gear selected black sea bass, scup, and tautog cohorts within state waters.
  - Identify spatiotemporal trends of migration and abundance.
  - Track annual cohorts.
  - Track abundance consistency with other surveys (RIDMF trawl, NMFS trawl).
  - Determine age structure of fish sampled.
- Collect additional information on species biological characteristics.



- Track the prevalence of trap prone mid-Atlantic/southern species (e.g., grey triggerfish, blue runner, pinfish, Atlantic croaker).

Data collected through this survey will be instrumental in meeting these objectives. It is hoped that the survey will also provide numerous pathways for cross-collaborations with other state and federal agencies and departments in the future.

### **Recommendations:**

Implementation across a whole sampling season of the new survey design in 2023 and moving forward will allow the survey to meet all project goals. Utilization of the new RIDMF vessel designed to run this survey will increase efficiency and scope of the survey greatly. The addition of staff in 2019 will alleviate issues that have led to reduced sampling effort in recent years. Continuation of this survey will provide invaluable data on structure-oriented species to allow for effective management.

Trap sets conducted in April 2022 indicated significant issues with sampling within Narragansett Bay at that time of year. Catch was very low across all stations and there was substantial damage to gear due to seals. It is recommended that in 2023 the month of April is sampled only in the East and West Rhode Island Sound subareas. This should alleviate gear interactions with seals and should allow for the catch of black sea bass as they reenter the region in the spring. It is recommended that 2 separate weeks be sampled in an attempt to capture the start of the species ingress to RI waters.

The 2019 exploratory survey examined soak time, gear type, and fishing baited vs. unbaited traps. It did not address potential differences among bait types. It is recommended that a 'bait preference' study be conducted to explore the differences in species interactions with different bait types. This survey would be conducted using baited remote underwaters video systems (BRUVS). Bait types to be considered include clam bellies, green crab, squid, mussels, and unbaited. This research may also help inform the commercial fish pot community about alternate bait efficacy.

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**Table 1 - Commercial landings (pounds) and value (dollars) of black sea bass landed in Rhode Island by year (NMFS 2023).**

<b>Year</b>	<b>Landings (lbs)</b>	<b>Value (dollars)</b>
2010	241,886	779,001
2011	211,597	734,732
2012	204,360	735,346
2013	265,691	988,877
2014	267,703	884,332
2015	238,647	808,797
2016	294,343	1,091,991
2017	458,153	1,603,746
2018	374,637	1,433,963
2019	399,085	1,508,814
2020	553,749	1,332,449
2021	660,033	2,024,679
<b>Average</b>	<b>347,490</b>	<b>1,160,561</b>

**Table 2 - Commercial landings (pounds) and value (dollars) of tautog landed in Rhode Island by year (NMFS 2023).**

<b>Year</b>	<b>Landings (lbs)</b>	<b>Value (dollars)</b>
2010	44,054	101,431
2011	47,426	124,739
2012	50,126	151,036
2013	53,428	168,479
2014	53,384	182,347
2015	47,140	172,694
2016	50,680	195,296
2017	52,844	194,380
2018	51,450	196,276
2019	46,562	168,046
2020	52,561	161,720
2021	50,164	180,723
<b>Average</b>	<b>49,985</b>	<b>166,431</b>

**Table 3 - Commercial landings (pounds) and value (dollars) of scup landed in Rhode Island by year (NMFS 2023).**

<b>Year</b>	<b>Landings (lbs)</b>	<b>Value (dollars)</b>
2010	4,298,488	2,833,017
2011	6,335,920	3,311,832
2012	6,310,689	3,904,255
2013	7,345,771	3,666,438
2014	6,948,870	4,117,991
2015	6,793,854	4,278,299
2016	6,808,917	4,053,288
2017	5,973,305	3,077,934
2018	4,713,742	2,739,752
2019	4,583,835	2,570,825
2020	4,302,324	2,418,396
2021	4,272,466	2,734,995
<b>Average</b>	<b>5,7124,015</b>	<b>3,308,919</b>

**Table 4 - MRIP Estimated Recreational Harvest for black sea bass in Rhode Island. Results from this query contain estimates resulting from the full application of both the Access Point Angler Intercept Survey (APAIS) and Fishing Effort Survey (FES) calibration. PSE values greater than 50 are highlighted red and indicate a very imprecise estimate. Preliminary data is highlighted yellow.**

<b>Year</b>	<b>Harvest (A+B1) Total Weight (lb)</b>	<b>PSE</b>
2010	643,348	26.8
2011	236,607	53
2012	645,039	21.7
2013	313,315	19.2
2014	659,562	19.6
2015	807,840	19.7
2016	1,124,414	21.4
2017	747,262	21.2
2018	1,628,875	15.3
2019	1,225,058	16.0
2020	1,480,782	20.1
2021	1,116,032	13.3
2022	581,694	16.0

**Table 5 - MRIP Estimated Recreational Harvest for tautog in Rhode Island. Results from this query contain estimates resulting from the full application of both the Access Point Angler Intercept Survey (APAIS) and Fishing Effort Survey (FES) calibration. PSE values greater than 50 are highlighted red and indicate a very imprecise estimate. Preliminary data is highlighted yellow.**

Year	Harvest (A+B1) Total Weight (lb)	PSE
2010	1,933,773	38.9
2011	328,959	54.3
2012	1,512,425	32.1
2013	2,602,962	47.6
2014	1,017,780	33.4
2015	1,105,259	24.3
2016	1,290,428	24.7
2017	600,869	25.3
2018	1,075,131	51.4
2019	1,483,123	24.1
2020	853,470	19.2
2021	2,623,172	19.1
2022	1,287,892	14.7

**Table 6 - MRIP Estimated Recreational Harvest for scup in Rhode Island. Results from this query contain estimates resulting from the full application of both the Access Point Angler Intercept Survey (APAIS) and Fishing Effort Survey (FES) calibration. Preliminary data is highlighted yellow.**

Year	Harvest (A+B1) Total Weight (lb)	PSE
2010	771,713	22.5
2011	1,269,888	29.4
2012	1,119,378	22.7
2013	2,622,654	32.5
2014	2,650,482	22.9
2015	1,370,141	25.7
2016	1,552,395	33.1
2017	1,113,035	23.5
2018	2,030,258	13.1
2019	2,856,459	15.3
2020	1,330,398	17.4
2021	2,467,932	14.7
2022	2,971,900	16.0

**Table 7 – Fish catch from the ventless fish pot survey from 2022. Mean catch is number of individuals per trawl (5 trap string) ± standard error.**

Species	Mean Catch ± SE	Total Catch
Black Sea Bass	9.1 ± 1.2	839
Scup	5.5 ± 0.7	502
Cunner	1 ± 0.4	92
Tautog	0.7 ± 0.2	68
Oyster Toadfish	0.3 ± 0.1	28
Conger Eel	0.2 ± 0.1	16
Atlantic Cod	0.1 ± <0.1	5
Summer Flounder	<0.1 ± <0.1	4
Red Hake	<0.1 ± <0.1	2
Striped Searobin	<0.1 ± <0.1	2
American Eel	<0.1 ± <0.1	1
Striped Bass	<0.1 ± <0.1	1

**Table 8 – Invertebrate catch from the ventless fish pot survey from 2022. Mean catch is number of individuals per trawl (5 trap string) ± standard error.**

<b>Species</b>	<b>Mean Catch ± SE</b>	<b>Total Catch</b>
Spider Crab	29 ± 7.1	2665
American Lobster	4.6 ± 0.7	421
Channeled Whelk	1.4 ± 0.6	128
Jonah Crab	0.3 ± 0.1	23
Rock Crab	0.2 ± 0.1	17
Knobbed Whelk	0.1 ± 0.1	9
Blue Crab	<0.1 ± <0.1	4
Quahog	<0.1 ± <0.1	4
Green Crab	<0.1 ± <0.1	1
Mantis Shrimp	<0.1 ± <0.1	1

**Figure 1 – Ventless pot multi-species monitoring and assessment program subregions and 0.5 degree grid.**

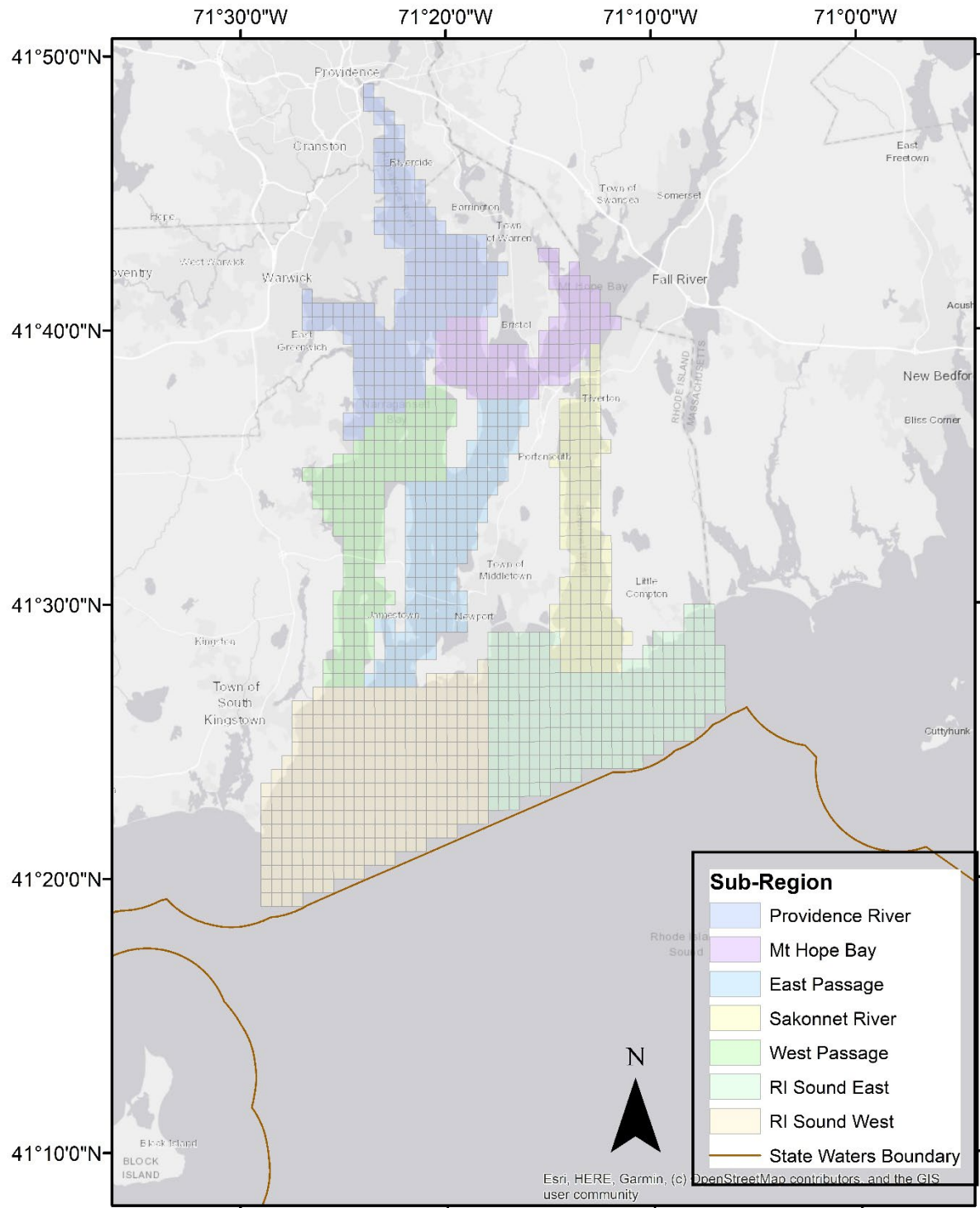




Figure 2 – Ventless pot multi-species monitoring and assessment program sampling locations 2022.

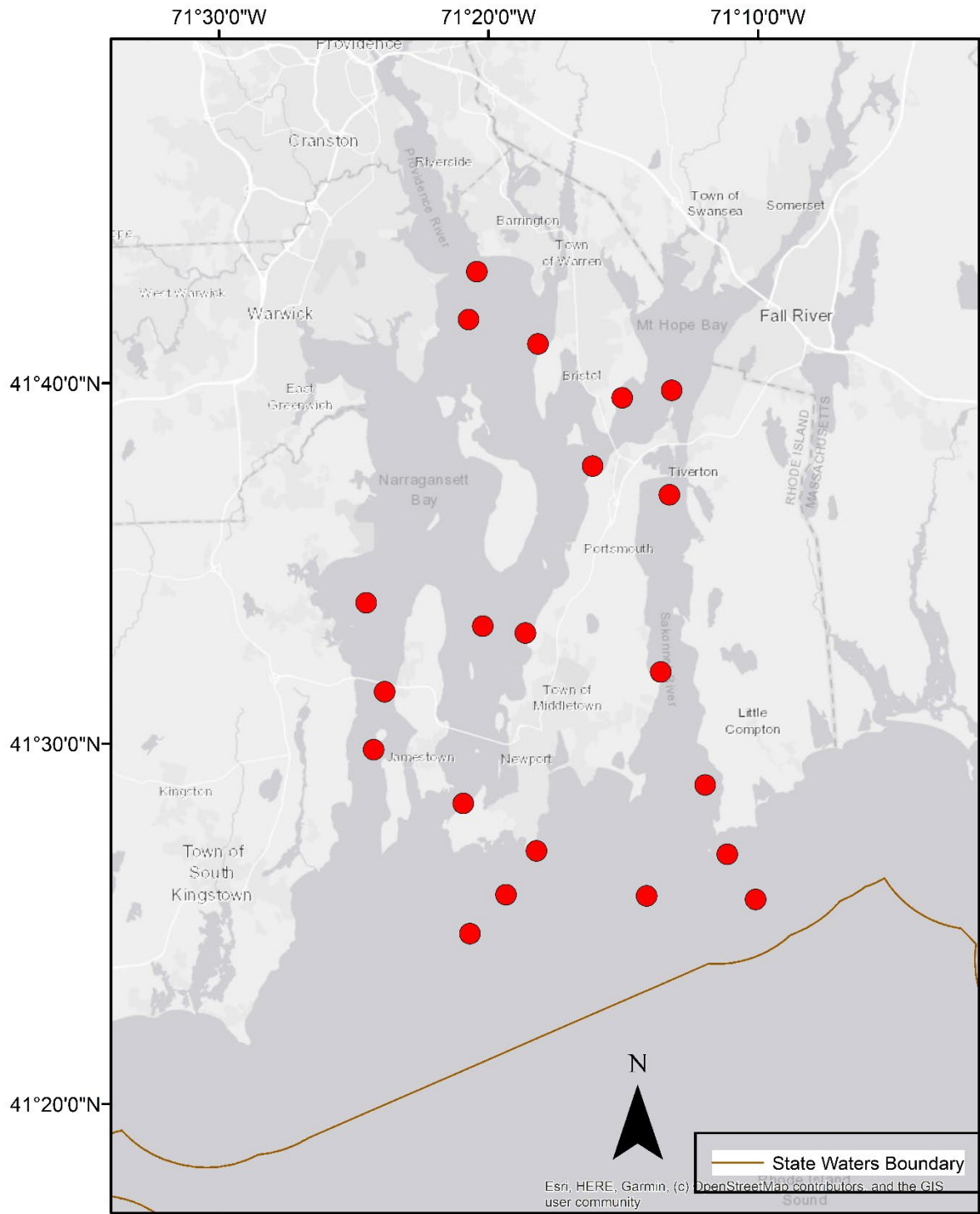


Figure 3 – Target fish species mean catch over structured and unstructured bottom types. Bars represent mean catch and error bars represent standard error.

