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Investigation of Maryland's Coastal Bays and Atlantic Ocean Finfish Stocks

F-50-R-33

July 2024 - June 2025
Final Report

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10/2025 DNR

UNITED STATES
DEPARTMENT OF INTERIOR
Fish & Wildlife Service
Division of Federal Assistance
Region 5

Final Performance Progress Report
Investigation of Maryland's Coastal Bays and Atlantic Ocean Finfish Stocks
July 1, 2024 through June 30, 2025

Grantee: Maryland Department of Natural Resources – Fishing and Boating Services

Grant No.: F24AF02777

Segment No.: F-50-R-33

Title: MD F-50-R-33 Investigation of Maryland Coastal Bays and Atlantic Ocean Finfish Stock

Period Covered: July 1, 2024 - June 30, 2025

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Date Submitted: October 28, 2025

Statutory Funding Authority:

Sport Fish Restoration CFDA #15.605	X	
State Wildlife Grants (SWG) Cooperative Management Act **CFDA #15.634**	______	

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Accomplishments July 1, 2024 - June 30, 2025

July - August 2024

- Collected 20 trawl samples at 20 fixed sites, monthly.
- Completed data entry and quality control from prior month's sampling.
- Completed the F-50-R-32 report.
- Wrote the Atlantic States Marine Fisheries Commission (ASMFC) Coastal Sharks Compliance report.

September - October 2024

- Collected 20 trawl samples at 20 fixed sites (monthly).
- Collected 19 beach seine samples at 19 fixed sites (September).
- Collected 16 Submerged Aquatic Vegetation Habitat Survey samples (September).
- Completed data entry and quality control from prior month's sampling.
- Processed and aged 200 tautog.

November 2024 - March 2025

- Completed quality control for the entire dataset.
- Conducted data analysis of the surveys.
- Drafted the F-50-R-33 annual report.
- Processed and aged tautog.

April - June 2025

- Prepared for the 2025 field sampling season (Trawl and Beach Seine surveys).
- Collected 158 tautog.
- Collected 20 trawl samples at 20 fixed sites (monthly).
- Collected 19 beach seine samples at 19 fixed sites (June).
- Completed data entry and quality control from prior months sampling.
- Edited the F-50-R-33 report.
- Wrote the Atlantic States Marine Fisheries Commission’s black sea bass, scup, summer flounder, and tautog compliance reports.

Year Round, as needed

- Technical assistance benefiting finfishes of material value for recreation as per Sport Fish Restoration guidelines.
- Responded to data requests from the Atlantic States Marine Fisheries Commission technical committees, the Mid-Atlantic Fishery Management Council monitoring committees, the National Oceanic and Atmospheric Administration, and researchers.

Preface

With the receipt of Sport Fish Restoration funds in 1989, the Trawl and Beach Seine surveys were performed following standardized protocols, eliminating the biases of previous years (1972 - 1988). This report highlights trends resulting from data collected during the standardized period (1989 - present).

The Submerged Aquatic Vegetation Habitat Survey was added in 2012. Refinements were made to the sampling approach to improve catchability of demersal fish. The survey protocol was standardized in 2015.

Although the Sport Fish Restoration reporting period covers July 2024 through June 2025, the terminal year of data used in this report is 2024, because a full sampling season is needed for data analyses.

Acknowledgements

Staff would like to recognize the contributions of some dedicated researchers that have shared cold mornings and hot, muddy days on the coastal bays.

Allan Beres (Ocean City Museum Society), Christine Okerblom (Ocean City Museum Society), Alexis Park (Maryland Department of Natural Resources), Michella Salvitti (University of Maryland Eastern Shore), Carly Toulan (Maryland Coastal Bays Program), Liz Wist (Maryland Coastal Bays Program), Sarah Cvach (Maryland Department of Natural Resources), Sloan Willey (Student), and Billy Weiland (Maryland Coastal Bays Program).

Executive Summary

The investigation was developed to characterize fishes and their abundances in Maryland's coastal bays and the Atlantic Ocean, protect finfish habitats, contribute to stock assessments, facilitate management decisions, and provide technical assistance on committees and projects. The investigation consists of the Trawl, Beach Seine, and Submerged Aquatic Vegetation Habitat surveys in the bays, behind Fenwick and Assateague Islands. Continuous standardized data support management decisions including compliance with the Atlantic States Marine Fisheries Commission and stock assessments. Data were also provided to state, federal, and university partners for education, essential fish habitat designations, and academic research. The investigation uses the previously mentioned surveys to meet the following objectives:

1. characterizes stocks and estimates relative abundance of fishes in Maryland's coastal bays and near-shore Atlantic Ocean;
2. delineates and monitors spawning, nursery and/or forage locations for finfish; and
3. provides technical assistance by participating on committees, writing Atlantic States Marine Fisheries Commission compliance reports, and contributing to environmental and permit reviews to help ensure potential impacts to fish and wildlife are avoided, minimized and/or compensated/mitigated.

In 2024, finfish were the most abundant taxa captured in the survey. Specifically, they accounted for 54,025 fish caught in the Trawl and Beach Seine surveys (24,403 fish trawling and 28,622 fish beach seining). The total number collected per gear and combined were within the normal range in the time series. Fishes represented 59 species for both gears, which was within the lowest quartile of values in the time series.

Atlantic croaker and spot had an above average trawl index while Atlantic silverside, bay anchovy, bluefish, summer flounder and weakfish had below average trawl indices. Atlantic croaker, Atlantic menhaden and spot had above average beach seine indices while silver perch and weakfish had below average seine indices. Since 2014, summer flounder had an average or below average trawl index and an average or above average beach seine index which may indicate a preference change to shallow habitat.

Richness is the number of different fishes sampled. High richness is an indicator that the overall habitat can support many species during their lifecycles. Embayment richness results differed by gear which was expected due to the different habitats sampled by each. Chincoteague Bay had the highest richness (90 fishes) in the trawl time series (1989 - 2024) whereas Newport Bay had the lowest (71 fishes). The Beach Seine Survey time series (1989 - 2024) results indicated that Assawoman Bay and Isle of Wight Bay had the richest fish populations (89 and 88 fishes, respectively) and the St. Martin River was lowest (71 fishes).

The Shannon Index of Diversity measures the proportion of fishes in the sample population. More evenly distributed species produce a greater H value. These values change from year to year and are generally low due to large year classes of baitfish such as menhaden, Atlantic silversides, and bay anchovies. In 2024, the trawl survey consisted of 41.5% spot and 31.25% bay anchovy while the beach seine survey consisted of 71.5% Atlantic menhaden and 10% Atlantic silverside.

Macroalgae bycatch is ephemeral with annual variation. It is quantified in these surveys for its positive and negative effects as habitat. The 2024 trawl and beach seine catch per unit of effort for macroalgae were below the time series grand means catch per unit of effort (43.7 liters/hectare and 21.9 liters/haul, respectively). Fourteen genera were collected by trawl and beach seine in 2024. *Agardhiella* was the most abundant genus for the trawl while *Polysiphonia* was most abundant for the beach seine.

The water quality at most sample sites was consistent with fish habitat requirements. Dissolved oxygen was rarely found below critical levels, and the salinity range supports coastal fishes. Analysis of dissolved oxygen and fish catches from the surveys indicated that the coastal bays rarely experienced low enough dissolved oxygen to negatively impact abundances. However, the investigations' sampling occurred during the day when the effects of low dissolved oxygen may not have been evident. Dissolved oxygen levels have been improving since 1989, and salinity has varied. Temperatures, while increasing over the time of the surveys, were within the acceptable range for coastal fishes.

The Submerged Aquatic Vegetation Habitat Survey has operated with a standardized protocol since 2015. The overall catch per unit effort of fishes in the submerged aquatic vegetation, especially tautog (*Tautoga onitis*) and black sea bass (*Centropristis striata*) demonstrates its importance as critical habitat in Sinepuxent Bay. The survey also confirms that with continued monitoring of fishes in this habitat, stock assessment and species-specific habitat criteria can be refined.

Tautogs (200 fish) were obtained for ageing from for hire vessels. Ageing results had a wide range of year classes ranging from two to 17 years old. The 2024 female and male mean and median age was six years. The age range for fishery recruit size (406 millimeters/16 inches) ranged from four to nine years old for both sexes.

Technical expertise and field observations obtained from the previously mentioned surveys were provided for research and management. With the passage of the Atlantic States Coastal Cooperative Management Act and the Magnuson-Stevens Fishery Conservation and Management Act, entities such as the Atlantic States Marine Fisheries Commission, Mid-Atlantic Fishery Management Council, and the National Marine Fisheries Service require stock assessment and habitat information. Technical expertise and data were contributed to 14 species.

Chapter 1 Trawl and Beach Seine Surveys

Introduction

The investigation was developed to characterize fishes and their abundances in Maryland's coastal bays and the Atlantic Ocean. The department has conducted the Trawl and Beach Seine surveys in Maryland's coastal bays since 1972, sampling with a standardized protocol since 1989. These gears target juvenile finfish although bycatch of crustaceans, macroalgae, molluscs, and sponges were common. This report includes data from 1989 - 2024.

Over 140 adult and juvenile species of fishes, 26 molluscs, 20 macroalgae genera, and two Submerged Aquatic Vegetation (SAV) species have been collected since 1972. These surveys contribute to the investigation's objectives in the following manner:

1. data are used to characterize the stocks and estimate relative abundance of juvenile marine and estuarine species in the coastal bays and near-shore Atlantic Ocean;
2. collects information necessary to assist in the management of regional and coastal fish stocks; and
3. delineates and monitors areas of high value, such as spawning, nursery, and/or forage habitat locations for finfish.

Methods

Data Collection

The coastal bays are separated from the Atlantic Ocean to the east by Fenwick Island and Assateague Island. From north to south, Maryland's coastal bays are comprised of Assawoman, Isle of Wight, Sinepuxent, Newport, and Chincoteague bays. Covering approximately 363 square kilometers (km^2; 140 square miles (mi^2)), these bays and associated tributaries average only 0.9 meters (m; 3 feet (ft)) in depth and are influenced by a watershed of 453 km^2 (175 mi^2). The Ocean City and Chincoteague inlets provide oceanic influences on these bays. The Chincoteague Inlet, located in Virginia, is approximately 56 km (34 mi) south of the Ocean City Inlet. Fenwick Island is heavily developed whereas Assateague Island is home to Assateague State Park and Assateague Island National Seashore. The western shore from Sinepuxent Bay north is urban whereas Chincoteague Bay is rural, and the area in between is moderately developed.

A 25 ft C-hawk vessel with a 250 horsepower Yamaha engine was used for transportation to the sample sites and gear deployment. A Global Positioning System (GPS) was used for navigation, marking latitude and longitude coordinates for each sample, and monitoring speed.

Gears

Trawl

Trawl sampling was conducted monthly at 20 fixed sites throughout the coastal bays from April through October (Table 1.1, Figure 1.1, Figure 1.2, and Figure 1.3). Except for June and September, samples were taken beginning the third week of the month. Sampling began the second week in June and September to allow enough time to incorporate beach seine collections.

The boat operator considered wind and tide (speed and direction) when determining trawl direction. A standard 4.9 m (16 ft) semi-balloon trawl net was used in areas with a depth greater than 1.1 m (3.5 ft). A zipper was added to the net in 2015 to help remove macroalgae. Each trawl was a standard six-minute (0.1 hour) tow at a speed of approximately 2.5 to 2.8 knots (kts). Speed was monitored during tows using the GPS. Waypoints marking the sample start (gear fully deployed) and stop (point of gear retrieval) locations were taken using the GPS to document location of the sample. Time was tracked using a stopwatch, which was started at full gear deployment.

Beach Seine

Beach seines were used to sample the shallow regions of the coastal bays frequented by juvenile fishes. Beach seine sampling was conducted at 19 fixed sites beginning in the second weeks of June and September (Table 1.2, Figure 1.1, Figure 1.2, and Figure 1.3).

A 30.5 m X 1.8 m X 6.4 millimeter (mm) mesh (100 ft X 6 ft X 0.25 inch (in) mesh) bag seine was used at 18 fixed sites in depths less than 1.1 m (3.5 ft) along the shoreline. A 15.24 m (50 ft) version of the previously described net was used at site S019 due to its restricted sampling area. Coordinates were taken at the start and stop points as well as an estimated percentage of net open.

Chemical and Physical Data Collection

For each sampling method, chemical and physical data were documented at each location. Chemical parameters included Dissolved Oxygen (DO; milligrams/Liter (mg/L)), salinity (parts per thousand (ppt)), water temperature (Celsius (C)), and pH (Potential of Hydrogen). Physical parameters included tide state, water clarity (Secchi disk; centimeters (cm)), water depth (ft), weather conditions, wind direction, and wind speed (kts). Data were recorded on a standardized project data sheet printed on Rite in the Rain All Weather paper.

Dissolved oxygen, salinity, water temperature, and pH were taken with a Yellow Springs Instrument Pro Quatro at two depths, 30 cm (1 ft) below the surface (all gears) and 30 cm (1 ft) from the bottom (trawl). The Pro Quatro cable was marked at one-foot intervals. Chemical data were taken 30 cm below the surface for each beach seine site and at trawl site T019 due to the shallow depth (< 1.1 m). The Pro Quatro was calibrated at the beginning of each sampling round.

Water turbidity was measured with a Secchi disk. Secchi readings were taken on the shaded side of the boat without wearing sunglasses. The Secchi disk was lowered into the water until it could not be seen. It was then raised until the black and white pattern could just be seen. The biologist marked the position on the string with their fingers and measured the length of the string to the end of the disk.

Both beginning and ending depths for each trawl were read on a depth finder and recorded. At beach seine sites, depth was estimated by the biologists pulling the net. Wind speed measurements were acquired using a handheld anemometer with digital readout. Measurements were taken facing the wind. Tidal states were from the GPS tide feature.

Sample Processing

Fishes and invertebrates were identified, counted, and measured for Total Length (TL) using a wooden mm measuring board with a 90-degree right angle (Table 1.3). A meter stick was used for species over 500 mm. At each site, a subsample of the first 20 fish (when applicable) of each species were measured and the remainder counted. An exception to this was made for black drum, black sea bass, and summer flounder where encounters of more than 20 fish were measured to improve assessment data. On occasion, small quantities (generally ≤ 10 specimens) of invertebrates were counted or visually estimated.

Blue crabs were measured for carapace width, sex was determined, and female maturity stage identified. Sex and maturity categories included immature female, male, mature female (sook) and mature female with eggs. A subsample of the first 20 blue crabs at each site was measured and the rest were counted. Sex and maturity status of the rest of the blue crabs were not recorded.