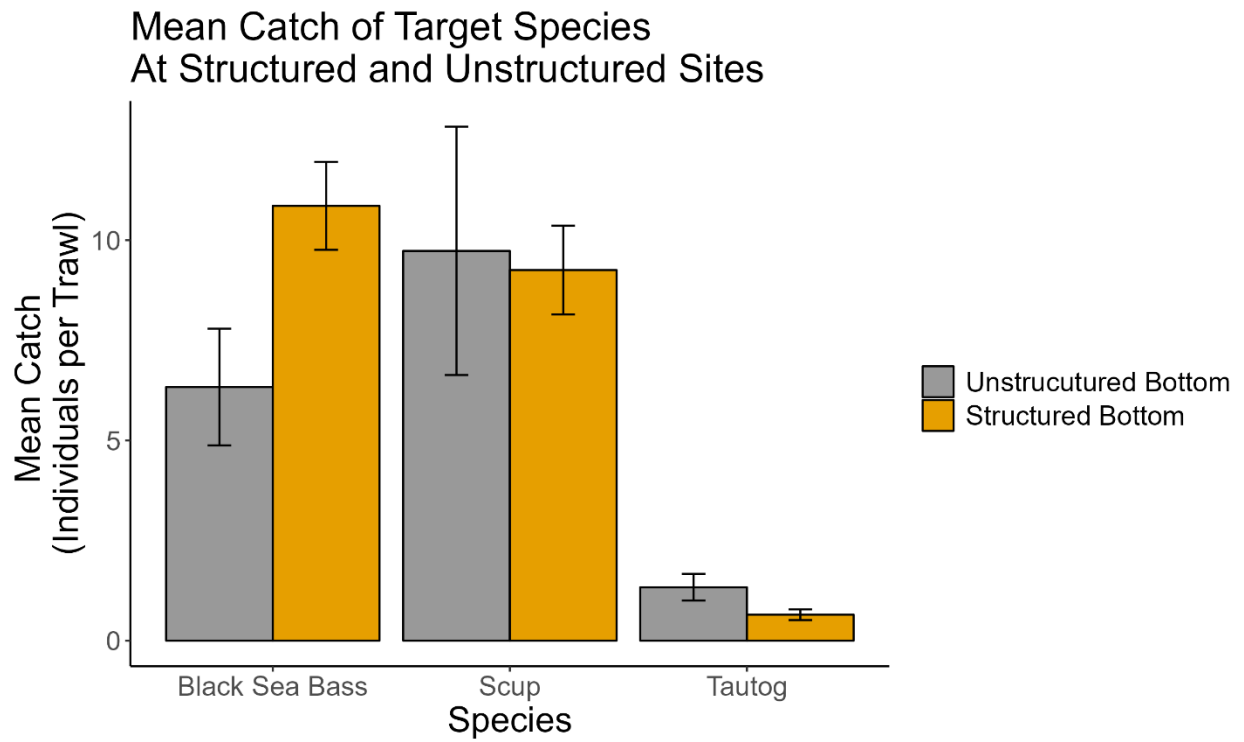


Figure 4 – Target fish species mean catch across bottom temperature bins. Bars represent mean catch and error bars represent standard error.

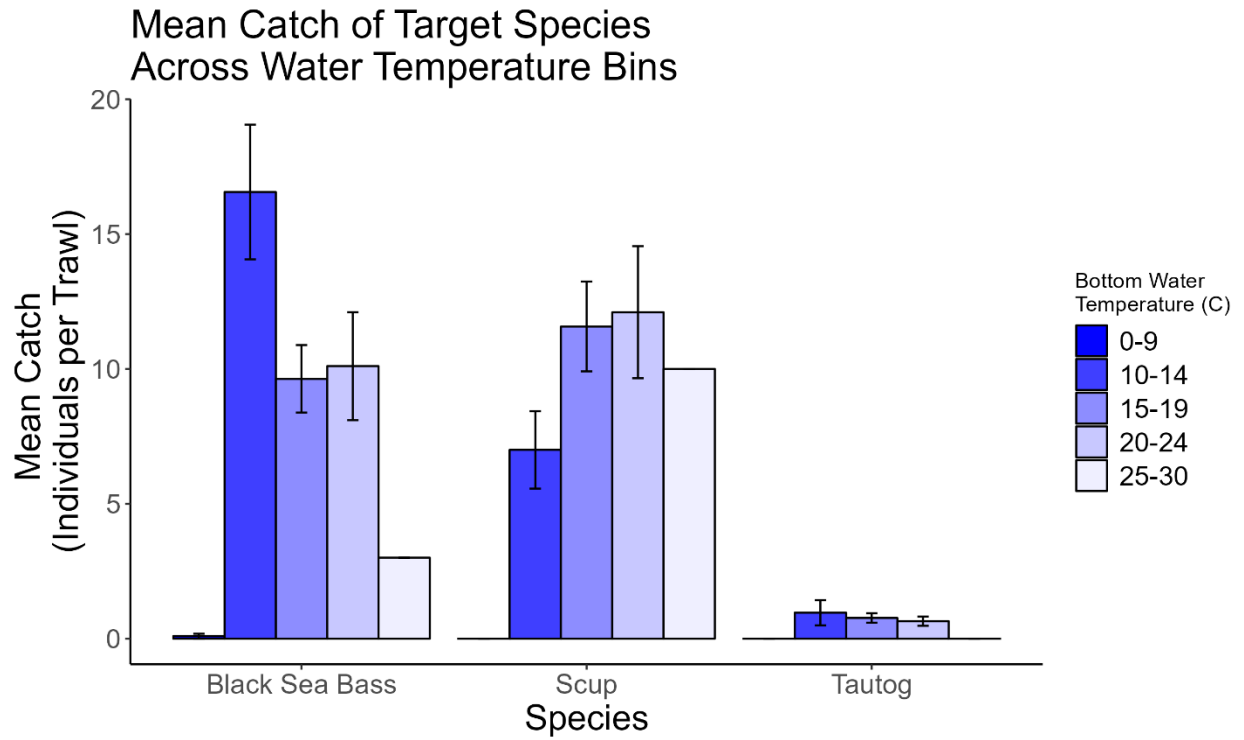


Figure 5 – Target fish species mean catch across bottom depth bins. Bars represent mean catch and error bars represent standard error.

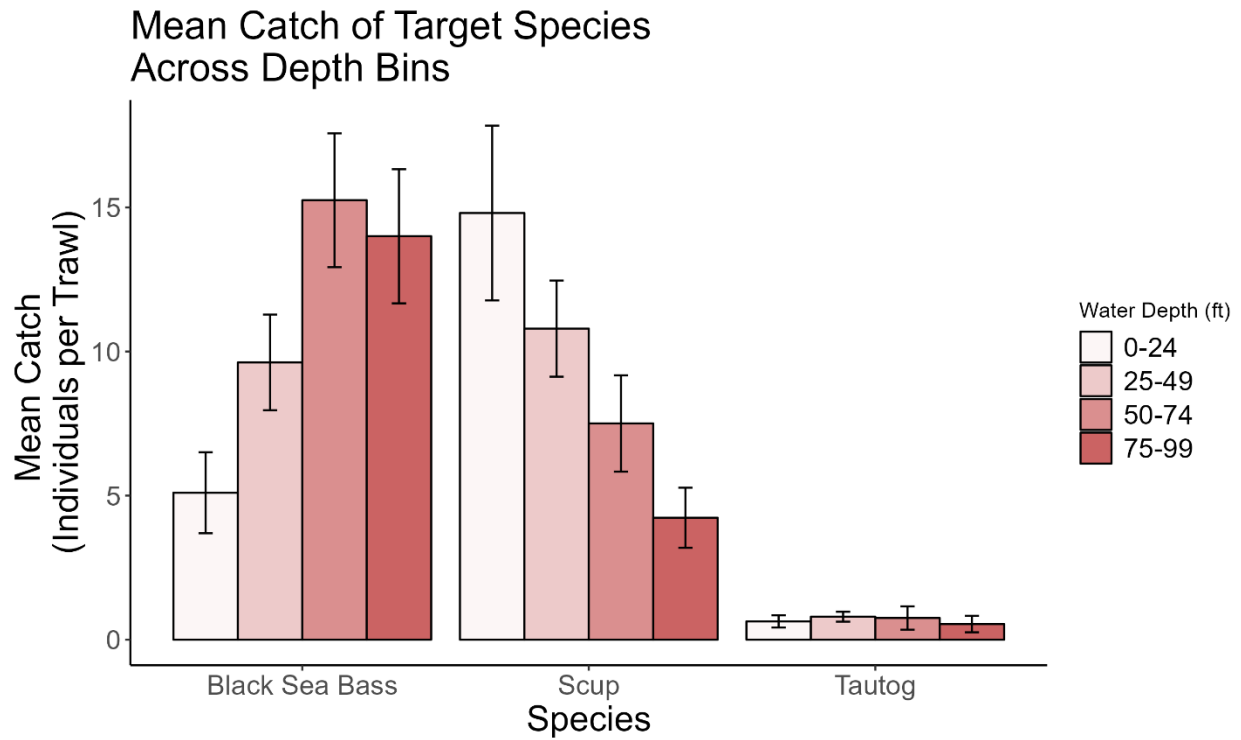
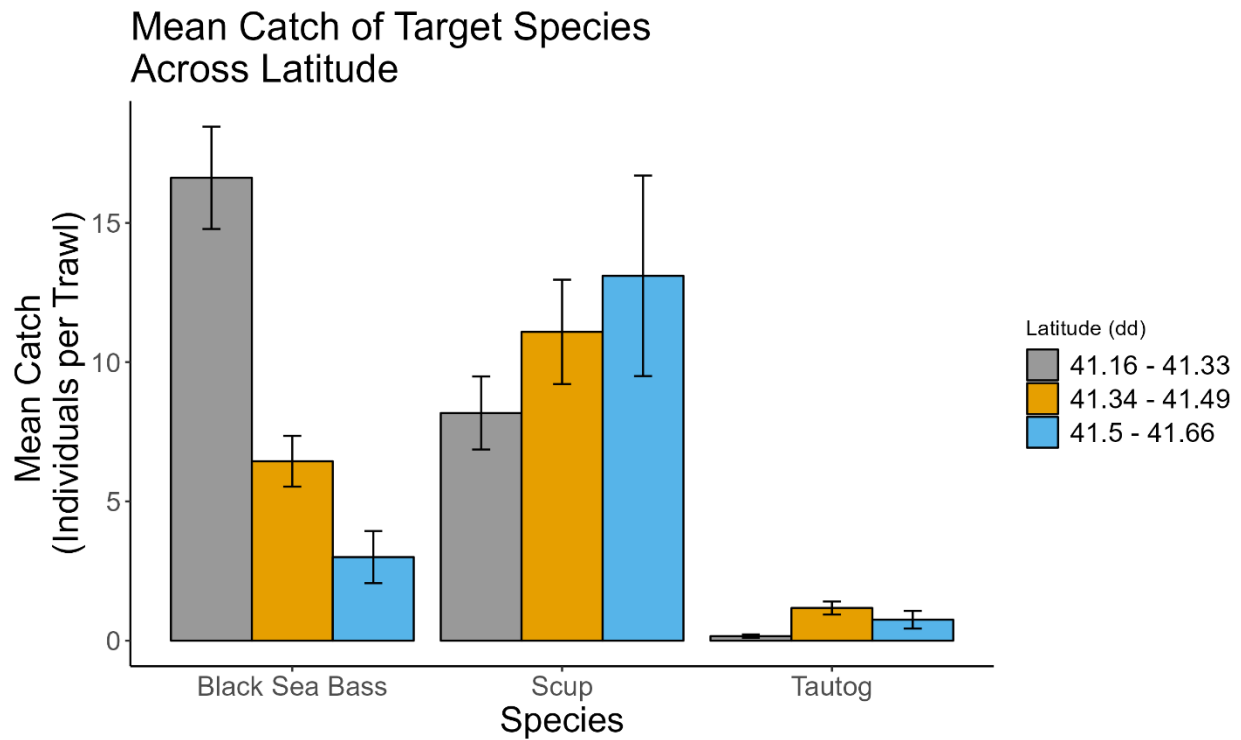


Figure 6 – Target fish species mean catch across latitude bins. Bars represent mean catch and error bars represent standard error.



ASSESSMENT OF RECREATIONALLY IMPORTANT  
FINFISH STOCKS IN RHODE ISLAND COASTAL WATERS

2022 ANNUAL PERFORMANCE REPORT

Federal Aid in Sportfish Restoration  
F-61-R  
SEGMENT 22, JOB 13

MARINE FISHES OF RHODE ISLAND

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March 2023

STATE: Rhode Island

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

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

JOB NUMBER: 13

JOB TITLE: Marine Fishes of Rhode Island

PERIOD COVERED: January 1, 2022 – December 31, 2022

JOB OBJECTIVE:

The goal of this project is to produce a manuscript which will act as a reference for recreational fishermen, commercial fishermen, and fisheries scientists alike. The finished product will summarize existing knowledge on the occurrence and distribution of fish species observed within Rhode Island marine waters, based on information collected through several field surveys conducted by Rhode Island Division of Marine Fisheries (RIDMF). The information will be presented systematically, and the manuscript will include scientific illustrations of fish species encountered occasionally to commonly in RIDMF surveys; rare species will not be illustrated. This work is designed to be a stand-alone manuscript, but also to be compatible with and be a companion volume to the "Inland Fishes of Rhode Island" book produced by the Rhode Island Division of Fish and Wildlife (RIDFW) in 2013.

SUMMARY:

The basic format and foundation of the book was laid out in 2017 during the previous grant award period for this project (January 1, 2014 – December 31, 2019) and included the following components: cover page, table of contents, acknowledgements, dedication, introduction, description of the data sources (field surveys) that collected the data with maps of survey sampling locations and survey activity photographs, tabular lists of species observed in RIDMF surveys (all surveys combined and by individual survey) and species reported to be observed historically by others with environmental and occurrence classifications, family descriptions, species names (including scientific and common name(s)), species identification and description characteristics, species distribution (general and in RI), current management in RI (where applicable), current RI sportfish and all-tackle (worldwide) records (where applicable), references used, glossary, and a taxonomic index.

The following sections and portions of the book were completed during the previous grant award period for this project (January 1, 2014 – December 31, 2019) (Table 1):

- cover page,
- acknowledgements,
- dedication page,

- table of contents,
- introduction,
- data source descriptions for 7 RIDMF field sampling surveys (including maps of sampling locations),
- tables of species (scientific and common name) caught in recent RIDMF surveys (all surveys combined and by individual survey) or observed by others historically, environmental and occurrence classifications, and relative abundance level by species and survey (abundant, common, occasional, rare),
- scientific names,
- current RI sportfish record for each species (if applicable),
- all-tackle worldwide record for each species (if applicable),
- data to create species distribution maps has been compiled from GPS sampling location data for each species for each RIDMF survey. To date, species distribution information has been compiled for all 7 RIDFW / RIDMF field sampling surveys being used for the book, and
- illustrations for 55 species (1 species with male and female illustrations) for a total of 56 illustrations completed previously for “Inland Fishes of Rhode Island” book)

The glossary, references, and index sections are near completion but will need occasional revision/updates as more text is added. Tables 1 and 2 summarize the book sections completed to date. A substantial amount of progress was made on text compilation and editing during 2022, resulting in completion of the initial draft of the book’s text (Table 3). The initial draft currently contains 759 pages of text that will be edited and reduced during 2023.

A total of 284 species will appear in the “Marine Fishes of Rhode Island” book. Of these, 186 species were observed in recent RIDMF surveys and 98 species were reported to be observed by entities other than RIDMF, either recently or historically. Of these 284 species, a total of 100 species will be illustrated, including 5 species with both sexes illustrated, for a total of 105 illustrations. There were 86 species observed rarely and 98 species never observed in RIDMF surveys but were reported to be observed by other sources (184 species total) that will not be illustrated.

A total of 56 illustrations previously completed for the RIDFW’s “Inland Fishes of Rhode Island” book (55 species; 1 species with both sexes illustrated; 2 species with only 1 of the sexes illustrated) will be utilized for this book, being species found in both agency’s sampling surveys, leaving 45 species with 49 species illustrations (2 species with both sexes illustrated; 2 species with only 1 of the sexes requiring illustration) to be completed for this book.

For this reporting period (January 1, 2022 – December 31, 2022), a total of 14 species illustrations were completed by the illustrator (Robert Jon Golder). There have been numerous email correspondences (≈50) and two (2) in-person meetings with the illustrator during this report period when completed illustrations and invoices were

delivered to RIDMF and additional frozen fish specimens were provided for illustration reference (Table 4).

TARGET DATE: December 31, 2024

SIGNIFICANT DEVIATIONS: None

RECOMMENDATIONS: Continue into the next grant segment reporting period.

REMARKS:

- The marine fish illustrations part of the job is now on schedule.
- One (1) species (*Serranus scriba*) was removed from inclusion in the book, as it was determined to be a misapplied name to the species *Sebastes norvegicus*.

Table 1. Summary of book sections completed during previous grant award, January 1, 2014 - December 31, 2019.

<b>Book Sections</b>	<b>Number completed</b>	<b>Total Number</b>
Cover page	1	1
Table of Contents	1	1
Acknowledgements	1	1
Dedication	1	1
Introduction	1	1
Description of Data Sources	7	7
Survey sampling maps	7	7
Survey activity photos	4	4
Tables	6	6
Glossary	In progress	1
Taxonomic Index	1	1
Family Description	60	117
Common / Species Name	284	284
Other Name(s)	204	284
RI Sportfish Record	284	284
All-Tackle Record	284	284
Species ID / Description	70	284
General / Local Distribution	73	284
Diet	71	284
Importance	73	284
Management	178	284
Illustrations	56 (55 species)	105 (100 species)
Species - text completed	66	284
Species - text incomplete	218	284



Table 2. Summary of book sections completed during current grant segment reporting period, January 1, 2022 - December 31, 2022 with total number completed\* (January 1, 2014 – December 31, 2022\*) and total number required (\* includes previous grant award).

<b>Book Sections</b>	<b>Number completed 1/1/2022-12/31/2022</b>	<b>Total Number Completed*</b>	<b>Total Number Required*</b>
Cover page	0	1	1
Table of Contents	0	1	1
Acknowledgements	0	1	1
Dedication	0	1	1
Introduction	0	1	1
Description of Data Sources	0	7	7
Survey sampling maps	0	7	7
Survey activity photos	0	4	4
Tables	0	6	6
Glossary	0	In progress	1
Taxonomic Index	0	1	1
Family Descriptions	8	117	117
Common / Species Name	0	284	284
Other Name(s)	12	284	284
RI Sportfish Record	0	284	284
All-Tackle Record	0	284	284
Species ID / Description	34	284	284
General / Local Distribution	35	284	284
Diet	33	284	284
Importance	31	284	284
Management	14	284	284
Illustrations	14 (14 species)	86 (100 species)	105 (100 species)
Species - text completed	31	284	284
Species - text incomplete	0	-	-

Table 3. Summary of book sections completed by species and illustration status for previous grant award (January 1, 2014 – December 31, 2019; x, done), current grant award (January 1, 2020 – December 31, 2024; **X, done**), and current segment reporting period (January 1, 2022 – December 31, 2022; **X, done**).

SPECIES	Family Description	Common / Species Name	Other Names	RI sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Alosa aestivalis	x	x	x	x	x	x	x	x	x	x	done	YES	done
Alosa mediocris	x	x	x	x	x	x	x	x	x	x	done	YES	done
Alosa pseudoharengus	x	x	x	x	x	x	x	x	x	x	done	YES	done
Alosa sapidissima	x	x	x	x	x	x	x	x	x	x	done	YES	done
Ameiurus nebulosus	<b>X</b>	x	x	x	x	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>done</b>	YES	done
Ammodytes americanus	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Anchoa hepsetus	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Anchoa mitchilli	x	x	x	x	x	x	x	x	x	x	done	YES	done
Anguilla rostrata	x	x	x	x	x	x	x	x	x	x	done	YES	done
Apeltes quadracus	x	x	x	x	x	x	x	x	x	x	done	YES	done
Bairdiella chrysoura	<b>X</b>	x	<b>X</b>	x	x	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>done</b>	YES	<b>done</b>
Brevoortia tyrannus	x	x	x	x	x	x	x	x	x	x	done	YES	done
Caranx crysos	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Caranx hippos	x	x	x	x	x	x	x	x	x	x	done	YES	done
Catostomus commersoni	x	x	x	x	x	x	x	x	x	x	done	YES	done
Centropristis striata (F)	<b>X</b>	x	x	x	x	<b>X</b>	<b>X</b>	x	<b>X</b>	<b>X</b>	<b>done</b>	YES	
Centropristis striata (M)	<b>X</b>	x	x	x	x	<b>X</b>	<b>X</b>	x	<b>X</b>	<b>X</b>	<b>done</b>	YES	<b>done</b>
Citharichthys arcifrons	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Clupea harengus	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Conger oceanicus	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Cynoscion regalis	<b>X</b>	x	<b>X</b>	x	x	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>done</b>	YES	done
Cyprinodon variegatus (F)	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Cyprinodon variegatus (M)	x	x	x	x	x	x	x	x	x	x	done	YES	done
Decapterus punctatus	x	x	x	x	x	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	x	done	YES	
Dorosoma cepedianum	x	x	x	x	x	x	x	x	x	x	done	YES	done
Enchelyopus cimbrius	x	x	x	x	x	x	x	x	x	x	done	YES	<b>done</b>
Esox niger	x	x	x	x	x	x	x	x	x	x	done	YES	done
Etropus microstomus	<b>X</b>	x	<b>X</b>	x	x	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>done</b>	YES	<b>done</b>
Eucinostomus argenteus	<b>X</b>	x	x	x	x	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>	x	<b>done</b>	YES	done
Fundulus diaphanus	x	x	x	x	x	x	x	x	x	x	done	YES	done

SPECIES	Family Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Fundulus heteroclitus (F)	x	x	x	x	x	x	x	x	x	x	done	YES	done
Fundulus heteroclitus (M)	x	x	x	x	x	x	x	x	x	x	done	YES	done
Fundulus majalis (F)	x	x	x	x	x	x	x	x	x	x	done	YES	done
Fundulus majalis (M)	x	x	x	x	x	x	x	x	x	x	done	YES	done
Gadus morhua	x	x	x	x	x	X	X	X	X	x	done	YES	done
Gasterosteus aculeatus	x	x	x	x	x	X	X	X	X	x	done	YES	done
Gobiosoma bosc	X	x	x	x	x	X	X	X	X	x	done	YES	done
Hemirhamphus americanus	X	x	x	x	x	X	X	X	X	x	done	YES	
Lagodon rhomboides	x	x	X	x	x	X	X	X	X	X	done	YES	done
Leiostomus xanthurus	X	x	X	x	x	X	X	X	X	X	done	YES	done
Lepomis auritus	x	x	x	x	x	X	X	X	x	x	done	YES	done
Lepomis gibbosus	x	x	x	x	x	X	X	X	X	x	done	YES	done
Lepomis macrochirus	x	x	x	x	x	X	X	X	X	x	done	YES	done
Leucoraja erinacea	X	x	X	x	x	X	X	X	X	X	done	YES	
Leucoraja ocellata	X	x	X	x	x	X	X	X	X	X	done	YES	
Lophius americanus	X	x	x	x	x	X	X	X	X	x	done	YES	
Lucania parva	x	x	x	x	x	x	x	x	x	x	done	YES	done
Lutjanus griseus	X	x	X	x	x	X	X	X	X	x	done	YES	done
Luxilus cornutus	x	x	x	x	x	x	x	x	x	x	done	YES	done
Melanogrammus aeglefinus	x	x	x	x	x	X	X	X	X	x	done	YES	
Menidia beryllina	x	x	x	x	x	x	x	x	x	x	done	YES	done
Menidia menidia	x	x	x	x	x	x	x	x	x	x	done	YES	done
Menticirrhus saxatilis	X	x	X	x	x	X	X	X	X	X	done	YES	done
Merluccius bilinearis	X	x	x	x	x	X	X	X	X	x	done	YES	
Microgadus tomcod	x	x	x	x	x	X	X	X	X	x	done	YES	done
Micropterus dolomieu	x	x	x	x	x	X	X	X	X	x	done	YES	done
Micropterus salmoides	x	x	x	x	x	x	X	X	X	x	done	YES	done
Morone americana	X	x	x	x	x	X	X	X	X	x	done	YES	done
Morone saxatilis	X	x	x	x	x	X	X	X	X	x	done	YES	done
Mugil curema	X	x	x	x	x	X	X	X	X	x	done	YES	done
Mustelus canis	X	x	X	x	x	X	X	X	X	X	done	YES	
Myoxocephalus aeneus	x	x	x	x	x	x	x	x	x	x	done	YES	
Myoxocephalus octodecemspinosus	x	x	x	x	x	X	X	X	X	x	done	YES	
Notemigonus crysoleucas	x	x	x	x	x	x	x	x	x	x	done	YES	done
Opsanus tau	x	x	x	x	x	x	x	x	x	x	done	YES	

SPECIES	Family Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Osmerus mordax	X	x	x	x	x	X	X	X	X	x	done	YES	done
Paralichthys dentatus	X	x	x	x	x	X	X	X	X	x	done	YES	done
Paralichthys oblongus	X	x	X	x	x	X	X	X	X	X	done	YES	done
Peprilus triacanthus	X	x	X	x	x	X	X	X	X	X	done	YES	done
Petromyzon marinus	x	x	x	x	x	x	x	x	x	x	done	YES	done
Pholis gunnellus	X	x	x	x	x	X	X	X	X	X	done	YES	done
Pollachius virens	x	x	x	x	x	X	X	X	X	x	done	YES	done
Pomatomus saltatrix	X	x	X	x	x	X	X	X	X	X	done	YES	done
Pomoxis nigromaculatus	x	x	x	x	x	x	x	x	x	x	done	YES	done
Priacanthus arenatus	X	x	X	x	x	X	X	X	X	x	done	YES	done
Prionotus carolinus	X	x	X	x	x	X	X	X	X	X	done	YES	done
Prionotus evolans	X	x	X	x	x	X	X	X	X	X	done	YES	
Pseudopleuronectes americanus	X	x	X	x	x	X	X	X	X	X	done	YES	done
Pungitius pungitius	x	x	x	x	x	X	X	X	X	x	done	YES	done
Raja eglanteria	X	x	X	x	x	X	X	X	X	X	done	YES	
Rhinichthys atratulus	x	x	x	x	x	x	x	x	x	x	done	YES	done
Salmo salar	X	x	X	x	x	X	X	X	X	X	done	YES	done
Salmo trutta	X	x	X	x	x	X	X	X	X	X	done	YES	done
Salvelinus fontinalis	X	x	X	x	x	X	X	X	X	X	done	YES	done
Scomber scombrus	X	x	X	x	x	X	X	X	X	X	done	YES	done
Scophthalmus aquosus	X	x	X	x	x	X	X	X	X	X	done	YES	done
Selene setapinnis	x	x	x	x	x	X	X	X	X	x	done	YES	done
Selene vomer	x	x	x	x	x	X	X	X	X	x	done	YES	done
Sphoeroides maculatus	x	x	x	x	x	X	X	X	X	x	done	YES	done
Sphyraena borealis	X	x	X	x	x	X	X	X	X	X	done	YES	done
Squalus acanthias	X	x	X	x	x	X	X	X	X	X	done	YES	done
Stenotomus chrysops	x	x	x	x	x	X	x	X	X	x	done	YES	done
Strongylura marina	x	x	x	x	x	X	X	X	X	x	done	YES	done
Syngnathus fuscus	X	x	x	x	x	X	X	X	X	x	done	YES	done
Synodus foetens	x	x	x	x	x	x	x	x	x	x	done	YES	
Tautoga onitis (F)	X	x	x	x	x	X	X	X	X	X	done	YES	
Tautoga onitis (M)	X	x	x	x	x	X	X	X	X	X	done	YES	done
Tautoglabrus adspersus	X	x	x	x	x	X	X	X	X	x	done	YES	done
Trachurus lathami	x	x	x	x	x	X	X	X	X	x	done	YES	done
Trinectes maculatus	x	x	x	x	x	x	x	x	x	x	done	YES	done

SPECIES	Family Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Upeneus parvus	X	x	x	x	x	X	X	X	X	x	done	YES	done
Urophycis chuss	X	x	x	x	x	X	X	X	X	x	done	YES	
Urophycis regia	X	x	x	x	x	X	X	X	X	x	done	YES	
Urophycis tenuis	X	x	x	x	x	X	X	X	X	x	done	YES	
Zoarcetes americanus	X	x	X	x	x	X	X	X	X	X	done	YES	
Ablennes hians	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Abudefduf saxatilis	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Acanthostracion polygonius	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Acanthostracion quadricornis	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Acanthurus chirurgus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Acipenser brevirostrum	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Acipenser oxyrinchus oxyrinchus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Acipenser sturio	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Albula vulpes	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Alectis ciliaris	x	x	x	x	x	X	X	X	x	x	done	NO	N/A
Alepisaurus ferax	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Alopias vulpinus	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Aluterus heudelotii	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Aluterus monoceros	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Aluterus schoepfii	x	x	x	x	x	x	X	x	x	x	done	NO	N/A
Aluterus scriptus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Amblyraja radiata	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Ammodytes dubius	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Anarhichas lupus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Antigonia capros	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Apogon imberbis	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Archosargus probatocephalus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Ariopsis felis	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Aspidophoroides monopterygius	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Astroscoptes guttatus	X	x	X	x	x	X	X	X	X	x	done	NO	N/A
Auxis thazard	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Bagre marinus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Balistes capriscus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Balistes vetula	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Bothus robinsi	x	x	x	x	x	X	X	X	X	x	done	NO	N/A

SPECIES	Family Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Brosme brosme	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Calamus bajonado	x	x	X	x	x	X	X	X	X	X	done	NO	N/A
Carangoides bartholomaei	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Carcharhinus obscurus	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Carcharhinus plumbeus	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Carcharias taurus	x	x	x	x	x	x	x	x	x	X	done	NO	N/A
Carcharodon carcharias	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Caulolatilus microps	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Centrolophus niger	x	x	x	x	x	X	x	X	X	x	done	NO	N/A
Centropristis philadelphica	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Cetorhinus maximus	x	x	x	x	x	X	X	X	x	X	done	NO	N/A
Chaetodipterus faber	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Chaetodon capistratus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Chaetodon ocellatus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Chaetodon striatus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Cheilopogon furcatus	x	x	x	x	x	X	x	X	X	x	done	NO	N/A
Chilomycterus schoepfii	x	x	x	x	x	X	x	X	X	x	done	NO	N/A
Coryphaena hippurus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Cryptacanthodes maculatus	x	x	x	x	x	X	x	X	X	x	done	NO	N/A
Ctenogobius boleosoma	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Cyclosetta fimbriata	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Cyclopterus lumpus	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Dactylopterus volitans	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Dasyatis centroura	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Dasyatis say	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Decapterus macarellus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Dibranchius atlanticus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Diodon hystrix	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Dipturus laevis	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Echeneis naucrates	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Echeneis neucratoides	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Elops saurus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Engraulis eurystole	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Epinephelus niveatus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Etrumeus teres	x	x	x	x	x	x	x	x	x	x	done	NO	N/A

SPECIES	Family Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Eucinostomus gula	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Euleptorhamphus velox	x	x	x	x	x	X	X	X	x	x	done	NO	N/A
Euthynnus alletteratus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Fistularia tabacaria	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Gaidropsarus ensis	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Galeocerdo cuvier	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Gasterosteus wheatlandi	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Ginglymostoma cirratum	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Glyptocephalus cynoglossus	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Gobiosoma ginsburgi	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Gymnura altavela	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Helicolenus dactylopterus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Heteropriacanthus cruentatus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Hippocampus erectus	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Hippoglossoides platessoides	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Hippoglossus hippoglossus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Histrio histrio	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Holocentrus adscensionis	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Hyperoglyphe perciformis	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Hyporhamphus unifasciatus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Isurus oxyrinchus	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Kajikia albida	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Katsuwonus pelamis	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Kyphosus sectator	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Lactophrys trigonus	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Lactophrys triqueter	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Lagocephalus laevigatus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Lamna nasus	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Lampris guttatus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Lepophidium profundorum	X	x	X	x	x	X	X	X	X	x	done	NO	N/A
Leptoclinus maculatus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Leucoraja garmani	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Limanda ferruginea	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Liopsetta putnami	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Liparis atlanticus	X	x	x	x	x	X	X	X	X	x	done	NO	N/A

SPECIES	Family Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Liparis liparis	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Lobotes surinamensis	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Lopholatilus chamaeleonticeps	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Lutjanus analis	X	x	X	x	x	X	X	X	X	x	done	NO	N/A
Lutjanus aratus	X	x	X	x	x	X	X	X	X	x	done	NO	N/A
Lutjanus campechanus	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Lycenchelys verrillii	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Lycodes reticulatus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Macroramphosus scolopax	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Makaira nigricans	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Malacoraja senta	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Manta birostris	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Megalops atlanticus	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Micropogonias undulatus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Mobula hypostoma	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Mola mola	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Monacanthus ciliatus	x	x	X	x	x	X	X	X	X	X	done	NO	N/A
Mugil cephalus	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Mullus auratus	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Mycteroperca microlepis	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Mycteroperca phenax	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Myliobatis freminvillii	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Myoxocephalus quadricornis	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Myoxocephalus scorpius	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Naucrates ductor	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Nomeus gronovii	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Oligoplites saurus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Ophidion marginatum	X	x	X	x	x	X	X	X	X	x	done	NO	N/A
Opisthonema oglinum	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Orthopristis chrysoptera	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Paralichthys albigutta	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Parexocoetus hillianus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Peprilus paru	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Peristedion miniatum	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Pogonias cromis	X	x	X	x	x	X	X	X	X	X	done	NO	N/A