Bryozoans, ctenophores, jellyfishes, macroalgae, sponges and SAV were measured volumetrically (L) using calibrated containers with small holes in the bottom to drain excess water. Bryozoans, macroalgae, and sponges were combined for one volume measurement, and a biologist estimated the percentage of each species in the sample. Unknown species were photographed and taken to the office for identification.

Data Analysis

Statistical analyses were conducted on species that historically were most abundant in the trawl and beach seine catch data. Additional species were added to the analyses dependent on their recreational importance, biological significance as forage, or indicators of water quality.

The Geometric Mean (GM) was calculated to develop species-specific annual trawl and beach seine indices of relative abundance (1989 - 2024). That method was adopted by the Atlantic States Marine Fisheries Commission (ASMFC) Striped Bass Technical Committee as the preferred index of relative abundance to model stock status. The mean was calculated using catch per area covered for trawl and catch per haul for beach seine. The geometric mean was calculated from the $\log_e(x + 1)$ transformation of the catch data and presented with 95% confidence intervals (Ricker, 1975). The geometric mean and confidence intervals were calculated as the antilog [$\log_e$-mean(x + 1)] and antilog [$\log_e$-mean(x + 1) ± standard error * (t value: $\alpha = 0.05$, n - 1)], respectively. A geometric grand mean was calculated for the time series (1989 - 2024) and used as a point estimate for comparison to the annual (2024) estimate of relative abundance.

Fish diversity was calculated by the Shannon index (H), which accounts for both abundance and evenness of the species present (Shannon, 1948). The proportion of species relative to the total number of species (pi) is calculated and then multiplied by the natural logarithm of this proportion (lnpi). The resulting product is summed across species and multiplied by -1. Typical values were generally between 1.5 and 3.5 in most ecological studies and the index is rarely greater than four. The Shannon index increases as both the richness and the evenness of the community increase.

Statistical analyses were conducted on all macroalgae from 2006 to 2024. The trawl measure of abundance, Catch Per Unit Effort (CPUE), was mean liters per hectare; the beach seine was mean liters per haul. Annual CPUE was compared to the time series grand mean. Macroalgae diversity was calculated by the Shannon index.

The Generalized Linear Model (GLM), and post hoc Duncan's Multiple Range Test (DMRT) were used to evaluate trawl survey annual and monthly mean parameter values for DO, salinity, temperature, and turbidity. For both surveys, the DO was reviewed at the set level to monitor if readings fell below 5 mg/L.

Results and Discussion

Overview

Finfish were the most abundant taxa captured in the survey. Specifically, they accounted for 54,025 fish caught in the trawl and beach Seine surveys in 2024 (25,403) fish trawling and 28,622 fish beach seining; Table 1.4). The total number of fish and other animals caught per gear and combined were within the normal range in the time series (Table 1.5). Collected fishes represented 59 species for both gears, which was within the lowest quartile of values in the time series.

Atlantic croaker (*Micropogonias undulatus*) and spot (*Leiostomus xanthurus*) had an above average trawl index while Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa hepsetus*), bluefish (*Pomatomus saltatrix*), summer flounder (*Paralichthys dentatus*), and weakfish (*Cynoscion regalis*) had below average trawl indices. Atlantic croaker, Atlantic menhaden (*Brevoortia tyrannus*) and spot had above average beach seine indices while silver perch (*Bairdiella chrysoura*) and weakfish had below average seine indices (Table 1.6). Since 2014, summer flounder had an average or below average trawl index and an average or above average beach seine index which may indicate a preference change to shallow habitat.

Seasonal arrival and peak abundance of fishes in the coastal bays have been steady and predictable based on the known spawning behavior (Table 1.7, Table 1.8). June reflects peak arrival and abundance of juveniles whereas September revealed diversity and richness. The surveys captured signals of abundance.

Crustaceans were the second most abundant taxa captured in this survey. Specifically, they accounted for 5,520 specimens caught trawling (2,071 crustaceans) and beach seining (2,172 crustaceans) in 2024 (Table 1.9). Sixteen crustacean species were identified, and the three most abundant species were blue crabs (*Callinectes sapidus*), grass shrimp (*Palaemon sp.*), and white shrimp (*Penaeus setiferus*), all of which were excellent forage to support recreational finfish species.

The third most abundant category was other species. Sixteen other species were captured including sea squirts (*Molgula manhattensis*), sea nettles (*Chrysaora quinquecirrha*), comb jellies (*Ctenophora Sp*.), horseshoe crabs (*Limulus polyphemus*), hairy sea cucumbers (*Sclerodactyla briareus*), sponges, and bryozoans (Table 1.10). Sea squirts were the most abundant by count (2,998) but comb jellies were the greatest by volume 319.8 L). The invasive pleated sea squirt (*Styela plicata*) were encountered for the first time in the surveys.

The fourth most abundant taxa captured in the survey were molluscs. Specifically, they accounted for 3,424 specimens caught trawling (2,917 molluscs) and beach seining (507 molluscs; Table 1.11). Molluscs were represented by 17 different species, and the most abundant species were solitary glass bubble snails, blue mussels, sponge slugs, and Atlantic brief squid.

Seventeen plant species were captured trawling and beach seining (Table 1.12). Two species of SAV and 15 macroalgae genera were encountered. SAV accounted for 70.6 L in the trawl and 49.8 L in the beach seine. Macroalgae accounted for 2,617.9 L in the trawl and 605 L in the beach seine.

American eel (*Anguilla rostrata*)

American eels, a forage and bait species of interest to recreational anglers, were captured in six of 140 trawls (4.3%) and in four of 38 beach seines (10.5%). A total of 14 American eels were collected in trawl (9 fish) and beach seine (5 fish) samples (Table 1.4). American eels ranked 24 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 0.5 fish/ha and 0.1 fish/haul, respectively.

The 2024 trawl and beach seine relative abundance indices were both equal to the grand means (Figure 1.4, Figure 1.5). Since 1989, the trawl index rarely (5 years) and the beach seine index rarely (8 years) varied significantly from the grand means.

American eels spawn in the Sargasso Sea; therefore, environmental conditions and ocean currents may be a factor influencing relative abundance (Murdy, Birdsong, & Musick, 1997). The harvesting of both elvers and adult eels may affect population size. American eels were previously caught close to land in shallow protected bays or creeks with macroalgae. Many of them were caught in Turville Creek (T006), a site known to have an abundance of macroalgae, where the department also annually conducts an elver survey further up the creek. The abundance of elvers at this site was attributed to the moderately sized freshwater source close to the ocean inlet where elvers grow to adulthood. It was normal for both adults and juveniles to be captured in these surveys.

American eel were caught in April, May, June, and September in the trawl survey. The monthly mean length ranged from 77 mm to 217 mm and generally increased throughout the season except for a jump in May due to the capture of one large 520 mm adult (Table 1.13). In the beach seine survey, there were five American eel caught in June and none in September. The mean length in the beach seine survey was 167 mm (Table 1.14).

Atlantic croaker (*Micropogonias undulatus*)

Atlantic croakers, a species of interest to anglers, were captured in 47 of 140 trawls (33.6%) and in 12 of 38 beach seines (31.6%). A total of 1,401 juvenile Atlantic croakers were collected in trawl (1,200 fish) and beach seine (201 fish) samples (Table 1.4). Atlantic croakers ranked 5 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 68.3 fish/ha and 5.3 fish/haul, respectively.

The 2024 trawl and beach seine relative abundance indices were both above the grand mean (Figure 1.6, Figure 1.7). Since 1989, the trawl index often (24 years) and the beach seine index sometimes (15 years) varied significantly from the grand means. The beach seine index was the highest of the time series.

In the history of the surveys, juvenile Atlantic croakers were more frequently caught in deeper water with the trawl; therefore, the trawl index represents a more accurate picture of changes in relative abundance. Abundance can be influenced by environmental conditions and ocean currents (Murdy, Birdsong, & Musick, 1997). Very cold winters negatively influence abundance by impacting overwintering young of the year and pushing spawning further south on the Atlantic coast in colder years (Murdy, Birdsong, & Musick, 1997). According to Murdy and Musick (2013), Atlantic croakers spawn in the continental shelf waters, peaking from August through October, and are transported by ocean currents to the coastal bays.

Productive trawl sites for collecting Atlantic croakers were in the relatively protected areas of Assawoman Bay, the St. Martin River, and Newport Bay. Most of those Atlantic croakers were very small and probably did not prefer the stronger currents found in Sinepuxent Bay. Juvenile Atlantic croakers share a similar pattern of distribution to spot and summer flounder. Atlantic croakers are a known prey item for summer flounder, which may explain the co-occurrence of these species (Latour, Gartland, Bonzek, & Johnson, 2008).

Atlantic croakers were caught April through October in the Trawl Survey with the greatest numbers May through July. The monthly mean length ranged from 29 mm to 152 mm and increased monthly from April through August. Starting in July there were young of the year individuals sampled indicating ingress of the next year class (Table 1.13). The Beach Seine Survey mean length was 105 mm in June and 150 mm in September (Table 1.14).

Atlantic menhaden (*Brevoortia tyrannus*)

Atlantic menhaden, a forage species, were captured in 20 of 140 trawls (14.3%) and in 26 of 38 beach seines (68.4%). A total of 19,636 juvenile Atlantic menhaden were collected in trawl (107 fish) and beach seine (19,529 fish) samples (Table 1.4). Atlantic menhaden ranked 2 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 6.1 fish/ha and 513.9 fish/haul, respectively.

The 2024 trawl relative abundance index was equal to the grand mean and the beach seine index was above the grand mean (Figure 1.8, Figure 1.9). Since 1989, the trawl index sometimes (17 years) and the beach seine index sometimes (10 years) varied significantly from the grand means. Atlantic menhaden were caught more often in nearshore locations in the Beach Seine Survey; therefore, that index represents a more accurate picture of changes in relative abundance.

Good beach seine sites were widely dispersed in shallow shoreline edge habitat with either muddy or sandy bottoms. Productive trawl sites for collecting Atlantic menhaden were in the protected headwaters of Turville Creek (T006) and the St. Martin River (T005) which have some of the preferred traits seen in the best beach seine sites: shallow depth and muddy bottom. Turville Creek is known to have high nutrient levels and may attract the prey sources of Atlantic menhaden (Maryland Department of Environment, 2001). Those trawl sites likely had high chlorophyll concentrations; a desirable characteristic for a filter feeder (Wazniak, et al., 2004).

The monthly mean length of Atlantic menhaden caught trawling increased from 38 mm in May to 80 mm in October (Table 1.13). The Beach Seine Survey had a similar trend with an increase from a mean length of 61 mm in June to a mean length of 84 mm in September (Table 1.14). The increase in mean length in both the Trawl and Beach Seine surveys reflects growth of the young of the year cohort throughout the summer season.

Atlantic silverside (*Menidia menidia*)

Atlantic silversides, a forage species, were captured in two of 140 trawls (0.5%) and in 35 of 38 beach seines (92.1%). A total of 2,338 Atlantic silversides were collected in trawl (eight fish) and beach seine 2,330 fish) samples (Table 1.4). Atlantic silversides ranked 3 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 0.5 fish/ha and 61.3 fish/haul, respectively.

The 2024 trawl relative abundance index was below the grand mean and beach seine index was equal to the grand mean (Figure 1.10, Figure 1.11). Since 1989, the trawl index sometimes (19 years) and beach seine index rarely (7 years) varied significantly from the grand mean. Atlantic silversides were more frequently caught in the beach seine survey, which indicates a preference for shallow water habitat. Similar characteristics found at these sites were the proximity to land and or inlets. Atlantic silversides are forage for gamefish and were frequently found occurring with spot, summer flounder, and winter flounder at multiple sites in this survey.

Atlantic silversides were caught in the Trawl Survey only in June. The mean length in June was 40 mm (Table 1.13). The Beach Seine Survey mean lengths were 80 mm in June, and 85 mm in September (Table 1.14). The monthly variability of the mean lengths is likely related to continuous spawning during the monthly lunar spawning cycle, March through July (Murdy & Musick, 2013).

Bay anchovy (*Anchoa hepsetus*)

Bay anchovies, a forage species, were captured in 84 of 140 trawls (60%) and in 28 of 38 beach seines (73.7%). A total of 2,079 bay anchovies were collected in trawl (1,511 fish) and beach seine (568 fish) samples (Table 1.4). Bay anchovies ranked 4 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 86 fish/ha and 14.9 fish/haul, respectively.

The 2024 trawl relative abundance index was below the grand mean and the beach seine index was equal to the grand mean (Figure 1.12, Figure 1.13). Since 1989, the trawl index often (19 years) and beach seine index sometimes (9 years) varied significantly from the grand means. Both bay anchovy indices represent an accurate picture of changes in relative abundance. This was the fourth year in a row of below mean trawl abundance for bay anchovy. They are, however, still being caught at a large percentage of sites. Annual fluctuations in relative abundance may reflect a combination of environmental conditions (DO, nutrient levels, salinity, and water temperature) and ecological changes including shifts in species composition and habitat type.

Bay anchovies were caught in both nearshore and open water locations indicating a wide distribution. Productive trawl and beach seine sites for collecting bay anchovies were in the northern bays for trawl and in the southern bays for beach seine. Bay anchovies are preferred forage for larger fishes and have been found occurring with spot and summer flounder at multiple sites in these surveys.

Most bay anchovy were caught in July and August in the Trawl Survey and the monthly mean lengths of bay anchovies in the Trawl Survey ranged between 43 mm to 67 mm (Table 1.13). The mean monthly lengths from the Beach Seine Survey were 69 mm in June and 57 mm in September (Table 1.14). Spawning appears to occur multiple times from May to September. The presence of both smaller and larger individuals throughout the year reflects the extended recruitment through the summer.

Black sea bass (*Centropristis striata*)

Black sea bass, a species of interest to recreational anglers, were collected in 36 of 140 trawls (25.7%) and 6 of 38 beach seines (15.8%). A total of 108 juvenile black sea bass were collected in trawl (69 fish) and beach seine (39 fish) samples (Table 1.4). Black sea bass ranked 9 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 3.9 fish/ha and 1.0 fish/haul, respectively.

In 2024, the trawl and beach seine relative abundance indices were both equal to the grand means (Figure 1.14, Figure 1.15). Since 1989, the trawl index sometimes (17 years) and beach seine index rarely (9 years) varied significantly from the grand means. The Trawl Survey usually catches more black sea bass; therefore, it was the better gear for inclusion in the stock assessment.

Juvenile black sea bass were more abundant at sites nearest to inlets. Measured water quality parameters did not show a correlation with abundance of black sea bass so other factors such as proximity to the inlets and availability of physical structure in the bays are likely the reasons for differences in abundance between sites (Peters & Chigbu, 2017). Some of the preferred sample sites had a hard shell bottom that provided the needed habitat structure desired by black sea bass (Murdy, Birdsong, & Musick, 1997).