SPECIES	Family Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Prionace glauca	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Prionotus rubio	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Pristigenys alta	X	x	X	x	x	X	X	X	X	x	done	NO	N/A
Prognichthys gibbifrons	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Pseudupeneus maculatus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Rachycentron canadum	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Remora brachyptera	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Remora osteochir	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Remora remora	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Rhinoptera bonasus	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Rypticus bistrispinus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Sarda sarda	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Sardinella aurita	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Sargocentron vexillarium	X	x	x	x	x	X	X	X	X	x	done	NO	N/A
Sciaenops ocellatus	X	x	X	x	x	X	X	X	X	x	done	NO	N/A
Scomber colias	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Scomberesox saurus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Scomberomorus maculatus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Scomberomorus regalis	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Scyliorhinus retifer	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Sebastes norvegicus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Selar crumenophthalmus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Seriola lalandei	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Seriola zonata	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Sphoeroides spengleri	x	x	x	x	x	x	X	x	x	x	done	NO	N/A
Sphoeroides testudineus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Sphyraena barracuda	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Sphyraena guachancho	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Sphyrna lewini	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Sphyrna tiburo	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Sphyrna zygaena	X	x	x	x	x	X	X	X	X	X	done	NO	N/A
Squatina dumeril	X	x		x	x	X	X	X	X	X	done	NO	N/A
Stegastes leucostictus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Stegastes partitus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Stephanolepis hispidus	x	x	X	x	x	X	X	X	X	X	done	NO	N/A

SPECIES	Family/Description	Common / Species Name	Other Names	R1 sportfish	All-Tackle	ID / Description	General / Local Distribution	Diet	Importance	Management	Text Status	Illustration	Illustration Status
Synodus synodus	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Thunnus alalunga	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Thunnus albacares	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Thunnus obesus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Thunnus thynnus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Torpedo nobiliana	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Trachinocephalus myops	x	x	x	x	x	x	x	x	x	x	done	NO	N/A
Trachinotus carolinus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Trachinotus falcatus	x	x	x	x	x	X	X	X	X	x	done	NO	N/A
Trichiurus lepturus	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Tylosurus crocodilus	x	x	x	x	x	X	X	X	X	X	done	NO	N/A
Ulvaria subbifurcata	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Xiphias gladius	X	x	X	x	x	X	X	X	X	X	done	NO	N/A
Zenopsis conchifera	x	x	x	x	x	x	x	x	x	x	done	NO	N/A

Table 4. Summary of species illustrations completed during current grant award (January 1, 2020 - December 31, 2024; **X, done**), current grant period (January 1, 2022 - December 31, 2022; **X, done**), and species previously illustrated for the “Inland Fishes of Rhode Island” book to be used in the “Marine Fishes of Rhode Island” book (x, done).

SPECIES	COMMON NAME	ILLUSTRATIONS COMPLETED							Book
		Draft pencil sketches	Final pencil sketch	Draft INK illustration	Final INK illustration	Draft COLOR illustration	Final COLOR illustration		
<i>Ammodytes americanus</i>	American sand lance	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Anchoa hepsetus</i>	Striped anchovy	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Bairdiella chrysoura</i>	Silver perch	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Caranx crysos</i>	Blue runner	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Centropristis striata</i> (F)	Black sea bass	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Centropristis striata</i> (M)	Black sea bass	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Citharichthys arcifrons</i>	Gulfstream flounder	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Clupea harengus</i>	Atlantic herring	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Conger oceanicus</i>	Conger eel	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Decapterus macarellus</i>	Mackerel scad								Marine Fishes of RI
<i>Decapterus punctatus</i>	Round scad								Marine Fishes of RI
<i>Enchelyopus cimbrius</i>	Fourbeard rockling	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Etropus microstomus</i>	Smallmouth flounder	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Euthynnus alletteratus</i>	False albacore								Marine Fishes of RI
<i>Fundulus heteroclitus</i> (F)	Mummichog	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Gadus morhua</i>	Atlantic cod	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Hemitripterus americanus</i>	Sea raven								Marine Fishes of RI
<i>Leiostomus xanthurus</i>	Spot	X	X	X	X	X	X	done	Marine Fishes of RI
<i>Leucoraja erinacea</i>	Little skate								Marine Fishes of RI
<i>Leucoraja ocellata</i>	Winter skate								Marine Fishes of RI
<i>Lophius americanus</i>	American goosefish								Marine Fishes of RI
<i>Melanogrammus aeglefinus</i>	Haddock								Marine Fishes of RI
<i>Merluccius bilinearis</i>	Silver hake								Marine Fishes of RI
<i>Mustelus canis</i>	Smooth dogfish								Marine Fishes of RI
<i>Myoxocephalus aeneus</i>	Grubby sculpin								Marine Fishes of RI

Myoxocephalus octodecemspinosus	Longhorn sculpin								Marine Fishes of RI
Opsanus tau	Oyster toadfish								Marine Fishes of RI
Paralichthys dentatus	Summer flounder	X	X	X	X	X	X	done	Marine Fishes of RI
Paralichthys oblongus	Fourspot flounder	X	X	X	X	X	X	done	Marine Fishes of RI
Pholis gunnellus	Rock gunnel	X	X	X	X	X	X	done	Marine Fishes of RI
Pollachius virens	Pollock	X	X	X	X	X	X	done	Marine Fishes of RI
Priacanthus arenatus	Bigeye	X	X	X	X	X	X	done	Marine Fishes of RI
Prionotus evolans	Striped searobin								Marine Fishes of RI
Raja eglanteria	Clearnose skate								Marine Fishes of RI
Sarda sarda	Atlantic bonito	X	X	X	X	X	X	done	Marine Fishes of RI
Scomber scombrus	Atlantic mackerel	X	X	X	X	X	X	done	Marine Fishes of RI
Selene setapinnis	Atlantic moonfish	X	X	X	X	X	X	done	Marine Fishes of RI
Sphoeroides maculatus	Northern puffer	X	X	X	X	X	X	done	Marine Fishes of RI
Sphyraena borealis	Northern sennet	X	X	X	X	X	X	done	Marine Fishes of RI
Squalus acanthias	Spiny dogfish	X	X	X	X	X	X	done	Marine Fishes of RI
Stenotomus chrysops	Scup	X	X	X	X	X	X	done	Marine Fishes of RI
Synodus foetens	Inshore lizardfish								Marine Fishes of RI
Tautoga onitis (F)	Tautog	X	X	X	X	X			Marine Fishes of RI
Tautoga onitis (M)	Tautog	X	X	X	X	X	X	done	Marine Fishes of RI
Tautogolabrus adspersus	Cunner	X	X	X	X	X	X	done	Marine Fishes of RI
Trachurus lathami	Rough scad	X	X	X	X	X	X	done	Marine Fishes of RI
Upeneus parvus	Dwarf goatfish	X	X	X	X	X	X	done	Marine Fishes of RI
Urophycis chuss	Red hake								Marine Fishes of RI
Urophycis regia	Spotted hake								Marine Fishes of RI
Urophycis tenuis	White hake								Marine Fishes of RI
Zoarces americanus	Ocean pout								Marine Fishes of RI
Alosa mediocris	Hickory shad	x	x	x	x	x	x	done	Inland Fishes of RI
Alosa pseudoharengus	Alewife	x	x	x	x	x	x	done	Inland Fishes of RI
Alosa sapidissima	American shad	x	x	x	x	x	x	done	Inland Fishes of RI
Ameiurus nebulosus	Brown bullhead	x	x	x	x	x	x	done	Inland Fishes of RI
Anchoa mitchilli	Bay anchovy	x	x	x	x	x	x	done	Inland Fishes of RI
Anguilla rostrata	American eel	x	x	x	x	x	x	done	Inland Fishes of RI
Apeltes quadracus	Fourspine stickleback	x	x	x	x	x	x	done	Inland Fishes of RI
Brevoortia tyrannus	Atlantic menhaden	x	x	x	x	x	x	done	Inland Fishes of RI
Caranx hippos	Crevalle jack	x	x	x	x	x	x	done	Inland Fishes of RI
Catostomus commersoni	White sucker	x	x	x	x	x	x	done	Inland Fishes of RI
Cynoscion regalis	Weakfish	x	x	x	x	x	x	done	Inland Fishes of RI
Cyprinodon variegatus (M)	Sheepshead minnow	x	x	x	x	x	x	done	Inland Fishes of RI
Dorosoma cepedianum	American gizzard shad	x	x	x	x	x	x	done	Inland Fishes of RI
Esox niger	Chain pickerel	x	x	x	x	x	x	done	Inland Fishes of RI
Eucinostomus argenteus	Spotfin mojarra	x	x	x	x	x	x	done	Inland Fishes of RI

Fundulus diaphanus	Banded killifish	x	x	x	x	x	x	done	Inland Fishes of RI
Fundulus heteroclitus (M)	Mummichog	x	x	x	x	x	x	done	Inland Fishes of RI
Fundulus majalis (F)	Striped killifish	x	x	x	x	x	x	done	Inland Fishes of RI
Fundulus majalis (M)	Striped killifish	x	x	x	x	x	x	done	Inland Fishes of RI
Gasterosteus aculeatus	Threespine stickleback	x	x	x	x	x	x	done	Inland Fishes of RI
Gobiosoma bosc	Naked goby	x	x	x	x	x	x	done	Inland Fishes of RI
Lagodon rhomboides	Pinfish	x	x	x	x	x	x	done	Inland Fishes of RI
Lepomis auritus	Redbreast sunfish	x	x	x	x	x	x	done	Inland Fishes of RI
Lepomis gibbosus	Pumpkinseed	x	x	x	x	x	x	done	Inland Fishes of RI
Lepomis macrochirus	Bluegill	x	x	x	x	x	x	done	Inland Fishes of RI
Lucania parva	Rainwater killifish	x	x	x	x	x	x	done	Inland Fishes of RI
Lutjanus griseus	Gray snapper	x	x	x	x	x	x	done	Inland Fishes of RI
Luxilus cornutus	Common shiner	x	x	x	x	x	x	done	Inland Fishes of RI
Menidia beryllina	Inland silverside	x	x	x	x	x	x	done	Inland Fishes of RI
Menidia menidia	Atlantic silverside	x	x	x	x	x	x	done	Inland Fishes of RI
Menticirrhus saxatilis	Northern kingfish	x	x	x	x	x	x	done	Inland Fishes of RI
Microgadus tomcod	Atlantic tomcod	x	x	x	x	x	x	done	Inland Fishes of RI
Micropterus dolomieu	Smallmouth bass	x	x	x	x	x	x	done	Inland Fishes of RI
Micropterus salmoides	Largemouth bass	x	x	x	x	x	x	done	Inland Fishes of RI
Morone americana	White perch	x	x	x	x	x	x	done	Inland Fishes of RI
Morone saxatilis	Striped bass	x	x	x	x	x	x	done	Inland Fishes of RI
Mugil curema	White mullet	x	x	x	x	x	x	done	Inland Fishes of RI
Notemigonus crysoleucas	Golden shiner	x	x	x	x	x	x	done	Inland Fishes of RI
Osmerus mordax	Rainbow smelt	x	x	x	x	x	x	done	Inland Fishes of RI
Peprilus triacanthus	Butterfish	x	x	x	x	x	x	done	Inland Fishes of RI
Petromyzon marinus	Sea lamprey	x	x	x	x	x	x	done	Inland Fishes of RI
Pomatomus saltatrix	Bluefish	x	x	x	x	x	x	done	Inland Fishes of RI
Pomoxis nigromaculatus	Black crappie	x	x	x	x	x	x	done	Inland Fishes of RI
Prionotus carolinus	Northern searobin	x	x	x	x	x	x	done	Inland Fishes of RI
Pseudopleuronectes americanus	Winter flounder	x	x	x	x	x	x	done	Inland Fishes of RI
Pungitius pungitius	Ninespine stickleback	x	x	x	x	x	x	done	Inland Fishes of RI
Rhinichthys atratulus	Blacknose dace	x	x	x	x	x	x	done	Inland Fishes of RI
Salmo salar	Atlantic salmon	x	x	x	x	x	x	done	Inland Fishes of RI
Salmo trutta	Brown trout	x	x	x	x	x	x	done	Inland Fishes of RI
Salvelinus fontinalis	Brook trout	x	x	x	x	x	x	done	Inland Fishes of RI
Scophthalmus aquosus	Windowpane flounder	x	x	x	x	x	x	done	Inland Fishes of RI
Selene vomer	Lookdown	x	x	x	x	x	x	done	Inland Fishes of RI
Strongylura marina	Atlantic needlefish	x	x	x	x	x	x	done	Inland Fishes of RI
Syngnathus fuscus	Northern pipefish	x	x	x	x	x	x	done	Inland Fishes of RI
Trinectes maculatus	Hogchoker	x	x	x	x	x	x	done	Inland Fishes of RI

**ASSESSMENT OF RECREATIONALLY IMPORTANT  
FINFISH STOCKS IN RHODE ISLAND WATERS**

University of Rhode Island  
Graduate School of Oceanography  
Weekly Fish Trawl  
2022

PERFORMANCE REPORT  
F-61-R SEGMENT 21  
JOB 14

Jeremy Collie, PhD  
Professor of Oceanography  
March 2023

## Annual Performance Report

STATE: Rhode Island

PROJECT NUMBER: F-61-R

SEGMENT NUMBER: 21

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, 2022 – December 31, 2022.

TARGET DATE: December 2022

SCHEDULE OF PROGRESS: On schedule.

SIGNIFICANT DEVIATIONS: None

RECOMMENDATIONS: Continuation of the weekly trawl survey into 2023; 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.

## **Introduction:**

The University of Rhode Island, Graduate School of Oceanography, began monitoring finfish populations in Narragansett Bay in 1959, and has continued through 2022. These data provide 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 2022 survey year as they relate to those of the past years since the beginning of the survey.

## **Methods:**

A weekly trawl survey is conducted on the URI research vessel *Cap'n Bert*. Two stations are sampled each week (Figure 1): one off Wickford, RI 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 since the survey began. A 30-minute 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 sexed. 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:

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

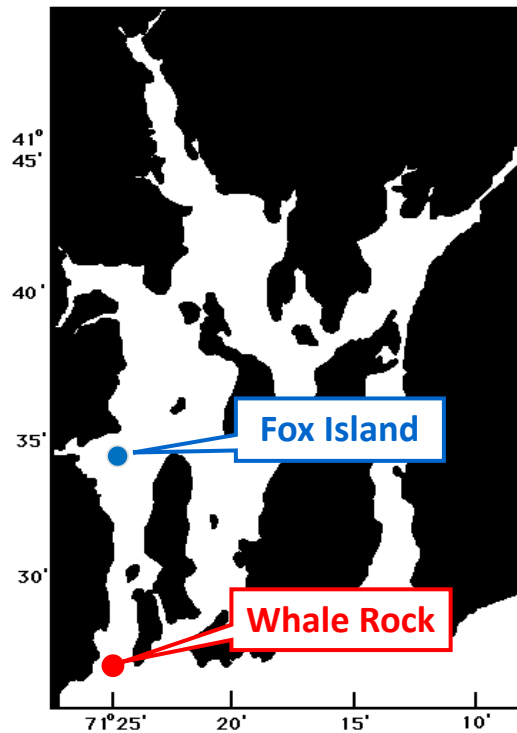


Figure 1. Location of trawl stations in Narragansett Bay.

(For more information about the GSO fish trawl go <https://web.uri.edu/gso/research/fish-trawl/>)

**Results:**

51 weekly tows were made at both the bay (Fox Island) and sound (Whale Rock) stations. One week of sampling was missed in September because of a positive case of Covid-19. Neither station was sampled that week.

*Environmental conditions*

Weekly water temperatures at both stations were slightly warmer than the historic average throughout the year (Figure 2), with short exceptions during Spring and late Summer/early Fall.

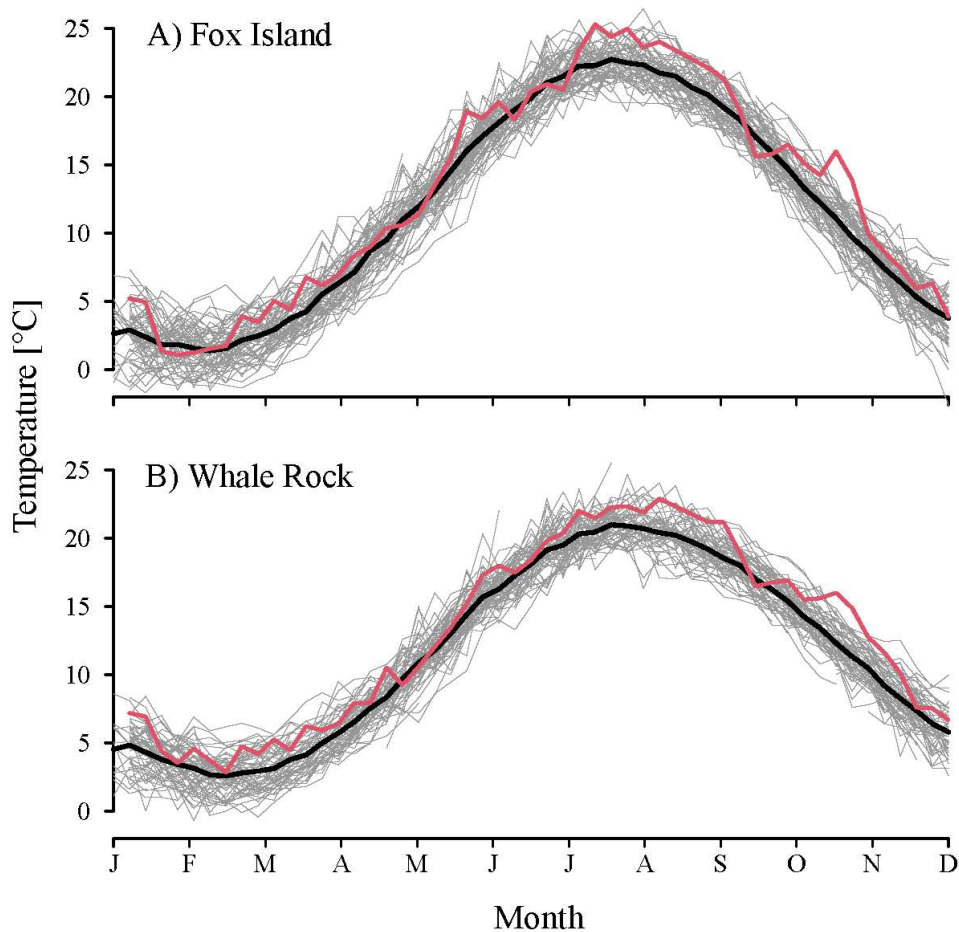


Figure 2. Weekly sea surface temperature of Narragansett Bay at each sampling station. The gray lines represent the seasonal temperature cycle for each previous year. The black line is the average temperature over all years. The most recent year, 2022, is labeled red.

Summary catch statistics

Table 3. Total catch by species at Fox Island (FI) and Whale Rock (WR) for the top 25 species caught in 2022.

<b>Species</b>	<b>Total</b>	<b>FI</b>	<b>WR</b>
SCUP ( <i>Stenotomus chrysops</i> )	13752	10190	3562
BUTTERFISH ( <i>Peprilus triacanthus</i> )	5102	734	4368
LONGFIN SQUID ( <i>Doryteuthis peali</i> )	3643	1072	2571
ATLANTIC SILVERSIDE ( <i>Menidia menidia</i> )	2129	1756	373
ATLANTIC ROCK CRAB ( <i>Cancer irroratus</i> )	1310	20	1290
SILVER HAKE ( <i>Merluccius bilinearis</i> )	528	40	488
SPIDER CRAB ( <i>Libinia emarginata</i> )	527	150	377
SUMMER FLOUNDER ( <i>Paralichthys dentatus</i> )	418	239	179
STRIPED SEAROBIN ( <i>Prionotus evolans</i> )	413	71	342
CTENOPHORE	410	400	10
LITTLE SKATE ( <i>Leucoraja erinacea</i> )	321	6	315
WINTER FLOUNDER ( <i>Pseudopleuronectes americanus</i> )	280	54	226
ATLANTIC MOONFISH ( <i>Selene setapinnis</i> )	262	42	220
HERMIT CRAB ( <i>Pagurus pollicaris</i> )	197	187	10
BLUE CRAB ( <i>Callinectes sapidus</i> )	180	131	49
ATLANTIC HERRING ( <i>Clupea harengus</i> )	157	111	46
NORTHERN PUFFER ( <i>Sphoeroides maculatus</i> )	137	18	119
SMOOTH DOGFISH ( <i>Mustelus canis</i> )	129	86	43
NORTHERN SEAROBIN ( <i>Prionotus carolinus</i> )	124	15	109
MENHADEN ( <i>Brevoortia tyrannus</i> )	111	77	34
SPONGE ( <i>Suberites spp.</i> )	105	104	1
ROUGH SCAD ( <i>Trachurus lathami</i> )	101	99	2
SMALLMOUTH FLOUNDER ( <i>Etropus microstomus</i> )	97	239	179
WEAKFISH ( <i>Cynoscion regalis</i> )	88	8	80
ALEWIFE ( <i>Alosa pseudoharengus</i> )	76	12	64
<b>Total</b>	<b>30597</b>	<b>15861</b>	<b>15057</b>

The top 10 species caught in 2022 (and the station where they were most numerous) were: Scup (FI), Butterfish (WR), Squid (WR), Silverside (FI), Rock crab (WR), Silver hake (WR), Spider crab (WR), Summer flounder (FI), Striped searobin (WR), Ctenophore (FI).

A number of species of recreational importance were collected during 2022 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 some of the lowest estimates on record for both stations occurring in the last decade (Figure 3). The survey information is used during the stock assessment process for winter flounder.

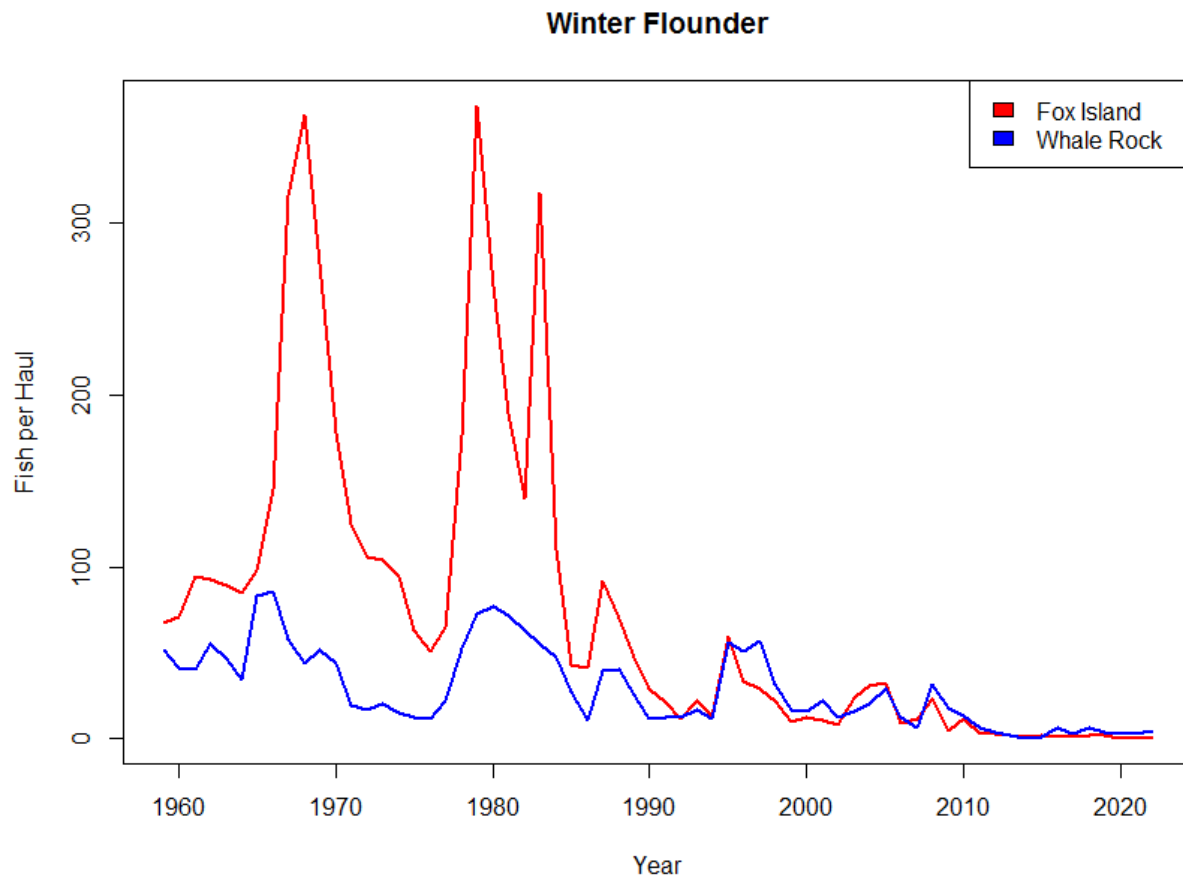


Figure 3 – Survey data for entire time series for winter flounder at both sampling stations (Fox Island and Whale Rock).



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 4). 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.

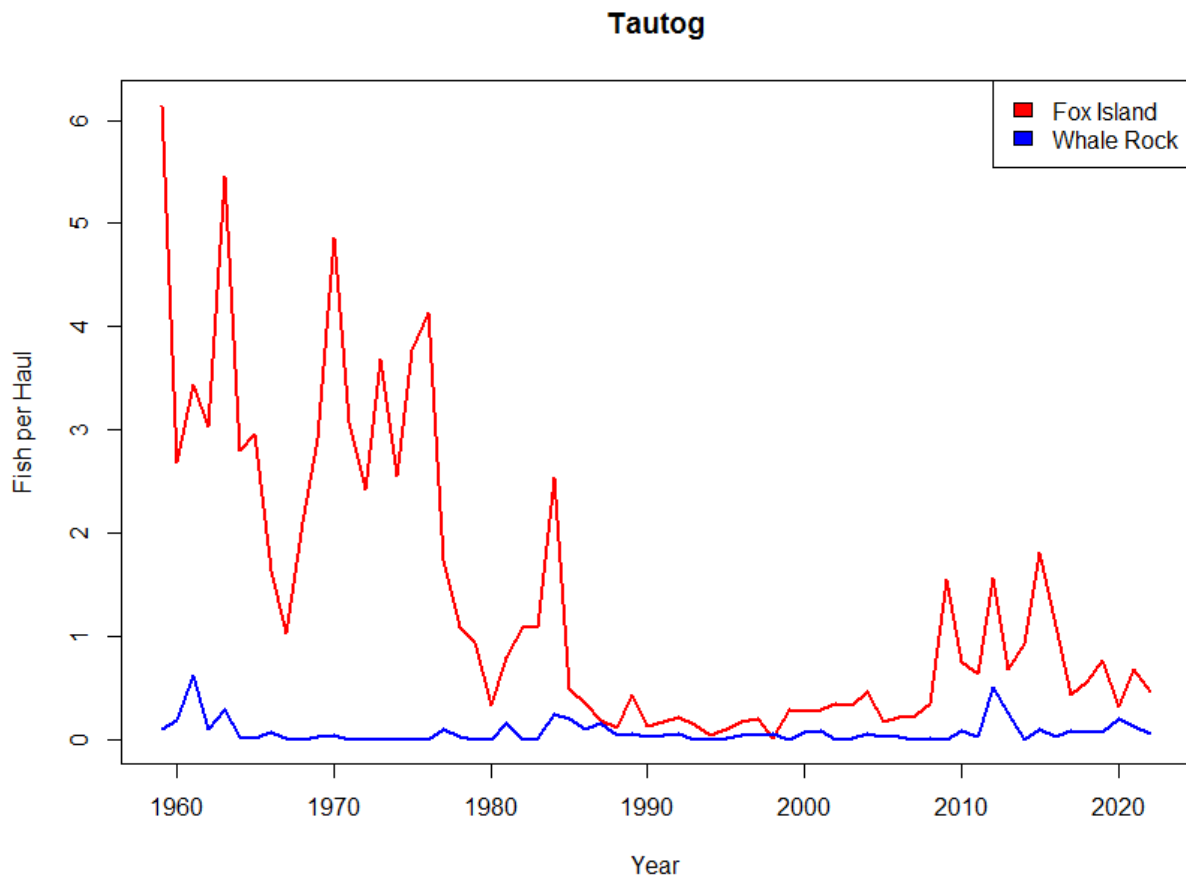


Figure 4 – Survey data for entire time series for tautog at both sampling stations (Fox Island and Whale Rock).



### 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 show a fair amount of variability in the most recent time period (Figure 5). Summer flounder are caught at both sampling stations consistently, although 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.

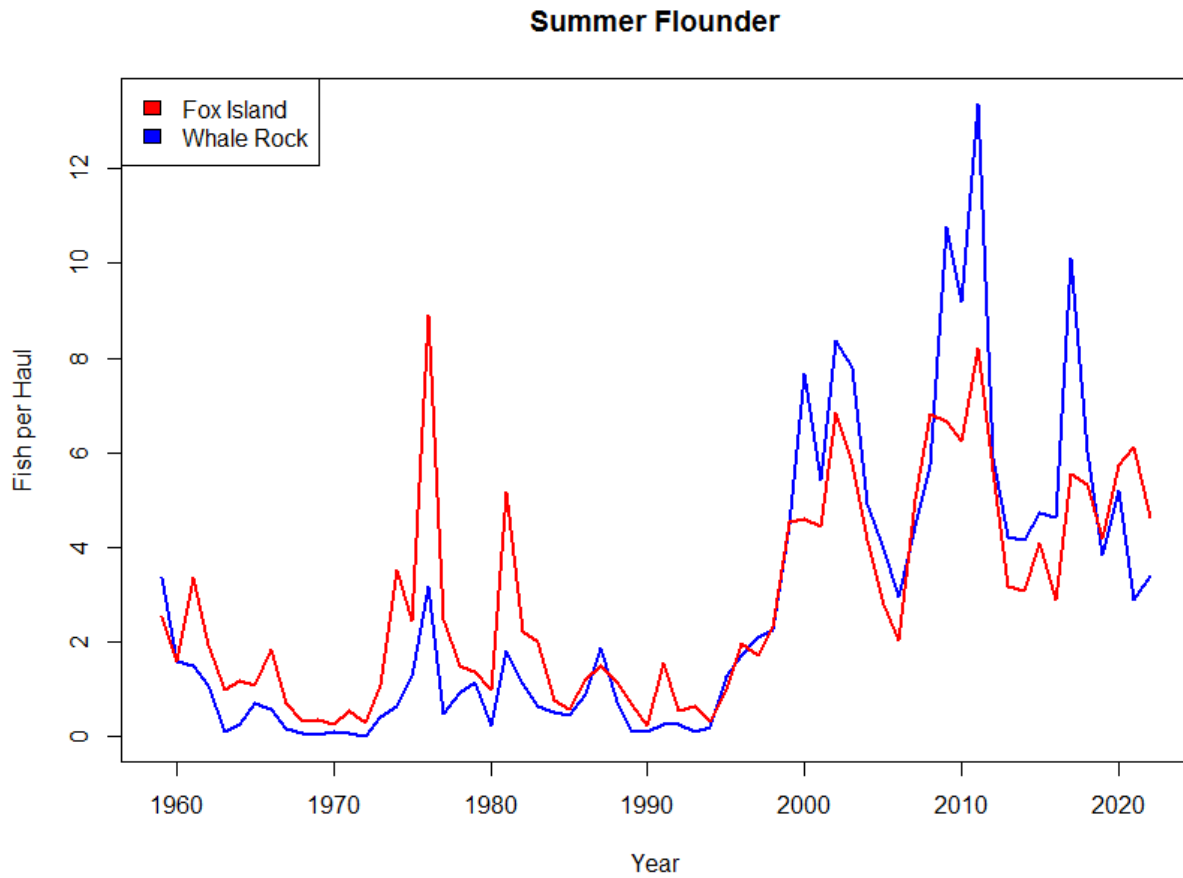


Figure 5 – Survey data for entire time series for summer flounder at both sampling stations (Fox Island and Whale Rock).