The monthly Trawl Survey mean length of black sea bass increased from 77 mm in April to 131 mm in October with most caught in June through August (Table 1.13). There was ingress of smaller young of the year individuals in October. Black sea bass increased in mean length through the sampling season reflecting growth, though the summer. The June mean length was 93 mm for the Beach Seine Survey. Zero black sea bass caught in September (Table 1.14). The coastal bays are a nursery for young of the year black sea bass through age-1.

Silver perch (*Bairdiella chrysoura*)

Silver perch, a forage species, were collected in 36 of 140 trawls (25.7%) and 12 of 38 beach seines (31.6%). A total of 362 silver perch were collected in trawl (224 fish) and beach seine (138 fish) samples (Table 1.4). Silver perch ranked 7 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 12.8 fish/ha and 3.6 fish/haul, respectively.

The 2024 trawl relative abundance index was equal to the grand mean and the beach seine relative abundance index was below the grand mean (Figure 1.16, Figure 1.17). Since 1989, the trawl index sometimes (18 years) varied significantly from the grand mean and the beach seine index rarely (6 years) varied from the grand mean.

Silver perch were widely dispersed in samples collected throughout the coastal bays. This indicates that most of the habitat of the Maryland coastal bays is favorable for this species. They were caught in both near shore and open water locations; therefore, both indices represent an accurate picture of changes in relative abundance. In the most recent five years the beach seine index for silver perch has been below the grand mean. Since silver perch spawn offshore and juveniles utilize SAV, environmental conditions including global weather patterns and ocean currents may be a factor influencing relative abundance (Murdy, Birdsong, & Musick, 1997) (Murdy & Musick, 2013).

Silver perch were collected by trawl from May through October with the most caught in July and the mean size varied from 28 mm to 155 mm. The mean length was the smallest in June and greatest in the early and later months, reflecting recruitment in mid-summer (Table 1.13). In the Beach Seine Survey, the mean length was 29 mm in June and 82 mm in September.

Spot (*Leiostomus xanthurus*)

Spot are important as forage for larger fish and for recreational anglers for bait and as a target species. Spot were collected in 116 of 140 trawls (82.9%) and 36 of 38 beach seines (94.7%). A total of 26,670 spot were collected in trawl (21,839 fish) and beach seine samples (4,831 fish; Table 1.4). Spot ranked 1 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 1243.8 fish/ha and 127.1 fish/haul, respectively.

The 2024 trawl relative and beach seine relative abundance indices were above the grand mean (Figure 1.18, Figure 1.19). Since 1989, the trawl (31 years) index frequently varied significantly from the grand mean and the beach seine (24 years) indices often varied significantly from the grand mean. Spot and Atlantic croaker have similar life histories, so it is not a surprise that they simultaneously had good recruitment years. Spot spawn offshore; therefore, environmental conditions including global weather patterns, ocean currents and the North Atlantic Oscillation may be a factor influencing relative abundance (Murdy, Birdsong, & Musick, 1997). Both indices indicated that the Maryland coastal bays are suitable nursery habitat for spot and represent an accurate picture of changes in relative abundance.

Most spot were caught in the Trawl Survey from May through October and the monthly mean length of spot increased from 44 mm in May to 103 mm in October reflecting growth throughout the summer season (Table 1.13). In the Beach Seine Survey, most spot were caught in June and the mean length increased from 84 mm in June to 105 mm in September (Table 1.14). The increase in mean length reflects growth of the young of the year cohort throughout the summer season.

Summer flounder *(Paralichthys dentatus)*

Summer flounder, a species of interest to recreational anglers, were collected in 39 of 140 trawls (27.9%) and 18 of 38 beach seines (47.4%). A total of 404 summer flounder were collected in trawl (132 fish) and beach seine (272 fish) samples (Table 1.4). Summer flounder ranked 6 out of 59 species in overall finfish abundance. The trawl and beach seine CPUE was 7.5 fish/ha and 7.2 fish/haul, respectively.

The 2024 trawl relative abundance index was below the grand mean while the beach seine index was equal to the grand mean (Figure 1.20, Figure 1.21). Since 1989, the trawl index frequently (26 years) varied significantly from the grand mean and the beach seine index sometimes (17 years) varied from the grand mean. In the past, summer flounder were caught more frequently in open water trawls; therefore, the trawl index represented a more accurate picture of changes in relative abundance when compared to the beach seine index. Additional work will be done in the coming year with NOAA to consider using the beach seine index in the coastal assessment. Since 2014, summer flounder have had an average or below average trawl index and an average or above average beach seine index which may indicate a preference change to shallow habitat (Figure 1.22).

Productive summer flounder trawl and beach seine sites were in all bays. This indicated that most of the Maryland coastal bays were favorable nursery habitat. Summer flounder are pelagic spawners and changes in relative abundance may reflect a combination of environmental conditions (DO, nutrient levels, salinity, pH, and water temperature) and ecological changes including shifts in forage species composition and habitat type. Those variables may have affected spawning and juvenile success.

The monthly mean length of summer flounder caught by the Trawl Survey increased from 34 mm in April to 156 mm in September with the most individuals caught in July (Table 1.13). In the Beach Seine Survey, the mean length increased from 69 mm in June to 90 mm in September (Table 1.14). The increase in mean length reflects growth of the young of the year cohort throughout the summer season.

Weakfish (*Cynoscion regalis*)

Weakfish, a species of interest to recreational anglers, were collected in 8 of 140 trawls (5.7%) and zero of 38 beach seines. A total of 66 juvenile weakfish were collected in trawl samples (Table 1.4). Weakfish ranked 14 out of 59 species in overall finfish abundance. The trawl CPUE was 3.8 fish/ha.

The 2024 trawl relative abundance index was below the grand mean (Figure 1.23). Since 1989, the trawl (19 years) often varied significantly from the grand mean. Weakfish were only caught in open water; therefore, the trawl index represents a more accurate picture of changes in relative abundance. Changes in relative abundance may reflect a combination of environmental conditions (DO, nutrient levels, salinity, and water temperature) and ecological changes including shifts in species composition and habitat type. Historical productive trawl sample sites for weakfish were in all coastal bays, indicating a broad distribution, with a particular affinity towards Assawoman Bay and the St. Martin River.

Weakfish seine mean length increased from 39 mm in July to 146 mm in September with most individuals caught in July (Table 1.13). Young of the year recruitment was most evident in July, which follows the peak spawning period of May through June (Murdy & Musick, 2013).

Richness and Diversity

Richness is the number of different fishes sampled. Diversity is defined by the Shannon index results, which is a measurement of richness and the proportion of those species in the sample population. In the 2024 Trawl Survey, Assawoman Bay (27 fishes) held the most species of fishes and St. Martin River (13 fishes) was the least species (Table 1.15). The Shannon index results indicated that Newport Bay (H = 1.2) was the most diverse whereas Chincoteague Bay (H = 0.2) was the least diverse. The Shannon Index values were down across the coastal bays in 2024 due to high abundance of juvenile spot from the 2024 year class. The percentage of spot in the total trawl catch ranged from 64% in Newport Bay to 96% in Chincoteague Bay.

Over the Trawl Survey time series (1989 - 2024), Chincoteague Bay had the highest richness (90 fishes) and annual mean richness (34 fishes) (Table 1.16). Newport Bay had the lowest richness (71 fishes) and mean richness (21 fishes) in the time series. The mean Shannon index results for the Trawl Survey time series indicated that Sinepuxent Bay (H = 1.7) was the most diverse whereas the St. Martin River (H = 1.3) was the least diverse. The richness and diversity of fishes in the coastal bays has been affected by the interannual variation of climate, resulting in strong or poor reproduction each year. The signals of low diversity in the coastal bays were a result of the high abundance of Atlantic silverside, Atlantic menhaden, bay anchovy, and spot over the time series.

In the 2024 Beach Seine Survey, Chincoteague Bay and Newport Bay held the most species of fish (32 fishes), and the St. Martin River (19 fishes) had the least species of fish (Table 1.17). The Shannon index results indicated that Newport Bay (H = 1.6) was the most diverse whereas Isle of Wight (H = 0.7) was the least diverse due to the high abundance of Atlantic menhaden.

The Beach Seine Survey time series (1989 - 2024) results indicated that Assawoman Bay had the richest fish populations (89 fishes), and Chincoteague Bay had the highest mean richness (34 fishes; Table 1.18). St. Martin River had the lowest richness (71 fishes). Both the St. Martin River and Newport Bay had the lowest annual mean richness (21 fishes) in the time series. The Shannon index results mean diversity (H = 1.6) was highest in Isle of Wight and Chincoteague bays.

The Ayers Creek beach seine site is located at the intersection of tidal/non-tidal water, connected via a large pipe and therefore was separated. In 2024, there were 12 species of fish and low diversity (H = 0.6), with Atlantic menhaden and spot a large proportion of the catch. Over the time series, 45 species of fish were measured, and the mean richness (14 fishes) each year the result of shifting habitat based on rainfall and tidal influences (Table 1.18).

Richness and diversity are important components of a healthy estuary and can provide fish communities with resilience to changes in the environment. There was not a linear relationship between richness and diversity in the coastal bays. Results indicated that the coastal bays' richness was relatively high while diversity was generally low. A strong year class can reduce the diversity value by minimizing the effect of other fish contributions to the sample population. The diversity analysis favored species richness proportions at equal levels in the sample population. While richness or diversity alone should not be used as a single indicator for sustainable fish abundance, as strong inner annual year classes are required to sustain species populations subject to high fishing pressure or natural mortality, increased diversity should allow for resilience to climate change.

Macroalgae

To date, 20 genera and 79,788 L of macroalgae were collected in Maryland's coastal bays using the trawl and beach seine from 2006 - 2024. Rhodophyta (red macroalgae) have been the dominant macroalgae in both gears (Table 1.19). Chlorophyta (green macroalgae), Phaeophyta (brown macroalgae), and Xanthophyta (yellow - green macroalgae) were also represented in the survey collections.

Fifteen genera and 2,617.9 L were collected by trawl within the coastal bays in 2024 (Table 1.12). The 2024 Shannon index of diversity among genera by trawl (H = 1.0) was below the time series average (H = 1.2). *Agardhiella* (59%) were the most abundant macroalgae in 2024. The other genera that contributed more than 5% to the sample population was *Polysiphonia* (29.5%). The 2024 trawl CPUE (149.1 L/ha) was equal to the grand mean (Figure 1.24). Since 2006, the trawl CPUE occasionally varied significantly from the grand mean.

Ten genera and 605 L were collected by beach seine in 2024 (Table 1.12). The Shannon index of diversity among genera (H = 1.0) was below the time series average (H = 1.1). Results indicated that *Polysiphonia* were most abundant (46.6%). The only other genera that contributed more than 5% to the sample population were *Agardhiella* (41.1%). The 2024 beach seine CPUE (15.9 L/haul) was below the grand mean (Figure 1.25). Since 2006, the beach seine CPUE occasionally varied significantly from the grand mean.

Macroalgae in Maryland's coastal bays were investigated consistently over 19 years. The results of this investigation show distribution and abundance of macroalgae encountered by each gear. These data are highly variable, and the survey designs were not developed to perform a population assessment for macroalgae. Abundances of Chlorophyta, Phaeophyta, Rhodophyta, and Xanthophyta are representative of our samples. The Trawl and Beach Seine surveys did not sample macroalgae habitat such as bulkheads, jetties, and rocks where macroalgae have been observed. However, the survey data shows that Rhodophyta and Chlorophyta were present at high levels in the bays closest to high human density population. The terminal year (2024) showed increases in abundance of *Agardhiella* and *Polysiphonia* compared to the previous year. *Polysiphonia* increased in Newport Bay.

The bays north of the Ocean City Inlet showed single species dominance of *Agardhiella,* and the higher CPUE when compared to those below the inlet. This stronghold of abundance must be driven by the environmental conditions that favor this genus such as water clarity, nutrient levels, salinity, and water temperature; however, these effects on macroalgae production are not clear. Chlorophyta abundance, specifically sea lettuce, was variable yet appeared able to compete with the Rhodophytes when suitable conditions presented themselves. *Polysiphonia* abundance and distribution have increased to complete *Agardhiella,* and a strong hold is being established at the mouth of Newport Bay.

Water Quality

These surveys collected surface water temperature and salinity since 1989. Dissolved oxygen and turbidity were added in 1998. Bottom water quality taken from annual mean depth of 6.5 feet was included at trawl sites in 2006, and pH was added in 2022 to monitor for changes in acidification that could impact fishes (Tomasetti & Gobler, 2020). There is increasing evidence that many ecologically and or economically important fishes experience decreased survival and or growth when exposed to hypoxic conditions that are further impaired by concurrent acidification. Tidal flushing, wave action, and shallow depths contribute to good habitat.

Temperature
Surface water temperature GLM results comparing annual means across the time series indicated significant interannual variability ($F_{35,4976} = 4.35$, $p < 0.01$). The DMRT results showed six temperature groups, with the year 2020 being the hottest (24.04 C) and 1992 the coolest (19.48 C). The linear regression analysis of annual mean temperature by year showed a weak-medium relationship ($R^2 = 0.36$) of increasing temperature over time in the last thirty-six years (Figure 1.26). Interannual variation was most prominent during October ($F_{35,720} = 33.96$, $p < 0.01$; Figure 1.27), and the October linear regression results were not predictive ($R^2 = 0.02$) of increasing water temperature over time (1989 - 2024).

Dissolved Oxygen
Bottom dissolved oxygen annual means ranged from 6.21 mg/L (2021) to 7.16 mg/L (2016). The linear regression analysis showed no predictive relationship (Figure 1.28). Surface annual means were greater than the bottom dissolved oxygen annual means. July was the warmest month of the survey, and the July dissolved oxygen bottom annual means ranged from 5.04 mg/L (2008) to 6.52 mg/L (2015). However, the lower confidence intervals during this time series fell below 5 mg/L in six of the last 19 years. The July linear regression analysis results were not predictive ($R^2 = 0.01$) (Figure 1.29).

Salinity
Salinity GLM results comparing annual means across the time series indicated significant interannual variability ($F_{35,4963} = 44.34$, $p < 0.01$) within the normal limits for Mid-Atlantic saltwater fishes. The DMRT results showed five salinity groups, ranging from 22 ppt (1990) to 30.6 ppt (2002). The linear regression analysis showed no predictive relationship ($R^2 = 0.00$) (Figure 1.30).