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 6). Black sea bass are caught at both sampling stations fairly consistently with recent catches higher at the Whale Rock station.

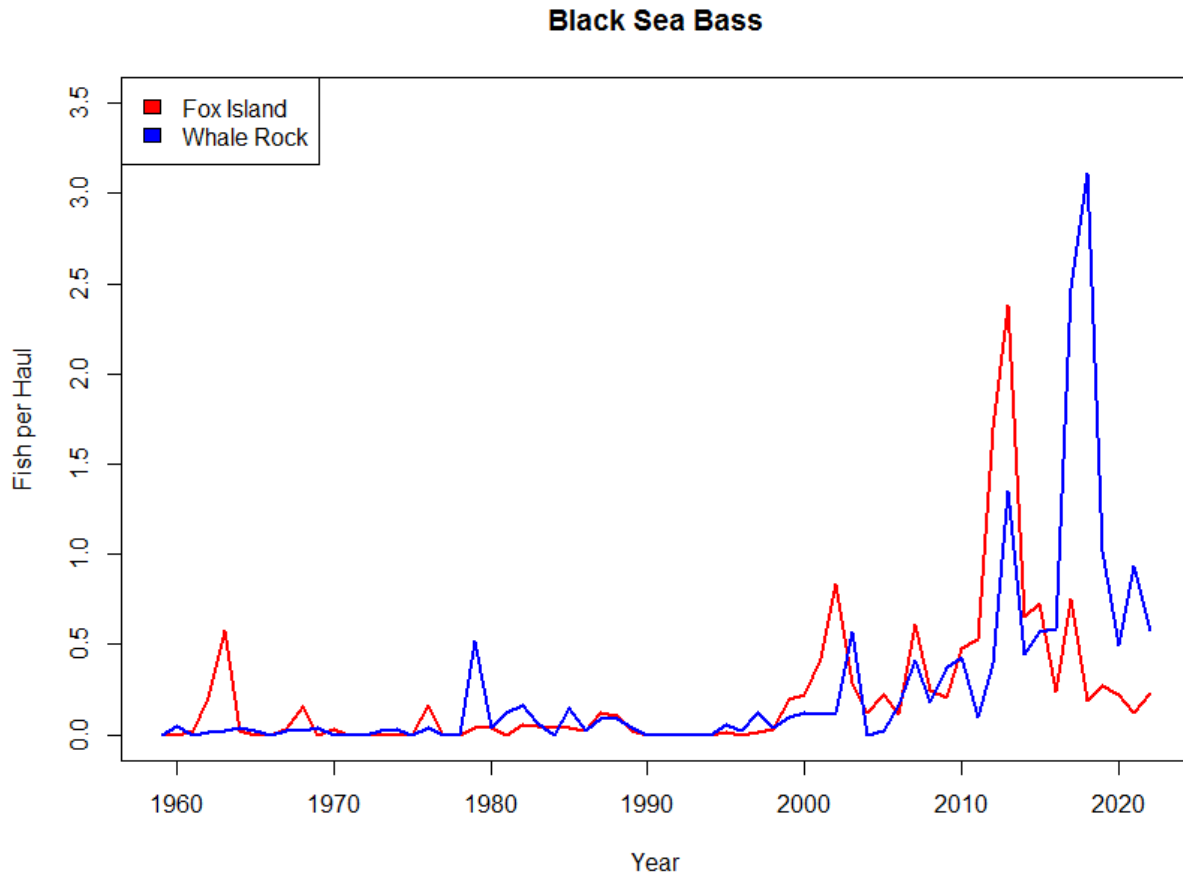


Figure 6 – Survey data for entire time series for black sea bass at both sampling stations (Fox Island and Whale Rock).



### 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 7). Scup are caught at both sampling stations consistently, although 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 was reviewed during the stock assessment process for scup.

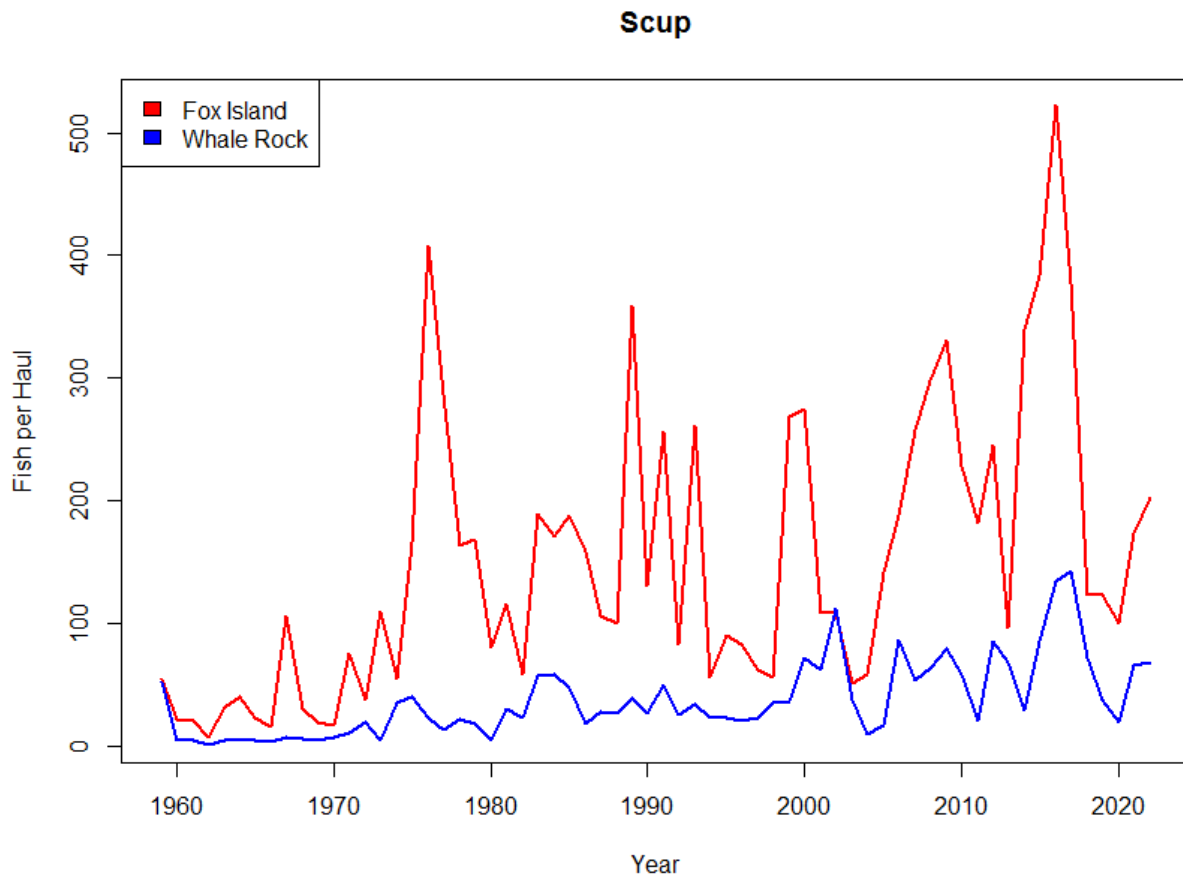


Figure 7 – Survey data for entire time series for scup at both sampling stations (Fox Island and Whale Rock).





### Bluefish

Bluefish is another of the Mid-Atlantic species caught consistently by the survey. The population of bluefish increased during the middle of the survey time period, 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 8). Bluefish are caught at both sampling stations fairly consistently.

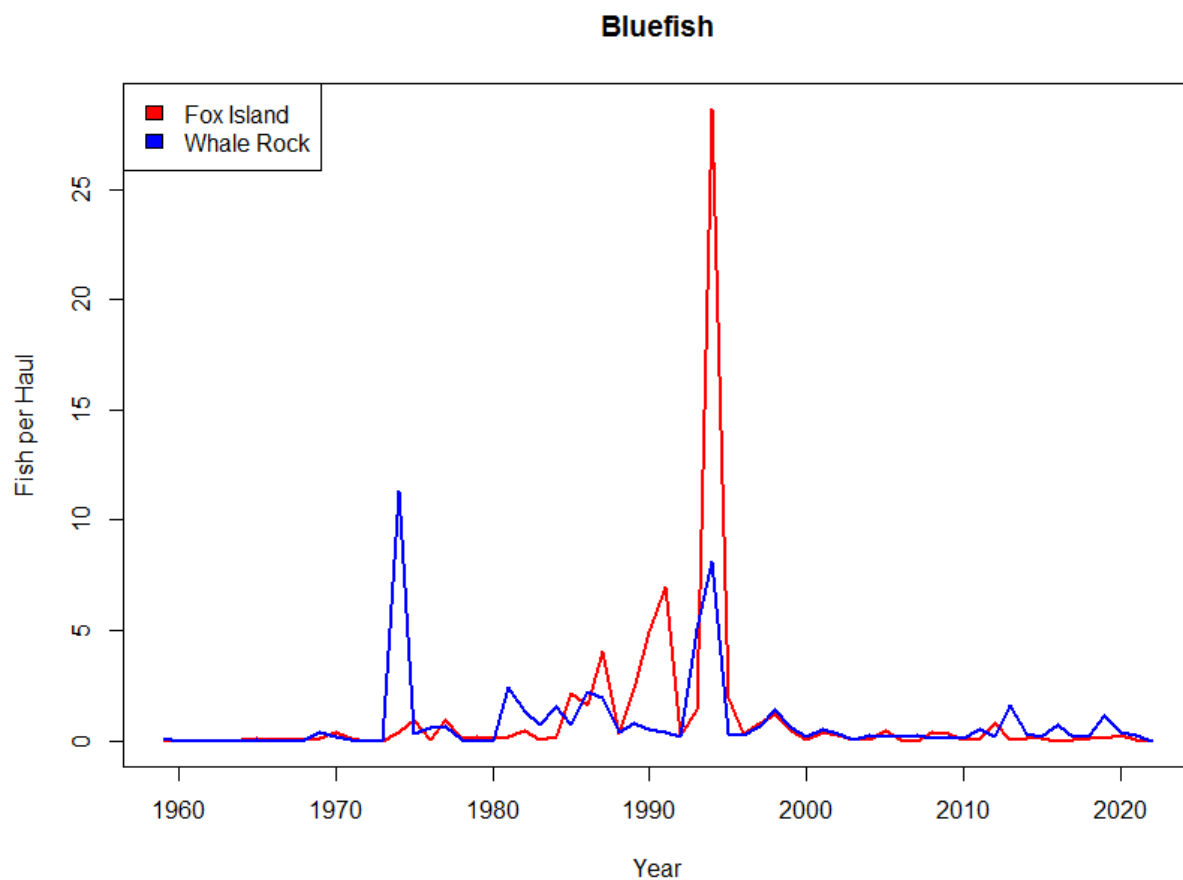


Figure 8 – Survey data for entire time series for bluefish at both sampling stations (Fox Island and Whale Rock).



### Weakfish

Weakfish is another of the Mid-Atlantic species caught consistently by the survey, as weakfish use Narragansett 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. 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 9), so this survey is probably a better indicator of recruitment than adult population size. Weakfish are caught at both sampling stations fairly consistently, with recent catches higher at the Whale Rock station.

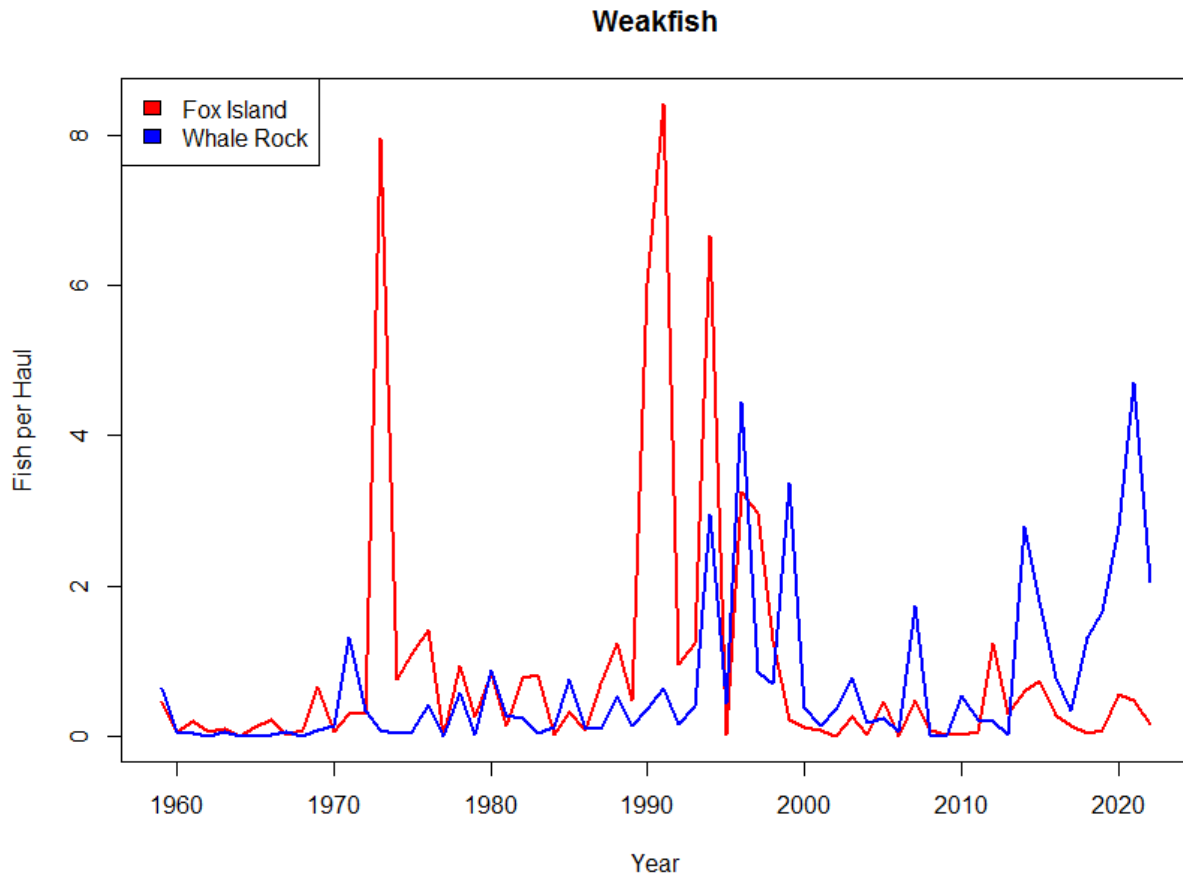


Figure 9 – Survey data for entire time series for weakfish at both sampling stations (Fox Island and Whale Rock).



### 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, with peaks between 1990 and 2010, and recently in 2018. There is high variability for this species in the survey data (Figure 10), but the survey catches both juveniles and adults. Striped bass are caught in greater abundance and frequency at Fox Island than at Whale Rock.