Turbidity
Water clarity has been measured since 2006. GLM results comparing annual means across the time series indicated significant interannual variability ($F_{21,2758} = 6.62$, $p < 0.01$). The DMRT results showed five distinct turbidity groups, with the most recent years in the better groups. The annual means ranged from 38 cm (2004) to 104.4 cm (2022). The linear regression analysis showed a weak-medium relationship ($R^2 = 0.35$) of improvement over time (Figure 1.31). Deeper sunlight penetration was a benefit to SAV habitat.

pH
This was the third year (2024) of monitoring pH in these surveys, and the median pH was 7.9 with no difference at depth in the water column.

Table 1.1. Trawl Survey site descriptions.

Site Number	Bay	Site Description	Longitude	Latitude
T001	Assawoman Bay	On a line from Corn Hammock to Fenwick Ditch	38 26.243	75 04.747
T002	Assawoman Bay	Grey's Creek (mid creek)	38 25.859	75 06.108
T003	Assawoman Bay	Assawoman Bay (mid bay)	38 23.919	75 05.429
T004	Isle of Wight Bay	St. Martin River, mouth	38 23.527	75 07.327
T005	Isle of Wight Bay	St. Martin River, in lower Shingle Landing Prong	38 24.425	75 10.514
T006	Isle of Wight Bay	Turville Creek, below the racetrack	38 21.291	75 08.781
T007	Isle of Wight Bay	Middle of Isle of Wight Bay, north of the shoals in bay (False Channel)	38 22.357	75 05.776
T008	Sinepuxent Bay	Day marker 2, south for 6 minutes (north end of Sinepuxent Bay)	38 19.418	75 06.018
T009	Sinepuxent Bay	Day marker 14, south for 6 minutes (Sinepuxent Bay north of Snug Harbor)	38 17.852	75 07.310
T010	Sinepuxent Bay	Day marker 20, south for 6 minutes (0.5 miles south of the Assateague Island Bridge)	38 14.506	75 09.301
T011	Chincoteague Bay	Newport Bay, across mouth	38 13.024	75 12.396
T012	Chincoteague Bay	Newport Bay, opposite Gibbs Pond to Buddy Pond, in marsh cut	38 15.281	75 11.603
T013	Chincoteague Bay	Between day marker 37 and 39	38 10.213	75 13.989
T014	Chincoteague Bay	1 mile off village of Public Landing	38 08.447	75 16.043
T015	Chincoteague Bay	Inlet Slough in Assateague Island (also known as Jim's Gut)	38 06.370	75 12.454
T016	Chincoteague Bay	300 yards off east end of Great Bay Marsh, west of day marker (also known as, south of day marker 20)	38 04.545	75 17.025
T017	Chincoteague Bay	Striking Marsh, south end about 200 yards	38 03.140	75 16.116
T018	Chincoteague Bay	Boxiron (Brockatonorton) Bay (mid-bay)	38 05.257	75 19.494
T019	Chincoteague Bay	Parker Bay, north end	38 03.125	75 21.110
T020	Chincoteague Bay	Parallel to and just north of the Maryland/Virginia state line, at channel	38 01.328	75 20.057

Table 1.2. Beach Seine Survey site descriptions.

Site Number	Bay	Site Description	Latitude	Longitude
S001	Assawoman Bay	Cove behind Ocean City Sewage Treatment Plant, 62nd street	38 23.273	75 04.380
S002	Assawoman Bay	Bayside of marsh at Devil's Island, 95th street	38 24.749	75 04.264
S003	Assawoman Bay	Small cove, east side, small sand beach; sand spit, bayside of Goose Pond	38 24.824	75 06.044
S004	Isle of Wight Bay	North side of Dredge Spoil Island across east channel from 4th street, northeast corner of the Ocean City Flats	38 20.388	75 05.390
S005	Isle of Wight Bay	Beach on sand spit north of Cape Isle of Wight (also known as, in cove on marsh spit, east and south of mouth of Turville Creek	38 21.928	75 07.017
S006	Isle of Wight Bay	Beach on west side of Isle of Wight, St. Martin River (also known as Marshy Cove, west side of Isle of Wight, north of route 90 Bridge)	38 23.627	75 06.797
S007	Isle of Wight Bay	Beach, 50th Street (next to Seacrets)	38 22.557	75 04.301
S008	Sinepuxent Bay	Sandy beach, northeast side, Assateague Island Bridge at National Seashore	38 14.554	75 08.581
S009	Sinepuxent Bay	Sand beach 0.5 miles south of Inlet on Assateague Island	38 19.132	75 06.174
S010	Sinepuxent Bay	Grays Cove, in small cove on north side of Assateague Pointe development's fishing pier	38 17.367	75 07.977
S011	Chincoteague Bay	Cove, 800 yards northwest of Island Point	38 13.227	75 12.054
S012	Chincoteague Bay	Beach north of Handy's Hammock (also known as, north side, mouth of Waterworks Creek)	38 12.579	75 14.921
S013	Chincoteague Bay	Cove at the mouth of Scarboro Creek	38 09.340	75 16.426
S014	Chincoteague Bay	North of the entrance to Inlet Slew	38 06.432	75 12.404
S015	Chincoteague Bay	Narrow sand beach, south of Figgs Landing	38 07.000	75 17.578
S016	Chincoteague Bay	Cove, east end, Great Bay Marsh (also known as Big Bay Marsh)	38 04.482	75 17.597
S017	Chincoteague Bay	Beach, south of Riley Cove in Purnell Bay	38 02.162	75 22.190
S018	Chincoteague Bay	Cedar Island, south side, off Assateague Island	38 02.038	75 16.619
S019	Chincoteague Bay	Land site - Ayers Creek at Sinepuxent Road	38 18.774	75 09.414

Table 1.3. Measurement types for fishes and invertebrates captured in the Trawl and Beach Seine surveys.

Species	Measurement Type
Crabs	Carapace width
Finfishes (most species)	Total length
Horseshoe Crabs	Prosomal width
Rays	Wingspan
Sharks	Total length
Shrimp	Rostrum to telson
Squid	Mantle length
Turtles	Carapace length
Whelks	Tip of spire to anterior tip of the body whorl

Table 1.4. List of fishes collected in Maryland's coastal bays Trawl (T) and Beach Seine (S) surveys from April through October 2024. Species are listed by order of total abundance (T = 140, S = 38).

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	CPUE (T) #/Hect.	CPUE (S) #/Haul
Spot	*Leiostomus xanthurus*	26,670	21,839	4,831	1243.8	127.1
Atlantic menhaden	*Brevoortia tyrannus*	19,636	107	19,529	6.1	513.9
Atlantic silverside	*Menidia menidia*	2,338	8	2,330	0.5	61.3
Bay anchovy	*Anchoa mitchilli*	2,079	1,511	568	86.0	14.9
Atlantic croaker	*Micropogonias undulatus*	1,401	1,200	201	68.3	5.3
Summer flounder	*Paralichthys dentatus*	404	132	272	7.5	7.2
Silver perch	*Bairdiella chrysoura*	362	224	138	12.8	3.6
Mummichog	*Fundulus heteroclitus*	166	1	165	0.1	4.3
Black sea bass	*Centropristis striata*	108	69	39	3.9	1.0
Blackcheek tonguefish	*Symphurus plagiusa*	102	12	90	0.7	2.4
Striped anchovy	*Anchoa hepsetus*	92	2	90	0.1	2.4
White mullet	*Mugil curema*	79	10	69	0.6	1.8
Hogchoker	*Trinectes maculatus*	72	66	6	3.8	0.2
Weakfish	*Cynoscion regalis*	66	66		3.8	
Striped killifish	*Fundulus majalis*	46		46		1.2
Atlantic needlefish	*Strongylura marina*	40		40		1.1
Dusky pipefish	*Syngnathus floridae*	29	7	22	0.4	0.6
Lookdown	*Selene vomer*	28	19	9	1.1	0.2
Smallmouth flounder	*Etropus microstomus*	28	15	13	0.9	0.3
Bluefish	*Pomatomus saltatrix*	26		26		0.7
Oyster toadfish	*Opsanus tau*	24	13	11	0.7	0.3
Northern pipefish	*Syngnathus fuscus*	23	18	5	1.0	0.1
Lined seahorse	*Hippocampus erectus*	16	13	3	0.7	<0.1
American eel	*Anguilla rostrata*	14	9	5	0.5	0.1
Pinfish	*Lagodon rhomboides*	13	2	11	0.1	0.3
Northern searobin	*Prionotus carolinus*	12	11	1	0.6	<0.1
Spotted seatrout	*Cynoscion nebulosus*	12	1	11	0.1	0.3
Striped bass	*Morone saxatilis*	11		11		0.3
Striped mullet	*Mugil cephalus*	11		11		0.3
Halfbeak	*Hyporhamphus unifasciatus*	10		10		0.3
Naked goby	*Gobiosoma bosc*	9	5	4	0.3	0.1
Northern puffer	*Sphoeroides maculatus*	9	2	7	0.1	0.2
Rainwater killifish	*Lucania parva*	9		9		0.2
Blue runner	*Caranx crysos*	7	3	4	0.2	0.1
Atlantic moonfish	*Selene setapinnis*	6	6		0.3	
Northern sennet	*Sphyraena borealis*	6	3	3	0.2	<0.1
Southern kingfish	*Menticirrhus americanus*	6		6		0.2

Table 1.4 continued. List of fishes collected in Maryland's coastal bays Trawl (T) and Beach Seine (S) surveys from April through October 2024. Species are listed by order of total abundance (T = 140, S = 38).

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	CPUE (T) #/Hect.	CPUE (S) #/Haul
Southern stingray	*Dasyatis americana*	6		6		0.2
Butterfish	*Peprilus triacanthus*	5	4	1	0.2	<0.1
Green goby	*Microgobius thalassinus*	4	4		0.2	
Rough silverside	*Membras martinica*	4		4		0.1
Striped blenny	*Chasmodes bosquianus*	4	1	3	0.1	<0.1
Striped burrfish	*Chilomycterus schoepfii*	4	1	3	0.1	<0.1
Striped cusk-eel	*Ophidion marginatum*	4	4		0.2	
Orange filefish	*Aluterus schoepfii*	3	3		0.2	
Striped searobin	*Prionotus evolans*	3	3		0.2	
Gag	*Mycteroperca microlepis*	2	2		0.1	
Golden shiner	*Notemigonus crysoleucas*	2		2		<0.1
Inshore lizardfish	*Synodus foetens*	2	1	1	0.1	<0.1
Pigfish	*Orthopristis chrysoptera*	2	2		0.1	
Tautog	*Tautoga onitis*	2	2		0.1	
Bluegill	*Lepomis macrochirus*	1		1		<0.1
Feather blenny	*Hypsoblennius hentz*	1		1		<0.1
Gizzard shad	*Dorosoma cepedianum*	1		1		<0.1
Northern kingfish	*Menticirrhus saxatilis*	1	1		0.1	
Sheepshead	*Archosargus probatocephalus*	1		1		<0.1
Sheepshead minnow	*Cyprinodon variegatus*	1		1		<0.1
Skilletfish	*Gobiesox strumosus*	1		1		<0.1
Spotfin mojarra	*Eucinostomus argenteus*	1	1		0.1	
	Total Finfish	**54,025**	**25,403**	**28,622**		

Table 1.5. Number of species and individual fish caught by year and gear in the Trawl and Beach Seine surveys (T = 140, S = 38).

	Number of Species			Number of Fish		
Year	Trawl	Beach Seine	Combined	Trawl	Beach Seine	Combined
1989	48	59	74	20,954	7,704	28,658
1990	55	52	70	28,080	21,362	49,442
1991	51	70	82	11,460	14,798	26,258
1992	49	60	70	8,188	21,426	29,614
1993	55	66	78	25,156	24,776	49,932
1994	55	56	72	48,087	29,386	77,473
1995	57	56	75	12,295	14,062	26,357
1996	49	51	67	10,258	17,083	27,341
1997	49	58	69	25,588	33,324	58,912
1998	52	59	71	11,684	13,729	25,413
1999	56	64	80	13,828	24,571	38,399
2000	60	61	81	19,167	22,664	41,831
2001	53	63	75	9,242	6,702	15,944
2002	69	57	81	16,766	32,716	49,482
2003	51	44	62	11,676	13,227	24,903
2004	48	51	66	9,231	19,473	28,704
2005	49	56	73	13,771	21,069	34,840
2006	51	60	79	10,053	10,380	20,433
2007	58	61	79	12,937	12,373	25,310
2008	56	59	79	26,942	19,122	46,065
2009	56	59	78	5,385	13,775	19,160
2010	49	59	74	10,887	34,552	45,439
2011	56	50	70	8,232	20,666	28,898
2012	52	57	71	36,002	11,289	47,291
2013	50	60	76	14,213	7,640	21,853
2014	46	58	68	7,586	52,093	60,329
2015	59	59	74	8,568	33,139	41,777
2016	44	63	71	9,480	18,187	27,667
2017	44	54	65	5,628	23,082	28,710
2018	55	59	73	8,881	33,677	42,558
2019	51	55	68	30,985	22,800	53,785
2020	46	63	74	5,654	17,912	23,566
2021	48	61	70	4,549	10,302	14,851
2022	42	55	66	9,723	45,598	55,321
2023	46	55	66	8,664	21,803	30,467
2024	42	48	59	25,403	28,622	54,025

Table 1.6. Summary of the 2024 Trawl and Beach Seine surveys; species abundance is defined as above, below, or equal to the grand mean.

Common Name	Scientific Name	Trawl	Beach Seine
American eel	*Anguilla rostrata*	Equal	Equal
Atlantic croaker	*Micropogonias undulatus*	Above	Above
Atlantic menhaden	*Brevoortia tyrannus*	Equal	Above
Atlantic silverside	*Menidia menidia*	Below	Equal
Bay anchovy	*Anchoa mitchilli*	Below	Equal
Black sea bass	*Centropristis striata*	Equal	Equal
Bluefish	*Pomatomus saltatrix*	Below	Equal
Silver perch	*Bairdiella chrysoura*	Equal	Below
Spot	*Leiostomus xanthurus*	Above	Above
Summer flounder	*Paralichthys dentatus*	Below	Equal
Weakfish	*Cynoscion regalis*	Below	Below

Table 1.7. Proportion of catch by month in the Trawl Survey time series (1989 - 2024). Green highlight indicates months of high abundance.

	Apr	May	Jun	Jul	Aug	Sep	Oct
American eel (*Anguilla rostrata*)	0.26	0.26	0.23	0.13	0.09	0.03	0.01
Atlantic menhaden (*Brevoortia tyrannus*)	0.01	0.30	0.47	0.10	0.06	0.03	0.04
Spot (*Leiostomus xanthurus*)	0.01	0.18	0.32	0.21	0.15	0.10	0.04
Summer flounder (*Paralichthys dentatus*)	0.03	0.18	0.32	0.21	0.14	0.08	0.04
Atlantic silverside (*Menidia menidia*)	0.06	0.02	0.35	0.32	0.05	0.15	0.05
Black sea bass (*Centropristis striata*)	0.02	0.10	0.20	0.25	0.20	0.16	0.06
Weakfish (*Cynoscion regalis*)	0.00	0.00	0.00	0.61	0.31	0.07	0.01
Bay anchovy (*Anchoa mitchilli*)	0.05	0.06	0.09	0.19	0.33	0.18	0.12
Silver perch (*Bairdiella chrysoura*)	0.00	0.00	0.01	0.20	0.42	0.30	0.07
Bluefish (*Pomatomus saltatrix*)	0.00	0.05	0.19	0.32	0.20	0.16	0.07
Atlantic croaker (*Micropogonias undulatus*)	0.04	0.09	0.14	0.14	0.06	0.13	0.41

Table 1.8. Proportion of catch by month in the Beach Seine Survey the time series (1989 - 2024). Green highlight indicates months of high abundance.

	Jun	Sep
American eel (*Anguilla rostrata*)	0.72	0.28
Atlantic croaker (*Micropogonias undulatus*)	0.84	0.16
Atlantic menhaden (*Brevoortia tyrannus*)	0.74	0.26
Black sea bass (*Centropristis striata*)	0.79	0.21
Bluefish (*Pomatomus saltatrix*)	0.58	0.42
Spot (*Leiostomus xanthurus*)	0.80	0.20
Summer flounder (*Paralichthys dentatus*)	0.79	0.21
Atlantic silverside (*Menidia menidia*)	0.19	0.81
Bay anchovy (*Anchoa mitchilli*)	0.37	0.63
Silver perch (*Bairdiella chrysoura*)	0.02	0.98
Weakfish (*Cynoscion regalis*)	0.02	0.98

Table 1.9. List of crustaceans collected in Maryland's coastal bays Trawl (T) and Beach Seine (S) surveys from April through October 2024. Species are listed by order of total abundance (T = 140, S = 38).

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	Estimated Count (T)	Estimated Count (S)	CPUE (T) #/Hect.	CPUE (S) #Haul
Blue crab	*Callinectes sapidus*	2,839	1,180	1,659			67.2	43.6
Grass shrimp	*Palaemon sp.*	1,511	99	265	577	570	38.5	22.0
White shrimp	*Penaeus setiferus*	383	261	122			14.9	3.2
Say mud crab	*Dyspanopeus sayi*	180	174	6			9.9	0.2
Lady crab	*Ovalipes ocellatus*	178	107	71			6.1	1.9
Sand shrimp	*Crangon septemspinosa*	177	47		130		10.1	
Long-armed hermit crab	*Pagurus longicarpus*	90	66	24			3.8	0.6
Mantis shrimp	*Squilla empusa*	83	83				4.7	
Brown shrimp	*Penaeus aztecus*	37	13	24			0.7	0.6
Portly spider crab	*Libinia emarginata*	28	28				1.6	
Arrow Shrimp	*Tozeuma carolinense*	4	4				0.2	
Atlantic mud crab	*Panopeus herbstii*	4	4				0.2	
Bigclaw snapping shrimp	*Alpheus heterochaelis*	2	2				0.1	
Iridescent swimming crab	*Portunus gibbesii*	2	1	1			0.1	<0.1
Atlantic rock crab	*Cancer irroratus*	1	1				0.1	
Peppermint shrimp	*Lysmata wurdemanni*	1	1				0.1	
	Total Crustaceans	**5,520**	**2,071**	**2,172**	**707**	**570**		

Table 1.10. List of other species collected in Maryland's coastal bays Trawl (T) and Beach Seine (S) surveys from April through October 2024. Species are listed by order of total abundance (T = 140, S = 38).

Common Name	Scientific Name	Total Number Collected	No. Collect (T)	No. Collect (S)	Est. Cnt. (T)	Est. Cnt. (S)	Spec. Vol (L) (T)	Spec. Vol (L) (S)	Est. Vol (L) (T)	Est. Vol (L) (S)	CPUE (T) #/Hect.	CPUE (S) #/Haul	CPUE (T) #/Hect. Vol	CPUE (S) #/Haul Vol
Sea squirt	*Molgula manhattensis*	2,951	44		2,907		15.2				168.1		0.9	
Comb jellies	*Ctenophora*	447	95	1	51	300	319.8	16.4	0.3		8.3	7.9	18.2	0.4
Sea nettle	*Chrysaora quinquecirrha*	299	19		80	200	7.3				5.6	5.3	0.4	
Moon jelly	*Aurelia aurita*	123	105	18							6.0	0.5		
Horseshoe crab	*Limulus polyphemus*	90	26	64							1.5	1.7		
Pleated sea squirt	*Styela plicata*	56	40	1	15		5.6	0.0			3.1	<0.1	0.3	
Hairy sea cucumber	*Sclerodactyla briareus*	42	39	3							2.2	<0.1		
Beroe comb jelly	*Beroe ovata*	13	12	1							0.7	<0.1		
Northern diamondback terrapin	*Malaclemys terrapin terrapin*	8	5	3							0.3	<0.1		
Sand dollar	*Echinarachnius parma*	4	4								0.2			
Goldstar tunicate	*Botryllus schlosseri*						0.4						<0.1	
Sea pork	*Aplidium sp.*						5.2	0.4					0.3	<0.1
Bryozoans	*Ectoprocta*						19.7	0.3					1.1	<0.1
Rubbery bryozoan	*Alcyonidium sp.*						11.5						0.7	
Fig sponge	*Suberites ficus*						0.0							
Halichondria sponge	*Halichondria sp.*						647.0	1.3					36.9	<0.1
Red beard sponge	*Microciona prolifera*						123.6	0.8					7.0	<0.1
Sulphur sponge	*Cliona celata*						90.7						5.2	
	Total Other	**4,033**	**389**	**91**	**3,053**	**500.0**	**1,246.2**	**19.3**	**0.3**					

Table 1.11. List of molluscs collected in Maryland's coastal bays Trawl (T) and Beach Seine (S) surveys from April through October 2024. Species are listed by order of total abundance (T = 140, S = 38).

Common Name	Scientific Name	Total Number Collected	No. Collect (T)	No. Collect (S)	Est. Cnt. (T)	Est. Cnt. (S)	Spec. Vol. (L) (T)	Spec. Vol. (L) (S)	Est. Vol. (L) (T)	Est. Vol. (L) (S)	CPUE (T) #/Hect.	CPUE (S) #Haul
Solitary glassy bubble snail	*Haminoea solitaria*	2,567	20		2,547						146.2	
Blue mussel	*Mytilus edulis*	500				500						13.2
Sponge slug	*Doris verrucosa*	176	72	4	100						9.8	0.1
Atlantic brief squid	*Lolliguncula brevis*	85	85								4.8	
Eastern white slippersnail	*Crepidula plana*	34	4		30						1.9	
Common Atlantic slippersnail	*Crepidula fornicata*	25			25						1.4	
Eastern mudsnail	*Nassarius obsoletus*	12	11	1							0.6	<0.1
Bruised nassa	*Nassarius vibex*	10	10								0.6	
Atlantic oyster drill	*Urosalpinx cinerea*	3	3								0.2	
Cayenne keyhole limpet	*Diodora cayenensis*	3	3								0.2	
Purplish tagelus	*Tagelus divisus*	2	2								0.1	
Thick-lip drill	*Eupleura caudata*	2	2								0.1	
Bay scallop	*Argopecten irradians*	1	1								0.1	
Green jackknife	*Solen viridis*	1	1								0.1	
Northern quahog	*Mercenaria mercenaria*	1		1								<0.1
Ribbed mussel	*Geukensia demissa*	1		1								<0.1
Striped nudibranch	*Cratena pilata*	1	1								0.1	
	Total Molluscs	**3,424**	**215**	**7**	**2,702**	**500**						

Table 1.12. List of Submerged Aquatic Vegetation (SAV) and macroalgae collected in Maryland's coastal bays Trawl (T) and Beach Seine (S) surveys from April through October 2024. Species are listed by order of total abundance (T= 140, S = 38).

Common Name	Genus	Specific Volume (L) (T)	Specific Volume (L) (S)
SAV			
Eelgrass	*Zostera*	70.4	49.4
Widgeon grass	*Ruppia*	0.2	0.4
	Total SAV	**70.6**	**49.8**
Macroalgae			
Brown			
Common southern kelp	*Laminaria*	0.2	0
Sour weeds	*Desmarestia*	0.2	
Rockweed	*Fucus*	0	
		0.5	**0**
Green			
Sea lettuce	*Ulva*	231.5	73.1
Green hair algae	*Chaetomorpha*	35.3	0.2
Green fleece	*Codium*	4.7	5.1
Hollow green weed	*Enteromorpha*	2.8	
Green tufted seaweed	*Cladophora*	0.6	
Green sea fern	*Bryopsis*		0.1
		274.9	**78.5**
Red			
Agardh's red weed	*Agardhiella*	1,548.4	242.6
Tubed weeds	*Polysiphonia*	774.7	281.9
Barrel weed	*Champia*	12.0	0.6
Banded weeds	*Ceramium*	4.9	1.2
Hairy basket weed	*Spyridia*	0.5	
		2,340.5	**526.3**
Yellow-Green			
Water felt	*Vaucheria*	2.0	0.2
		2.0	**0.2**
	Total Macroalgae	**2,617.9**	**605.0**

Table 1.13. Length by month for selected fishes from the 2024 Trawl Survey.

	Month	Number Counted	Number Measured	Min Length (mm)	Max Length (mm)	Mean Length (mm)	SD
American eel (*Anguilla rostrata*)	April	3	3	47	160	86.3	63.8
	May	3	3	60	520	217.0	262.5
	June	2	2	70	84	77.0	9.9
	Sep	1	1	118	118	118.0	.
Atlantic croaker (*Micropogonias undulatus*)	April	70	70	28	102	54.2	15.0
	May	477	87	12	166	80.6	22.9
	June	398	132	51	197	112.8	21.9
	July	208	100	25	189	134.6	24.0
	Aug	39	38	45	210	152.7	22.1
	Sep	4	4	86	175	134.0	40.9
	Oct	4	4	20	42	29.5	9.7
Atlantic menhaden (*Brevoortia tyrannus*)	May	44	27	30	51	37.6	4.4
	June	3	3	41	55	49.3	7.4
	July	44	43	50	98	64.6	7.9
	Aug	12	12	69	87	76.0	6.2
	Oct	4	4	79	82	80.0	1.4
Atlantic silverside (*Menidia menidia*)	June	8	8	23	83	40.4	18.1
Bay anchovy (*Anchoa mitchilli*)	April	13	13	37	76	58.2	10.0
	May	120	89	21	91	54.2	12.3
	June	73	69	51	94	67.4	10.2
	July	374	183	12	86	49.1	19.6
	Aug	800	173	24	88	43.9	12.6
	Sep	97	87	33	91	53.3	15.0
	Oct	34	34	20	87	50.9	14.3
Black sea bass (*Centropristis striata*)	May	9	9	53	100	77.2	13.5
	June	16	16	61	134	106.9	19.6
	July	15	15	94	140	111.1	14.8
	Aug	21	21	92	152	126.3	14.3
	Sep	4	4	122	141	129.0	9.1
	Oct	4	4	59	168	131.5	49.3
Silver perch (*Bairdiella chrysoura*)	May	5	5	132	187	155.8	21.9
	June	33	32	11	148	28.4	22.5
	July	113	58	27	68	49.7	10.0
	Aug	29	29	45	114	78.5	14.4
	Sep	30	30	48	191	118.8	37.0
	Oct	14	14	71	123	105.4	16.8

Table 1.13. Length by month for selected fishes from the 2024 Trawl Survey.

	Month	Number Counted	Number Measured	Min Length (mm)	Max Length (mm)	Mean Length (mm)	SD
Spot (*Leiostomus xanthurus*)	Apr	89	56	25	376	44.1	50.2
	May	6,811	236	15	88	52.1	12.1
	Jun	4,715	379	32	182	80.3	16.8
	Jul	4,896	361	35	151	91.7	14.4
	Aug	2,782	326	67	150	98.0	13.1
	Sep	1,686	227	71	188	100.0	13.9
	Oct	860	241	72	170	103.8	12.8
Summer flounder (*Paralichthys dentatus*)	April	11	11	24	52	34.3	9.4
	May	28	28	30	298	69.3	58.2
	June	19	19	53	259	95.8	45.7
	July	57	57	54	255	83.2	39.6
	Aug	5	5	64	114	84.2	18.6
	Sep	7	7	105	403	156.6	108.9
	Oct	5	5	117	151	132.6	12.1
Weakfish (*Cynoscion regalis*)	Jul	61	14	14	56	39.1	12.7
	Aug	3	3	36	111	85.7	43.0
	Sep	1	1	146	146	146.0	.
	Oct	1	1	91	91	91.0	.

Table 1.14. Length by month for selected fishes from the 2024 Beach Seine Survey.

	Month	Number Counted	Number Measured	Min Length (mm)	Max Length (mm)	Mean Length (mm)	SD
American eel (Anguilla rostrata)	Jun	5	5	80	210	167.0	51.9
Atlantic croaker (*Micropogonias undulatus*)	Jun	175	86	34	148	105.4	21.0
	Sep	26	26	72	204	150.3	42.2
Atlantic menhaden (*Brevoortia tyrannus*)	Jun	12,950	242	32	100	61.4	14.5
	Sep	6,579	111	53	146	84.5	16.4
Atlantic silverside (*Menidia menidia*)	Jun	887	198	32	130	80.2	21.7
	Sep	1,443	237	44	131	85.8	14.6
Bay anchovy (*Anchoa mitchilli*)	Jun	283	193	30	110	69.2	11.4
	Sep	285	145	31	85	57.3	9.8
Black sea bass (Centropristis striata)	Jun	39	39	64	120	92.9	15.1
	Sep	0	0				
Bluefish (Pomatomus saltatrix)	Jun	5	5	64	119	85.8	24.8
	Sep	21	21	8	112	87.8	20.6
Silver perch (*Bairdiella chrysoura*)	Jun	60	22	20	37	29.4	4.6
	Sep	78	78	36	133	82.3	24.5
Spot (*Leiostomus xanthurus*)	Jun	4,453	360	32	195	84.6	22.8
	Sep	378	201	68	208	105.8	18.1
Summer flounder (*Paralichthys dentatus*)	Jun	266	233	47	358	69.3	27.7
	Sep	6	6	75	105	90.3	12.6

Table 1.15. Finfish richness and diversity by system for the 2024 Trawl Survey (Assawoman Bay (n = 21), St. Martin River (n = 14), Isle of Wight Bay (n = 14), Sinepuxent Bay (n = 21), Newport Bay (n = 14), and Chincoteague Bay (n = 56)).