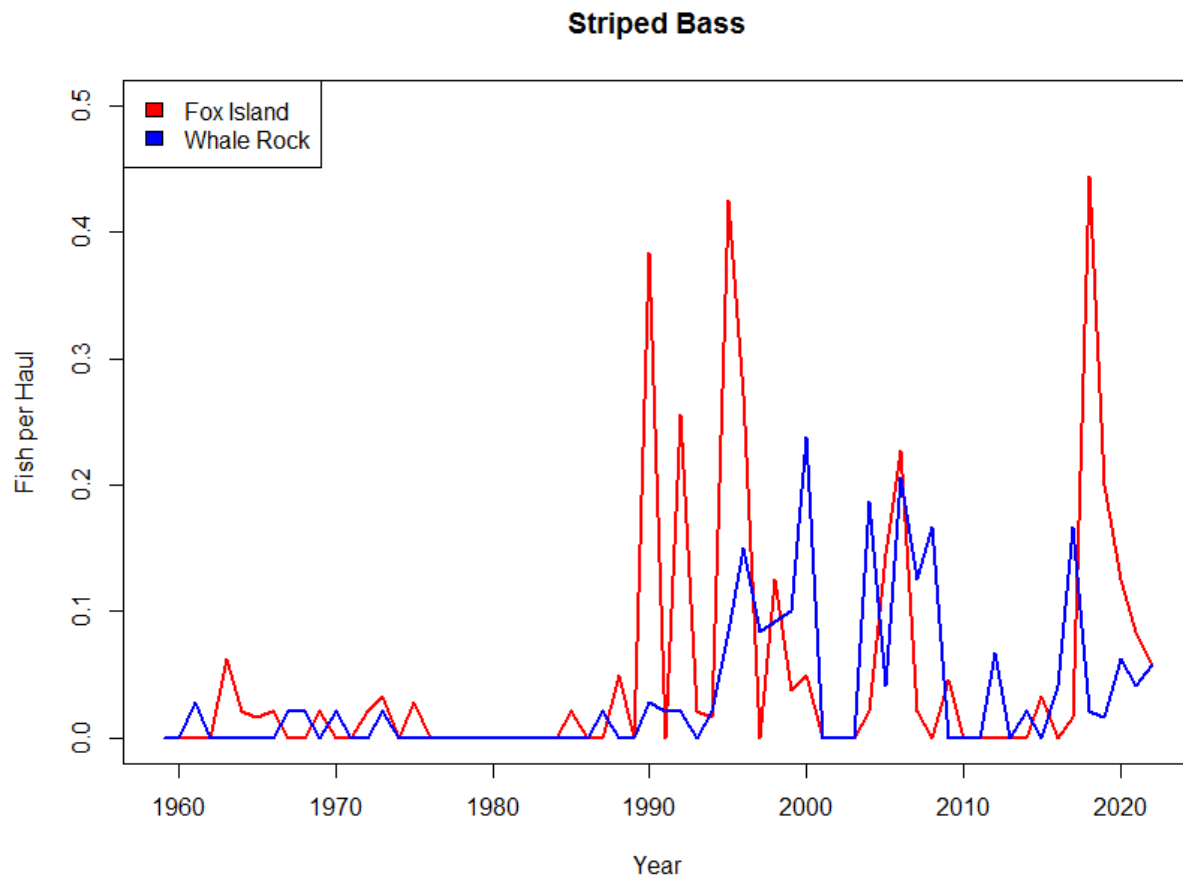


Figure 10 – Survey data for entire time series for striped bass at both sampling stations (Fox Island and Whale Rock).



### 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 (Figure 11), but the survey mainly catches juveniles. 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.

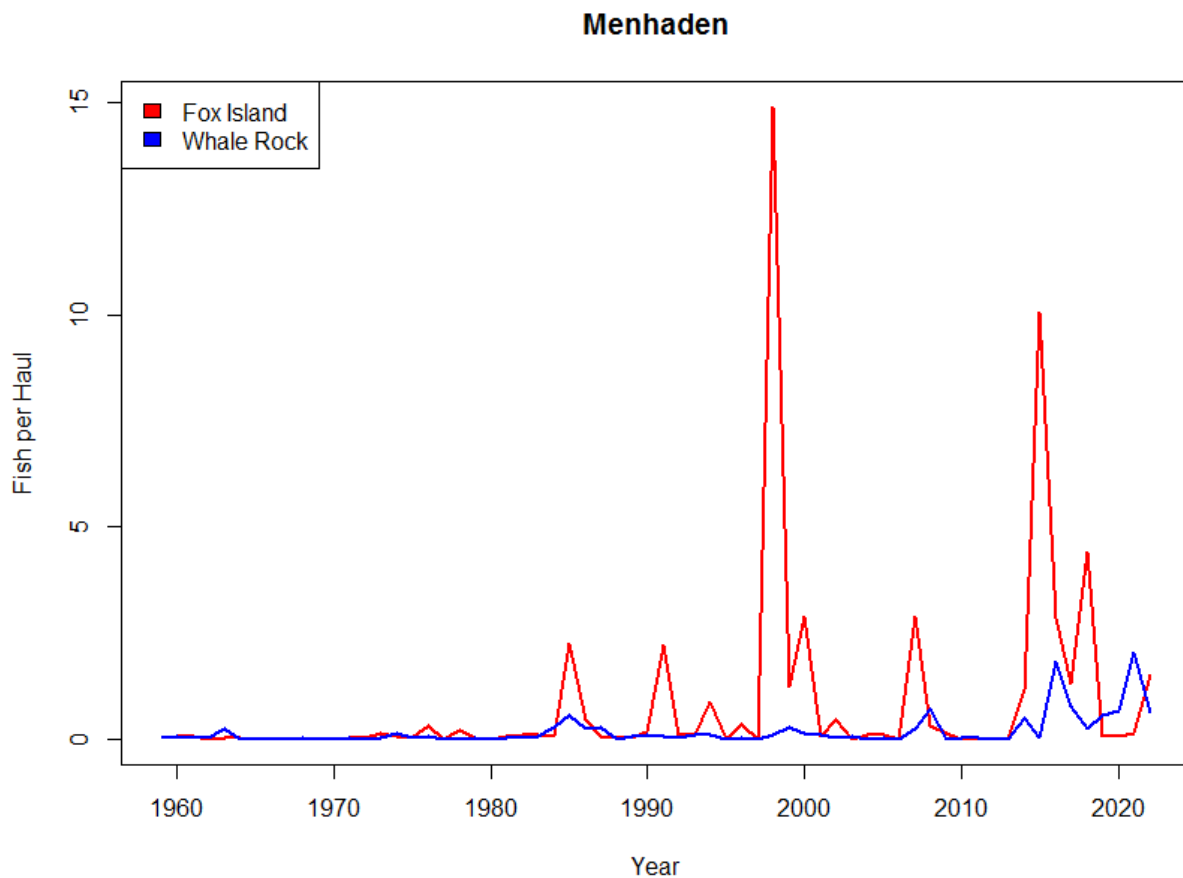


Figure 11 – Survey data for entire time series for menhaden at both sampling stations (Fox Island and Whale Rock)

## **Special Projects**

Atlantic cod data were requested and used in the 2023 Research Track assessment of Atlantic cod.

### *Undergraduate Research Assistants*

Undergraduate assistants were recruited from URI for the summer and fall semesters to gain experience and provide extra assistance on the Fish Trawl Survey. 2022 Undergraduate assistants included: Leland Macey

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## **Enhancements to MRIP Data Collection**

John Lake  
Rhode Island Department of Environmental Management  
Division Marine Fisheries  
John.Lake@dem.ri.gov

**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, 2021 – December 31, 2021

**JOB NUMBER 8 TITLE:** Enhancements to MRIP Data Collection

**Job 16:** Enhancements to MRIP Data Collection

During this segment the RIDMF Access Point Angler Interview Survey (APAIS) hired 6 additional seasonal staff members and provided 2 months of a full time employees time in support of the survey. These complement the staff that is provided by the NOAA MRIP base funding and allows RIDMF to order additional assignments from the NOAA Marine Recreational Information Program (MRIP). During 2022 RIDMF APAIS was able to add on 227 assignments in shore, private/rental and Party charter modes. Additionally, RIDMF APAIS added an additional 22 samples in Head Boat mode for ride along, in 2022. We lost several staff at the end of wave 4 and could not re-hire resulting in 28 missed assignments. Staff hired via this grant are also used to preform scouting assignments of existing and potentially new sites to determine site pressures and sampling feasibility.

Currently, the 2022 MRIP estimates are available on the NOAA Fisheries web site. A detailed summary of the total 2022 APAIS assignments is provided in table one. This table shows the assignments broken down by mode, the response statistics and the productivity rate which is the number of completed interviews over the number of assignments. Table 2 provides a summary of APAIS interview statistics from 2016-2022 by wave. The program hopes to improve the interview statistics back to the levels seen in 2019 as the pandemic eases and anglers are more likely to interact with our samplers.



Table 1. APAIS Interview Statistics from 2022 Assignments. (CH = Party/Charter, PR = Private/Rental Boat, SH = Shore, HB = Head Boat)

Year	Wave	Mode	Assignments	Completed	Initially Refused	Language Barrier	Missed Anglers	Productivity
2022	2	HB	3	26	6	1	0	8.67
2022	2	PR	17	15	1	0	5	0.88
2022	2	SH	32	71	26	54	17	2.22
2022	3	CH	49	221	358	10	52	4.51
2022	3	HB	11	156	62	8	0	14.18
2022	3	PR	63	423	131	55	110	6.71
2022	3	SH	57	215	68	108	56	3.77
2022	4	CH	80	657	1102	66	255	8.21
2022	4	HB	19	350	351	20	0	18.42
2022	4	PR	104	987	453	116	255	9.49
2022	4	SH	45	269	113	77	64	5.98
2022	5	CH	50	218	650	25	85	4.36
2022	5	HB	8	55	41	14	0	6.88
2022	5	PR	69	368	195	78	114	5.33
2022	5	SH	39	248	134	95	91	6.36
2022	6	CH	15	74	195	11	22	4.93
2022	6	HB	6	43	17	13	0	7.17
2022	6	PR	16	9	6	0	5	0.56
2022	6	SH	28	66	18	7	23	2.36
<b>2022</b>			<b>711</b>	<b>4471</b>	<b>3927</b>	<b>758</b>	<b>1154</b>	<b>6.29</b>

Table 2. Summary of APAIS interview Statistics from 2016 – 2021 assignments by wave.

Year	Wave	Completed	Refused	Language Barriers	Missed	Percent Refused	Percent Complete / Total Anglers
2016	2	116	63	3	8	35.20%	61.05%
2016	3	396	549	66	65	58.10%	36.80%
2016	4	857	1157	190	260	57.45%	34.78%
2016	5	665	557	101	143	45.58%	45.36%
2016	6	111	61	41	4	35.47%	51.15%
<b>2016</b>		<b>2145</b>	<b>2387</b>	<b>401</b>	<b>480</b>	<b>53.00%</b>	<b>39.63%</b>
2017	2	124	15	8	13	10.79%	77.50%
2017	3	759	579	128	146	43.27%	47.08%
2017	4	1908	1011	217	629	34.64%	50.68%
2017	5	901	518	37	267	36.50%	52.29%
2017	6	149	94	36	37	38.68%	47.15%
<b>2017</b>		<b>3841</b>	<b>2217</b>	<b>416</b>	<b>1092</b>	<b>36.60%</b>	<b>50.77%</b>
2018	2	149	46	14	19	23.59%	65.35%
2018	3	782	532	114	277	40.49%	45.87%
2018	4	1740	989	151	704	36.24%	48.55%
2018	5	1058	583	150	434	35.53%	47.55%
2018	6	199	147	70	87	42.49%	39.56%
<b>2018</b>		<b>3928</b>	<b>2297</b>	<b>499</b>	<b>1521</b>	<b>36.90%</b>	<b>47.64%</b>
2019	2	199	63	31	31	24.05%	61.42%
2019	3	1001	460	142	142	31.49%	57.36%
2019	4	1659	765	147	147	31.56%	61.04%
2019	5	1044	354	182	182	25.32%	59.25%
2019	6	140	75	27	27	34.88%	52.04%
<b>2019</b>		<b>4043</b>	<b>1717</b>	<b>529</b>	<b>529</b>	<b>29.81%</b>	<b>59.30%</b>
2020	2	46	12	8	17	20.69%	55.42%
2020	3	661	426	128	227	39.19%	45.84%
2020	4	1463	1082	147	486	42.51%	46.04%
2020	5	1115	522	155	261	31.89%	54.31%
2020	6	118	105	7	41	47.09%	43.54%
<b>2020</b>		<b>3403</b>	<b>2147</b>	<b>445</b>	<b>1032</b>	<b>38.68%</b>	<b>48.43%</b>
2021	2	135	26	29	29	16.15%	61.64%
2021	3	1142	745	163	386	39.48%	46.88%
2021	4	1628	1315	221	571	44.68%	43.59%

2021	5	988	720	256	287	42.15%	43.89%
2021	6	225	281	25	84	55.53%	36.59%
<b>2021</b>		<b>4118</b>	<b>3087</b>	<b>687</b>	<b>1357</b>	<b>42.85%</b>	<b>44.52%</b>
2022	2	112	33	55	22	22.76%	50.45%
2022	3	1015	619	181	218	37.88%	49.93%
2022	4	2263	2019	279	574	47.15%	44.07%
2022	5	889	1020	212	290	53.43%	36.87%
2022	6	192	236	31	50	55.14%	37.72%
<b>2022</b>		<b>4471</b>	<b>3927</b>	<b>687</b>	<b>1154</b>	<b>46.76%</b>	<b>43.67%</b>

## **Recreational Fisheries Management Support**

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**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, 2022 – December 31, 2022

**JOB NUMBER 8 TITLE:** Enhancements to MRIP Data Collection

**Job 17:** Recreational Fisheries Management Support

During this segment RIDMF provided staff and support for state and regional recreational fishing program coordination, planning, and outreach meetings. These meetings include the ACCSP Recreational Technical committee, the Rhode Island Marine Fisheries Council, ASMFC technical and stock assessment committees for various recreationally important species, RIDEM Boating and Access point workgroup, and local stake holder meetings. Additionally, the Division published and produced recreational angler outreach materials including the annual saltwater recreational magazine, a one page informational brochure, and stickers for handing out at events and during APAIS interviews. The RI Saltwater Fishing magazine can be viewed here:

<http://www.eregulations.com/rhodeisland/fishing/saltwater/>. The Division held its annual kids fish camp in 2022 as well other attending other youth fishing events. Governor's Bay day the annual free fishing day continued to be scaled back with no in person presence. The large annual recreational fishing show which the Division attends was attended by staff who promoted the RIDMF SW recreational fishing program. The Division is resuming that outreach activities as normal in 2023.

## **Recreational Coastal Sharks Monitoring**

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Federal Aid in Sportfish Restoration  
F-61-21

State: Rhode Island Project Number: F-61-R-21

Project Title: Recreational Coastal Sharks Monitoring

Period Covered: January 1, 2022 – December 31, 2022

Job Number Job XV – Recreational Coastal Sharks Monitoring

Job Objective: To assess the movement patterns and presence of coastal sharks in and adjacent to Rhode Island state waters using electronic tagging technologies.

Significant  
Deviations: Tag Deployment Breakdown To-Date Under the Project: 38 of 50 Vemco V-16 acoustic tags purchased are now deployed, and 6 of 10 SPOT tags purchased are now deployed. In 2022, three SPOT tags were deployed and 16 Vemco tags were deployed.

### **Justification and Objective:**

Coastal pelagic sharks of the North Atlantic Ocean are keystone species in regulating lower trophic levels, serving as an important service in marine ecosystems. As top predators and larger fish, these species have also been long sought after by recreational harvesters throughout the eastern United States, including Rhode Island. Many of these species frequent state waters through various months of the year, primarily during the warmer months of July through October in New England. Several species of coastal sharks can be observed in Rhode Island state waters, including smooth dogfish (*Mustelus canis*), blue sharks (*Prionace glauca*), shortfin mako sharks (*Isurus oxyrinchus*), thresher sharks (*Alopias vulpinus*) and spinner sharks (*Carcharhinus brevipinna*). These and other species have supported pastimes of recreational fishing amongst avid anglers for leisure, as well as support party and charter businesses and shark diving tours during certain times of the year. In addition to recreational harvest, several coastal shark species can be caught and sold commercially, although these instances are few for Rhode Island. As such, the roles that coastal sharks serve in the marine ecosystem, recreation, and local economies is widely evident. Fisheries managers are charged to insure adequate, healthy stocks of these species for harvest. To do so, comprehensive data on the species' life history, population trends, and harvest rates must be available to construct effective stock assessments and management plans. For coastal sharks, few data exist on the species' abundance trends given the major fisheries-independent data surveys that are plentiful across the species range or stock bounds (e.g. trawl surveys) do not effectively catch them. This has been quite challenging for state fisheries programs that are charged with trying to understand the life history patterns of these fish in their waters.

Through a collaboration between Rhode Island Department of Environmental Management (RIDEM) Division of Marine Fisheries (DMF) and the Atlantic Shark Institute (ASI) and charter captains, the objective of this work is to initiate a coastal shark monitoring for recreationally significant species to the state of Rhode Island. Data from this project are intended to provide information on these species use of state waters, the habitat they are associated with, and more broadly to be available for use in informing their sustainability. Given shark abundance data is often sparse within state waters (particularly for northeast U.S. states), we hope to improve this data gap through this tagging endeavor.