Embayment	Richness	Diversity
Assawoman Bay	27	0.7
St. Martin River	13	0.7
Isle of Wight Bay	21	0.6
Sinepuxent Bay	19	1.1
Newport Bay	15	1.2
Chincoteague Bay	20	0.2

Table 1.16. Finfish richness and diversity by system for the 1989 - 2024 Trawl Survey Assawoman Bay (n = 735), St. Martin River (n = 504), Isle of Wight Bay (n = 504), Sinepuxent Bay (n = 756), Newport Bay (n = 504), and Chincoteague Bay (n = 2.116)).

Embayment	Richness	Mean Richness	Mean Diversity
Assawoman Bay	82	28	1.4
St. Martin River	79	23	1.3
Isle of Wight Bay	85	30	1.6
Sinepuxent Bay	76	25	1.7
Newport Bay	71	21	1.4
Chincoteague Bay	90	34	1.4

Table 1.17. Finfish richness and diversity by system for the 2024 Beach Seine Survey (Assawoman Bay (n = 6), St. Martin River (n = 2), Isle of Wight Bay (n = 6), Sinepuxent Bay (n = 6), Newport Bay (n = 4), Chincoteague Bay (n = 12), and Ayers Creek (n = 2)).

Embayment	Richness	Diversity
Assawoman Bay	23	1.3
St. Martin River	19	1.2
Isle of Wight Bay	23	0.7
Sinepuxent Bay	25	1.3
Newport Bay	32	1.6
Chincoteague Bay	32	1.0
Ayers Creek	12	0.6

Table 1.18. Finfish richness and diversity by system for the 1989 - 2024 Beach Seine Survey: Assawoman Bay (n = 216), St. Martin River (n = 72), Isle of Wight Bay (n = 216), Sinepuxent Bay (n = 216), Newport Bay (n = 144), Chincoteague Bay (n = 432), and Ayers Creek (n = 72)).

Embayment	Richness	Mean Richness	Mean Diversity
Assawoman Bay	89	30	1.5
St. Martin River	71	21	1.4
Isle of Wight Bay	88	29	1.6
Sinepuxent Bay	81	28	1.3
Newport Bay	74	21	1.5
Chincoteague Bay	86	34	1.6
Ayers Creek	45	14	1.1

Table 1.19. Macroalgae dominance in the Maryland Coastal Bays as sampled by the Trawl and Beach Seine surveys 2006 - 2024.

	Assawoman Bay	Isle of Wight Bay	St. Martin River	Sinepuxent Bay	Newport Bay	Chincoteague Bay
2006	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2007	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2008	Rhodophyta	Rhodophyta	Rhodophyta	Chlorophyta	Chlorophyta	Phaeophyta
2009	Rhodophyta	Rhodophyta	Rhodophyta	Chlorophyta	Chlorophyta	Chlorophyta
2010	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Chlorophyta	Chlorophyta
2011	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2012	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2013	Rhodophyta	Rhodophyta	Chlorophyta	Rhodophyta	Rhodophyta	Rhodophyta
2014	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2015	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Chlorophyta
2016	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2017	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2018	Rhodophyta	Rhodophyta	Rhodophyta	Chlorophyta	Rhodophyta	Chlorophyta
2019	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2020	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Chlorophyta
2021	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2022	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2023	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta
2024	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta	Rhodophyta

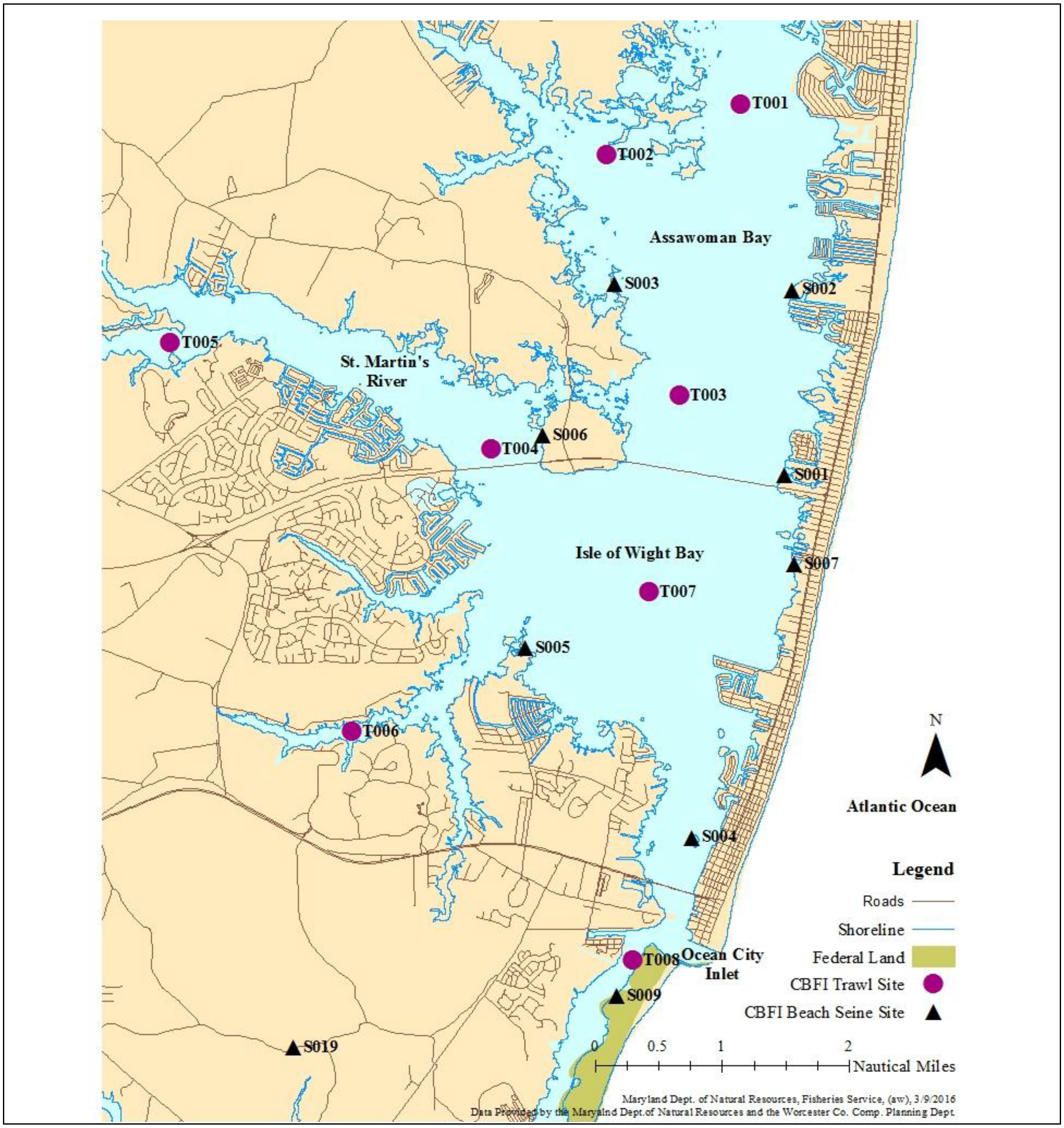

Figure 1.1. Trawl and Beach Seine surveys sampling locations in the Assawoman and Isle of Wight bays, Maryland.

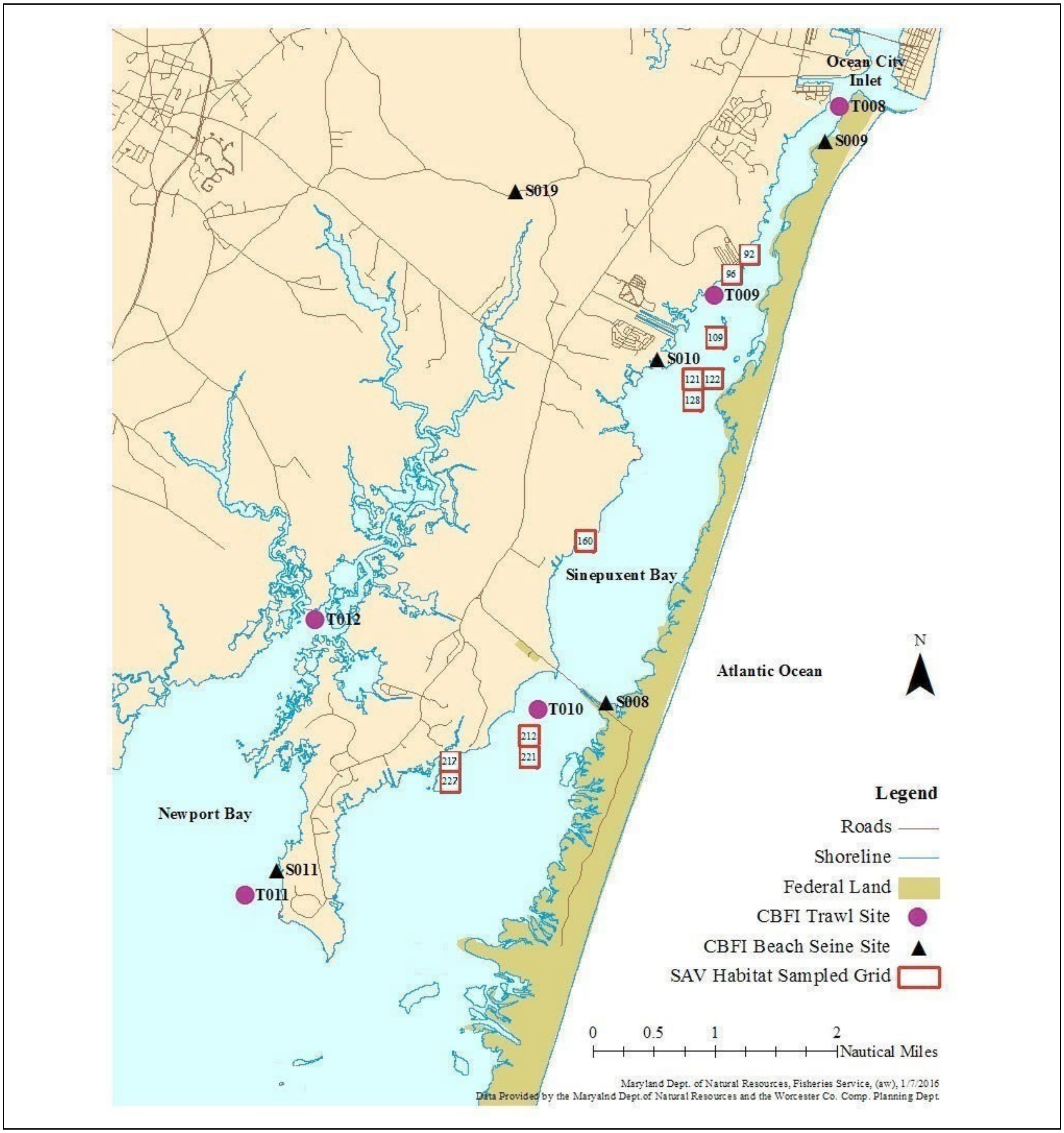

Figure 1.2. Trawl and Beach Seine surveys sampling locations in Sinepuxent and Newport bays, Maryland

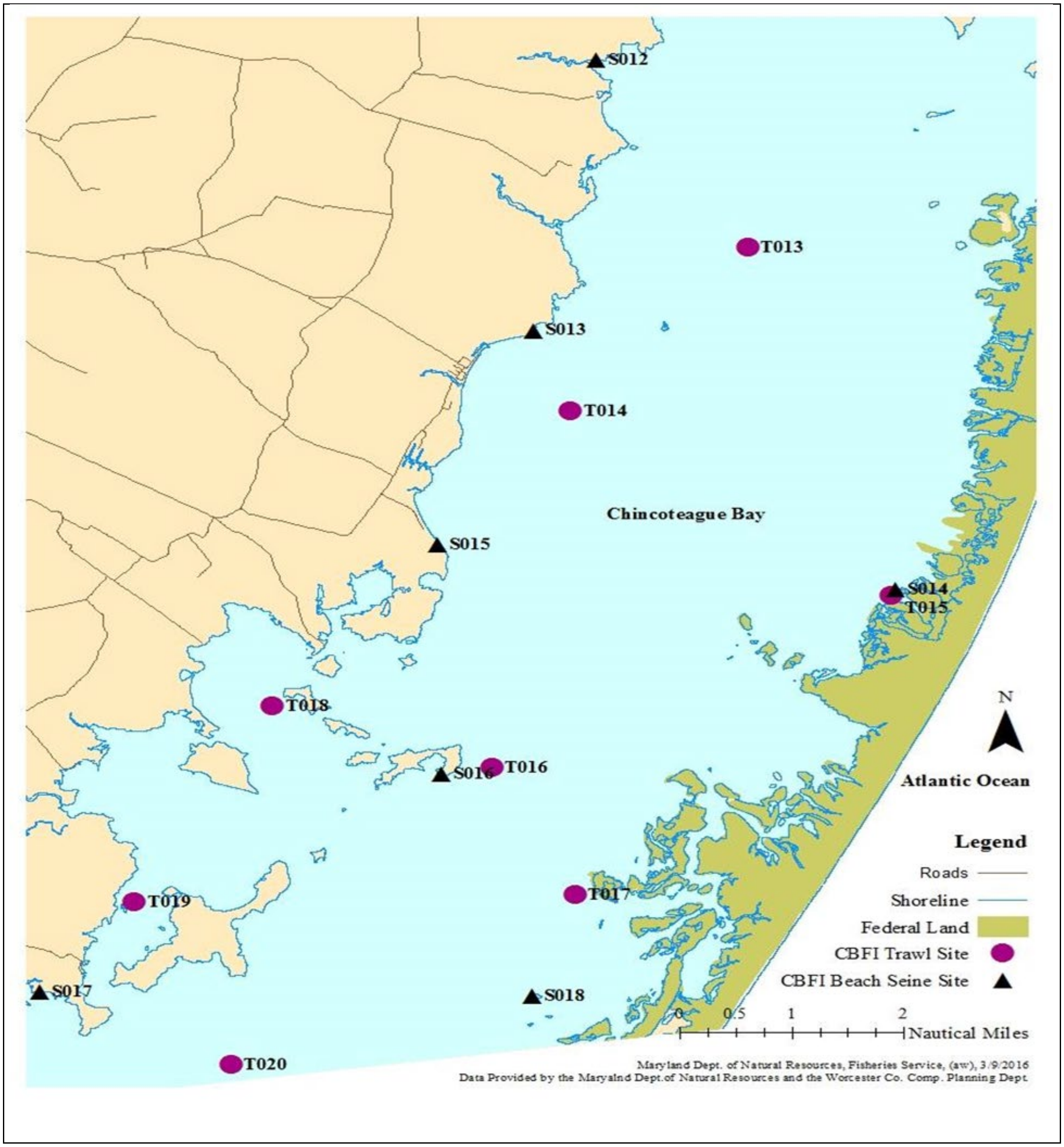

Figure 1.3. Trawl and Beach Seine surveys sampling locations in Chincoteague Bay, Maryland.

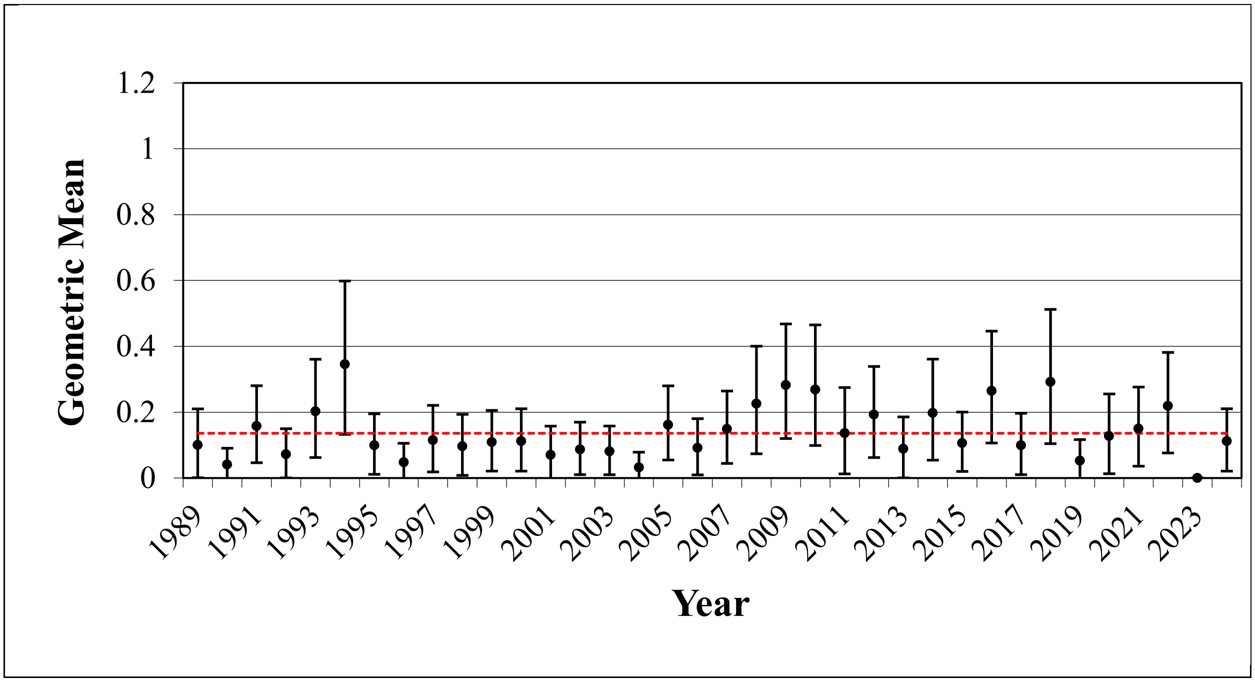

Figure 1.4. American eel (*Anguilla rostrata*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989 - 2019, 2021 - 2024}$ = 140/year, n_{2020} = 120).

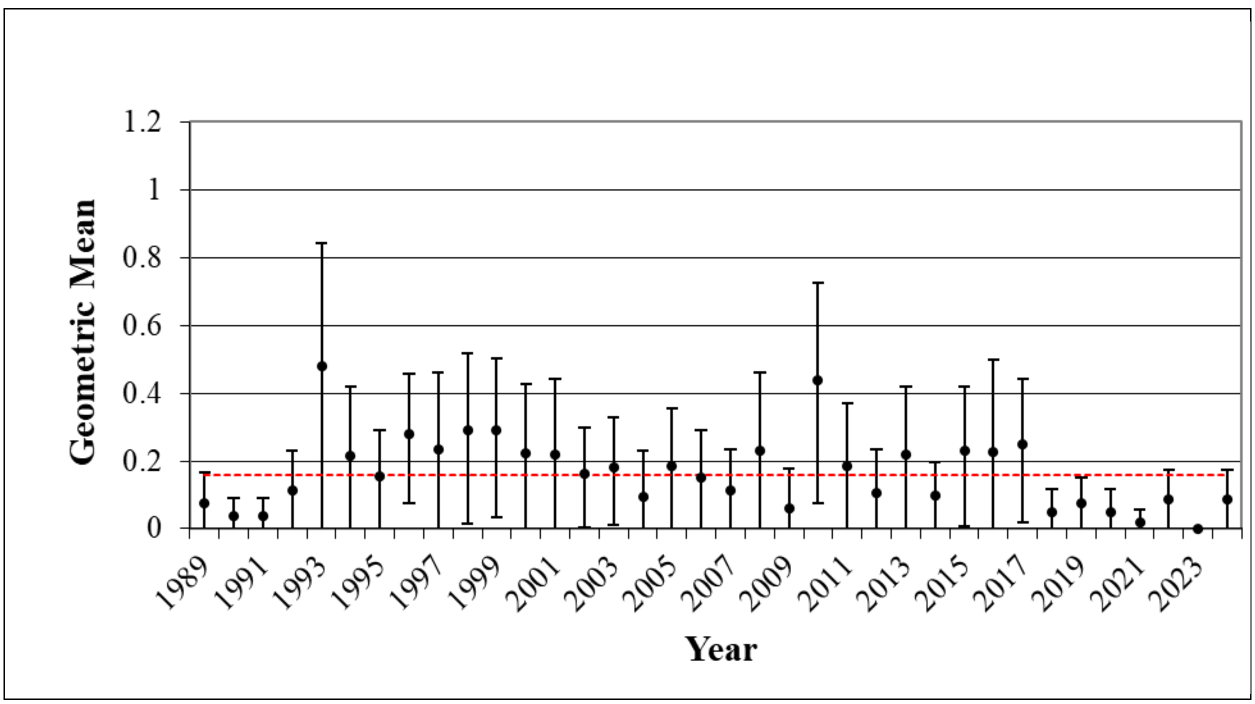

Figure 1.5. American eel (*Anguilla rostrata*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

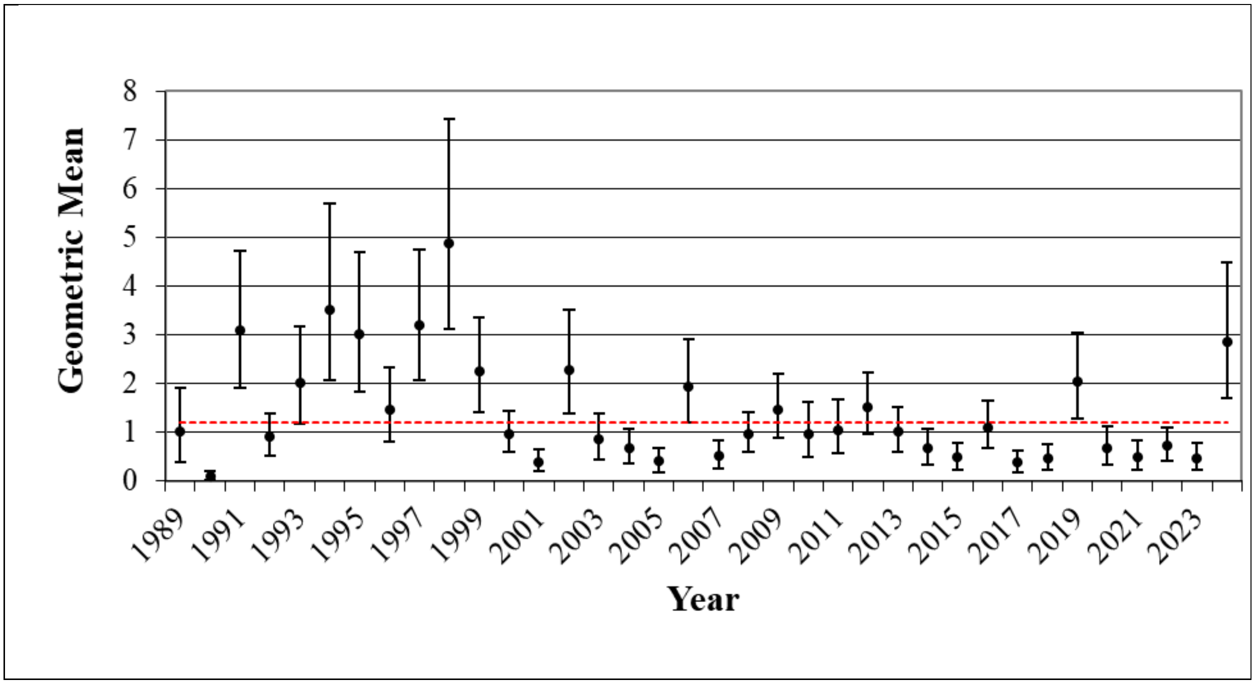

Figure 1.6. Atlantic croaker (*Micropogonias undulatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989\text{ - }2019,\ 2021\text{ - }2024}$ = 140/year, n_{2020} = 120).

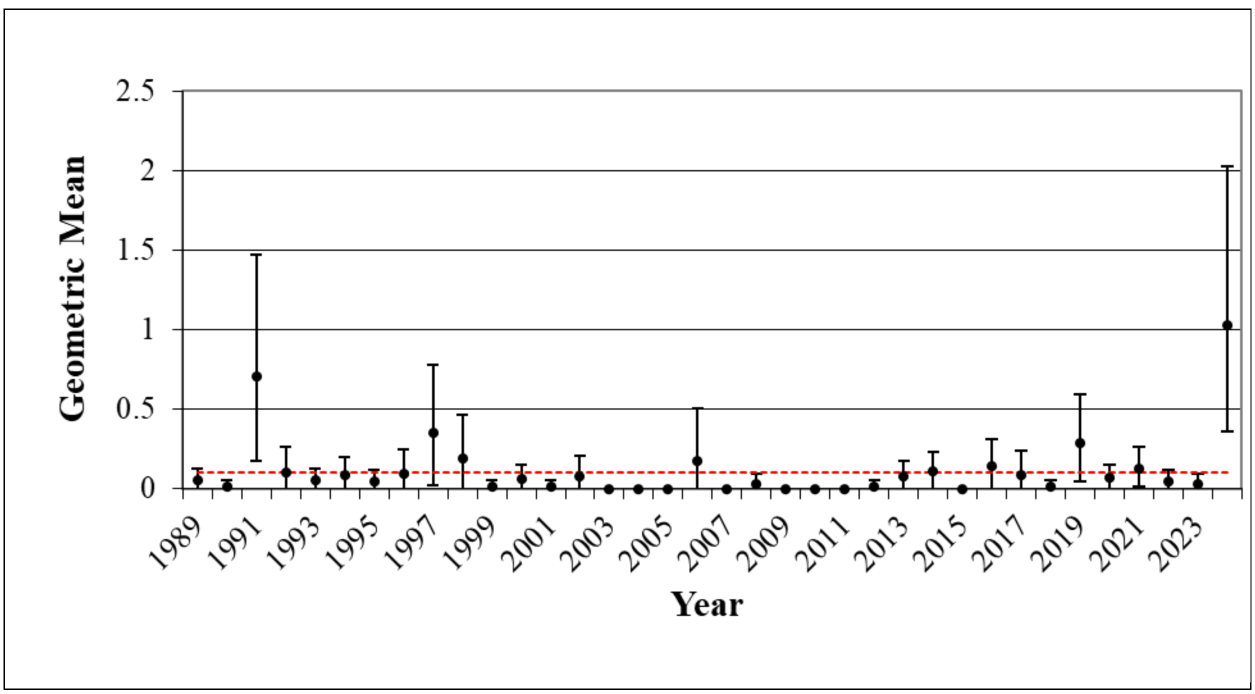

Figure 1.7. Atlantic croaker (*Micropogonias undulatus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

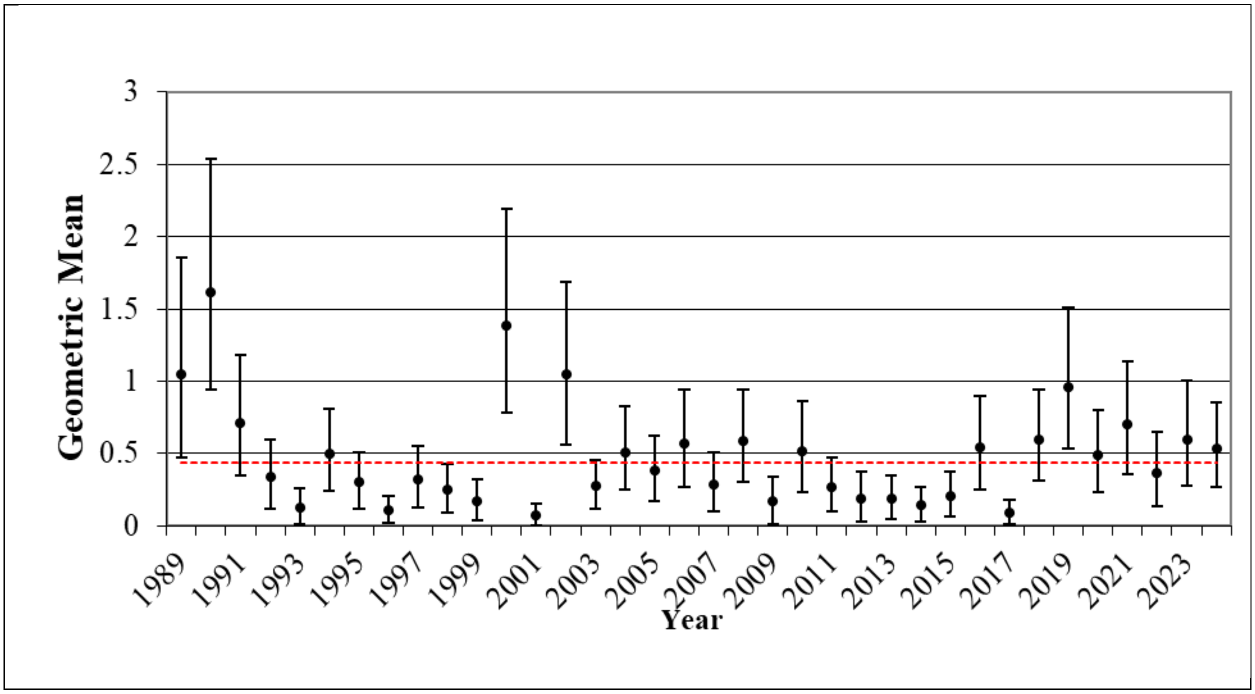

Figure 1.8. Atlantic menhaden (*Brevoortia tyrannus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989\text{ - }2019,\ 2021\text{ - }2024}$ = 140/year, n_{2020} = 120).