### **Progress Summary:**

ASI supported eight research trips for shark tagging purposes in 2022 (Table 1). Sixteen Vemco V-16 acoustic tags were deployed in 2022. One was lost during a tagging effort. This results in 38 of the 50 total purchased acoustic tags as a part of this five-year grant now having been deployed on coastal sharks (Figure 1, Table 2). The metadata on these tags have been entered in the Atlantic Cooperative Telemetry (ACT) Network and Mid-Atlantic Acoustic Telemetry Observation System (MATOS) database, so if telemetry scientists detect the species on their receivers, we will be able to receive those detections. We will also be checking to see if we get any detections on the preexisting RIDEM DMF-ASI receiver array. In 2022, three SPOT tags were also deployed (Table 3).

All acoustic tags to-date have been deployed in southern New England waters that Rhode Island recreational shark fishermen operate in, and/or are adjacent to Rhode Island state waters. For acoustic tags in 2022, 10 were deployed on shortfin mako sharks, four were deployed on blue sharks, and two were deployed on a common thresher shark (Table 2). Of the three SPOT tags deployed in 2022, two were deployed on blue sharks (two males) and one was deployed on a male shortfin mako (Table 3). The shortfin mako and one of the blue sharks with these SPOT tags represent two of the sharks tagged with acoustic tags; the double-tagged nature of these shark will provide a direct comparison of the two data types for the species.

As of the time of this report (last MATOS data push: 7/13/2022), detections from eleven of the sharks tagged with the acoustic tags have been reported for this project: one thresher, one blue shark, and nine shortfin makos. It should be noted that returns to-date are reflective of only the sharks tagged prior to 2022, as 2022 detection data from MATOS partners have not been uploaded and processed. As such, the 11 sharks with detections are from the 22 sharks tagged over 2020 and 2021 (i.e. 50% return rate). Detections from these sharks ranged from 8 to 190 over time periods of a single day to several months. Of the 804 total detections, 588 came from shortfin makos, 62 from the blue shark, and 190 from the thresher shark. Detections ranged from as far south as Georgia and as north as Atlantic Canada. The inferred movement paths have begun to be explored, with some examples provided (Figures 2-4). The next MATOS data push is anticipated to occur in March 2023, at which time we believe many more detections will be provided for these sharks and those newly tagged in 2022. More sophisticated movement analyses will be presented in future reports.

Movement paths are provided for the 2022 deployed SPOT tagged sharks. The shortfin mako was tagged in June 2022. The shark moved southward from southern New England and then



northwest across the Atlantic Ocean. The shark was last detected by satellite on September 5, 2022, located at latitude but east of Newfoundland (Figure 5). One of the blue sharks (tagged the same day as the mako shark) moved southward and offshore. The shark was last detected later that month in June 2022 at latitude with Delaware Bay (Figure 5). The second blue shark tagged in the fall of 2022 moved south far off the continental shelf at latitude with the Bahamas, but in early January 2023, it moved back north towards Bermuda (Figure 5). It was last heard from on February 16, 2023.

Table 1. Description of shark tagging trips conducted in 2022.

Date	Location
6/16/2022	Butterfish Hole
6/22/2022	Butterfish Hole
6/29/2022	Tuna Ridge
7/11/2022	Cox Ledge
8/1/2022	Block Island Sound
8/11/2022	Block Island Sound
8/12/2022	Block Island Sound
10/6/2022	Butterfish Hole

Table 2. Sharks tagged with Vemco V-16 acoustic transmitters with their corresponding tagging date, species (common name), size, and sex (F=female;M=male;U=unknown).

Year	Date	Species	Total Length (in)	Sex
2020	7/24/2020	Shortfin Mako	70	F
2020	8/28/2020	Blue Shark	108	M
2020	10/4/2020	Blue Shark	86	M
2020	10/4/2020	Shortfin Mako	79	F
2021	6/15/2021	Thresher	168	M
2021	6/17/2021	Shortfin Mako	63	F
2021	6/24/2021	Blue Shark	102	M
2021	6/24/2021	Blue Shark	90	M
2021	6/24/2021	Shortfin Mako	66	F
2021	7/1/2021	Shortfin Mako	60	U
2021	7/1/2021	Shortfin Mako	66	M
2021	7/1/2021	Shortfin Mako	70	F
2021	7/1/2021	Shortfin Mako	66	M
2021	7/8/2021	Shortfin Mako	66	U
2021	7/8/2021	Shortfin Mako	60	M
2021	7/8/2021	Shortfin Mako	72	M
2021	7/8/2021	Shortfin Mako	60	F
2021	7/14/2021	Shortfin Mako	78	F
2021	7/29/2021	Shortfin Mako	66	F

2021	8/6/2021	Shortfin Mako	60	F
2021	9/3/2021	Shortfin Mako	72	U
2021	10/6/2021	Shortfin Mako	90	M
2022	6/16/2022	Blue Shark	104	M
2022	6/16/2022	Shortfin Mako	78	M
2022	6/23/2022	Shortfin Mako	84	F
2022	6/24/2022	Shortfin Mako	74	F
2022	6/26/2022	Shortfin Mako	71	F
2022	7/4/2022	Blue Shark	86	F
2022	7/11/2022	Shortfin Mako	63	F
2022	7/13/2022	Shortfin Mako	65	F
2022	8/12/2022	Thresher	120	F
2022	9/4/2022	Thresher	91	F
2022	6/28/2022	Blue Shark	90	F
2022	6/29/2022	Blue Shark	90	F
2022	7/1/2022	Shortfin Mako	53	M
2022	7/14/2022	Shortfin Mako	60	M
2022	7/24/2022	Shortfin Mako	64	F
2022	8/15/2022	Shortfin Mako	48	M

Table 3. Sharks tagged with SPOT satellite tags with their corresponding tagging date, species common name, size, and sex. Date of last detection are also presented (as of 3/4/2023).

Date	Species	Total Length (in)	Sex	Date of Last Detection
10/6/2021	Shortfin Mako Shark	90	M	3/9/2022
10/6/2021	Blue Shark	126	M	2/21/2022
10/6/2021	Blue Shark	102	M	3/9/2022
7/29/2021	Blue Shark	72	F	8/28/2021
7/29/2021	Blue Shark	72	F	9/19/2021
6/16/2022	Shortfin Mako Shark	78	M	9/5/2022
6/16/2022	Blue Shark	104	M	6/27/2022
10/24/2022	Blue Shark	120	M	2/16/2023

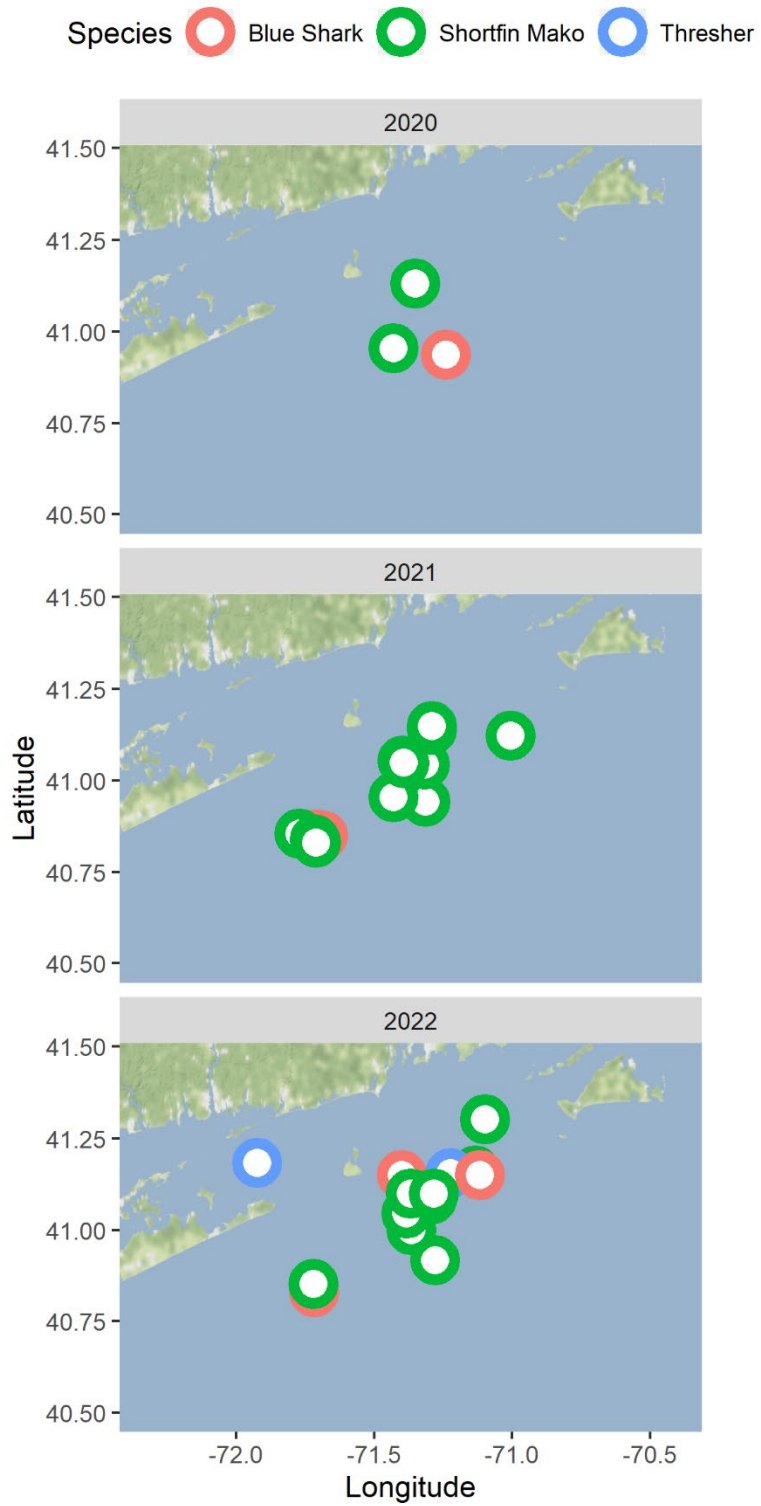


Figure 1. Release locations of sharks tagged with acoustic tags by year and species.

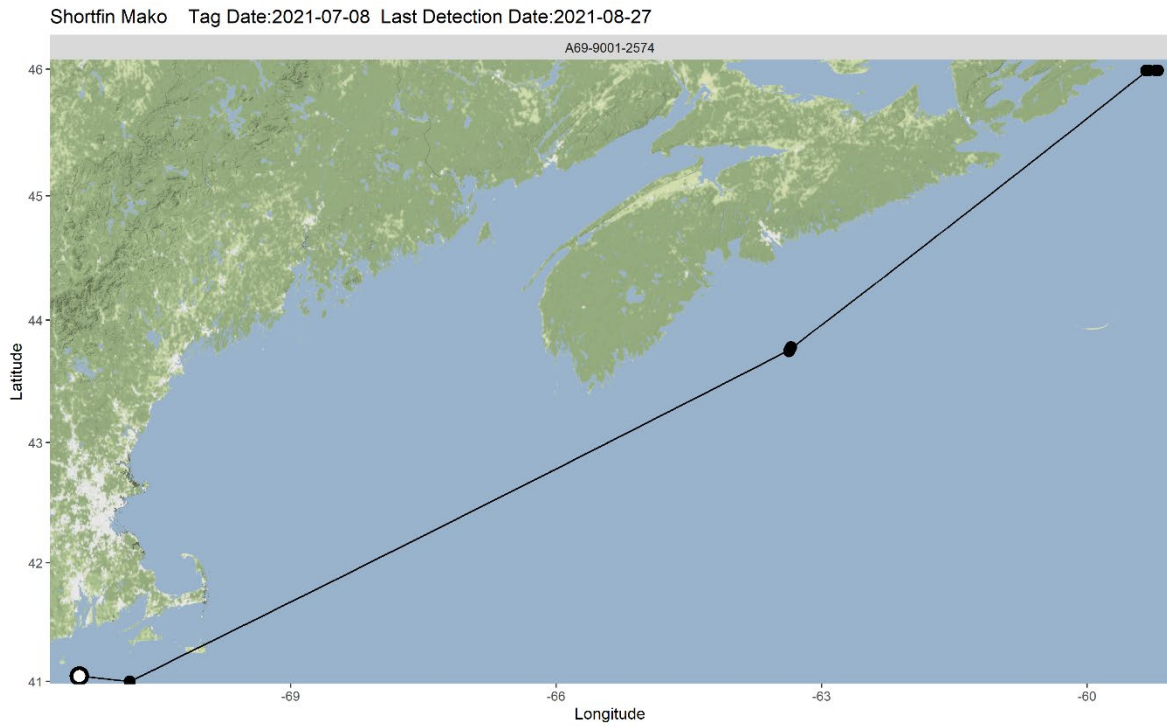


Figure 2. Inferred path for a shortfin mako that was tagged 7/8/2021 and over the course of approximately seven weeks (8/27/21) was located north of Nova Scotia.

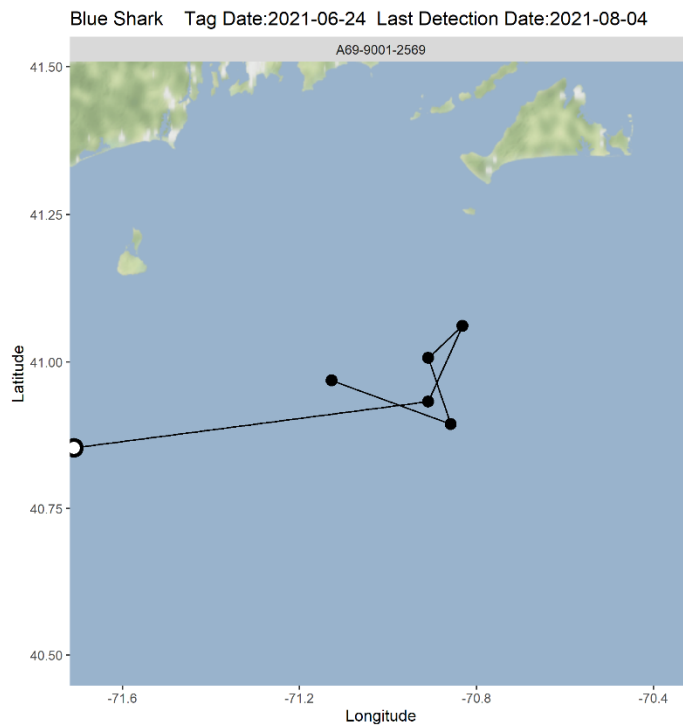


Figure 3. Inferred path for a blue shark that was tagged 6/24/2021 and over the course of approximately six weeks (8/4/21) was found more east in southern New England.

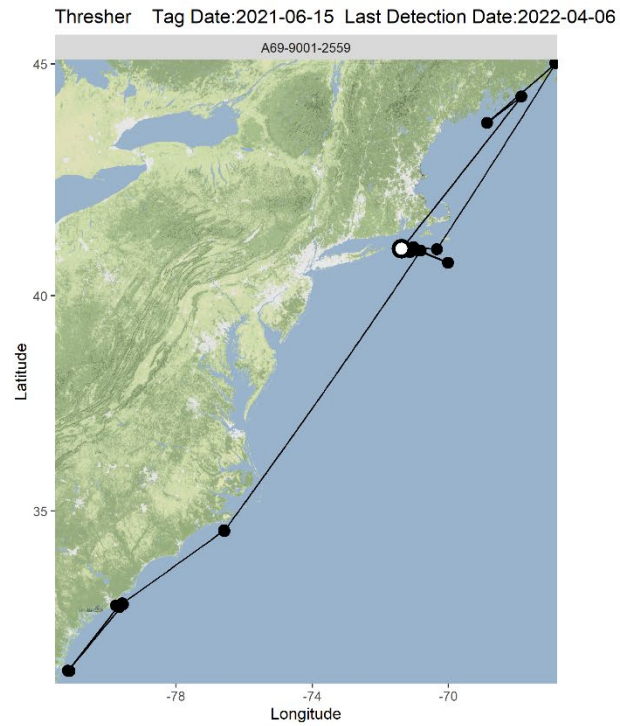


Figure 4. Inferred path for a thresher shark that was tagged 6/15/2021 and was last detected 4/6/22. Over this time period, the thresher moved from southern New England to Canadian waters just of the US-Canada border, and then made its way back south going as far as Georgia. It was last seen farther north of Georgia in the Carolinas, presumably undergoing its 2022 migration.



Figure 5. Movement path for the shortfin mako (#213761) and two blue sharks (#213762 and #213760) tagged with SPOT tags in 2022. See Table 3 for further descriptions.