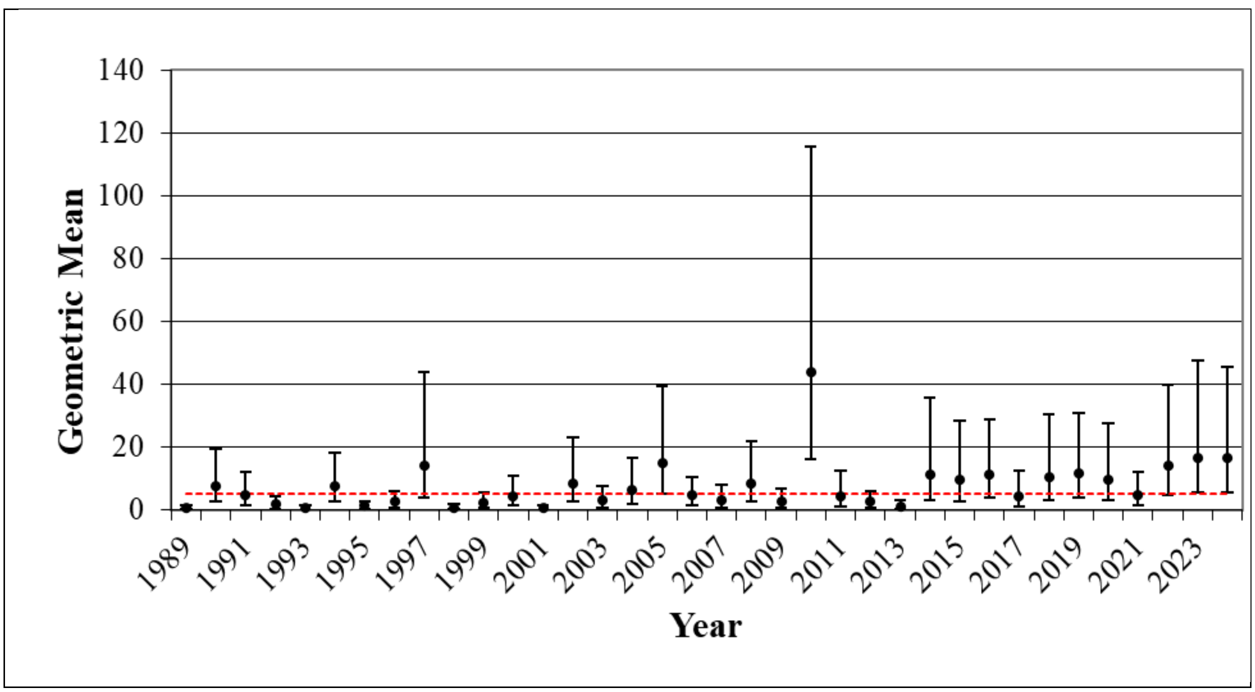

Figure 1.9. Atlantic menhaden (*Brevoortia tyrannus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

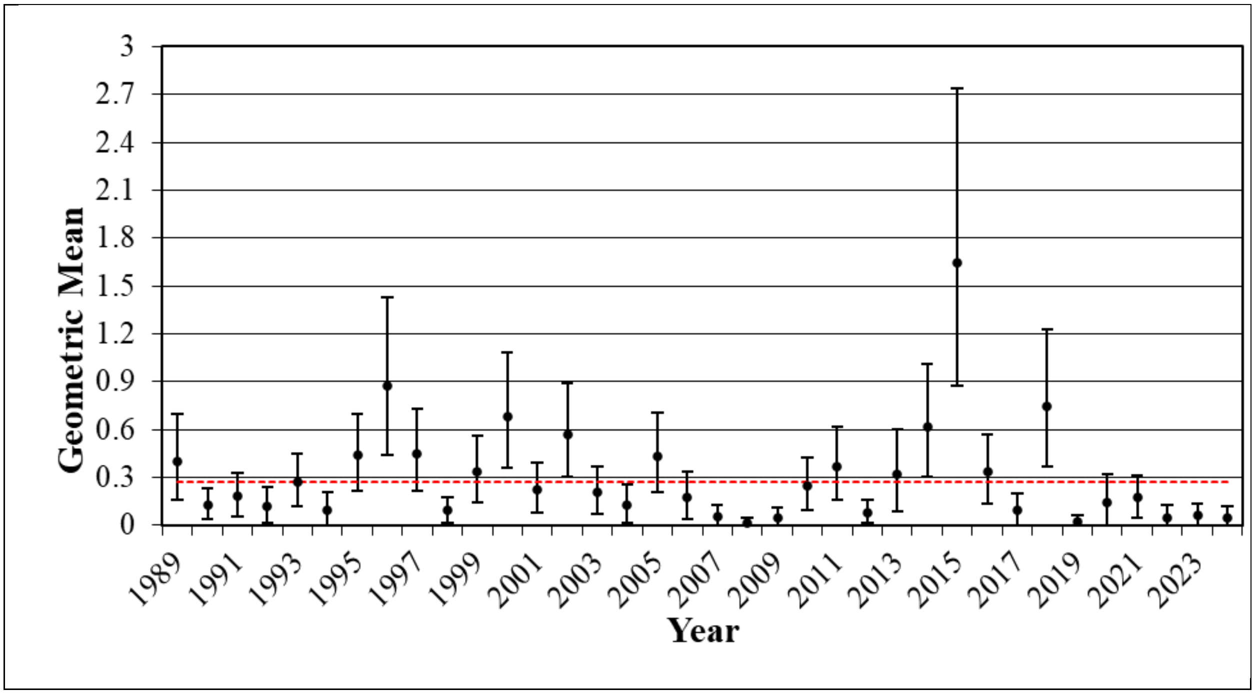

Figure 1.10. Atlantic silverside (*Menidia menidia*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989-2019, 2021-2024}$ = 140/year, n_{2020} = 120).

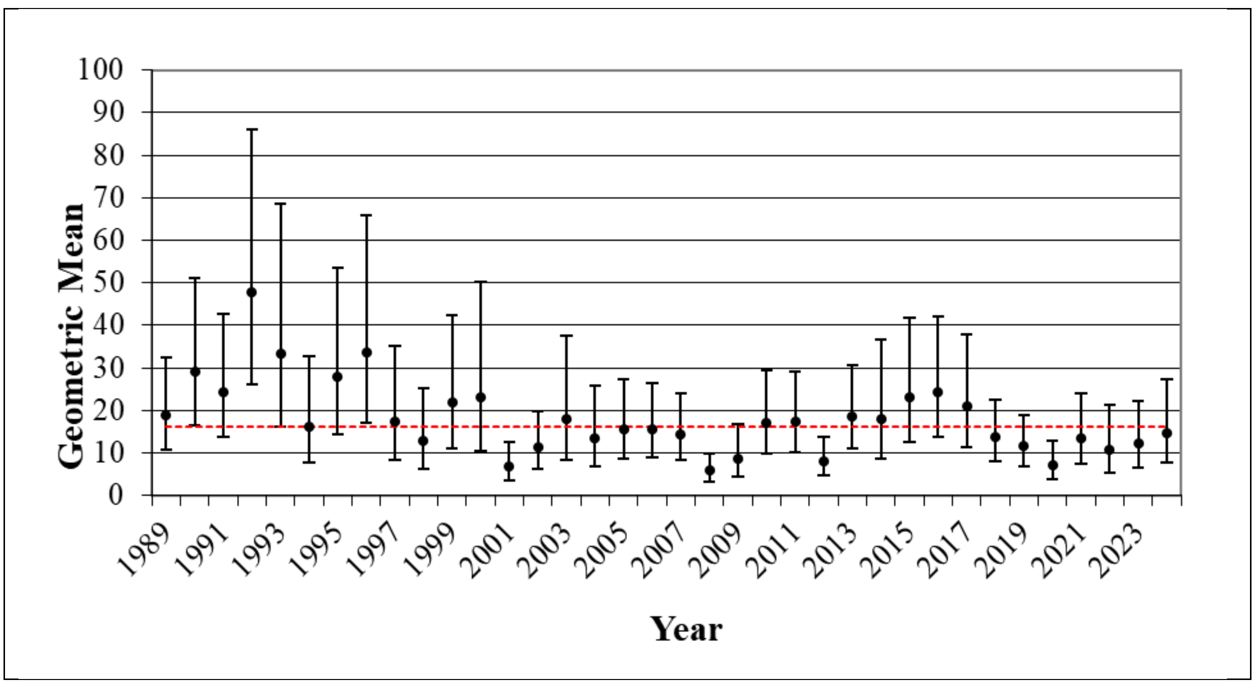

Figure 1.11. Atlantic silverside (*Menidia menidia*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

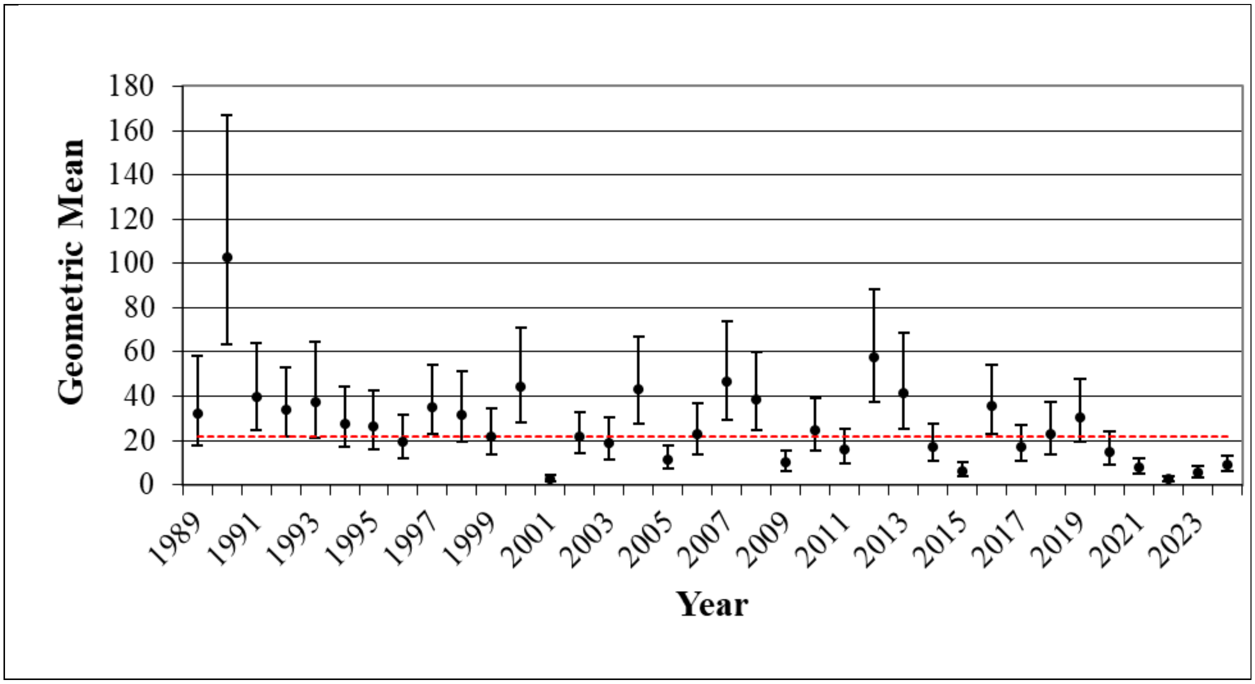

Figure 1.12. Bay anchovy (*Anchoa mitchilli*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n1989 - 2019, 2021 - 2024 = 140/year, n2020 = 120.

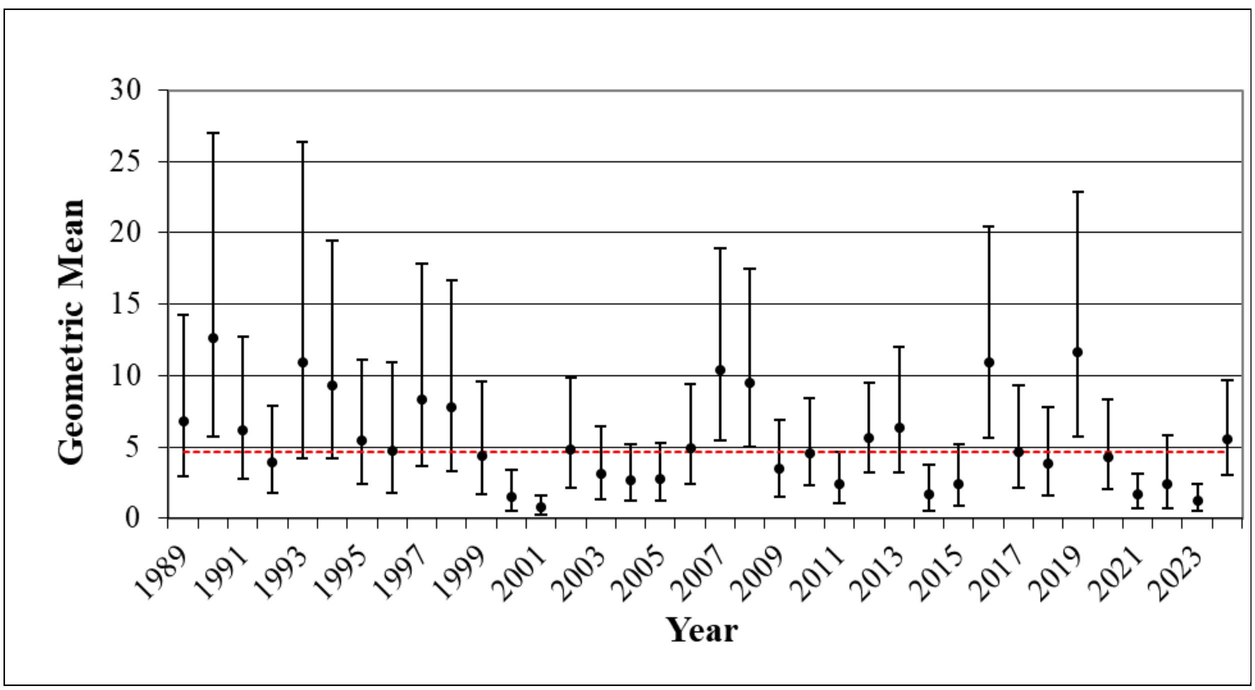

Figure 1.13. Bay anchovy (*Anchoa mitchilli*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

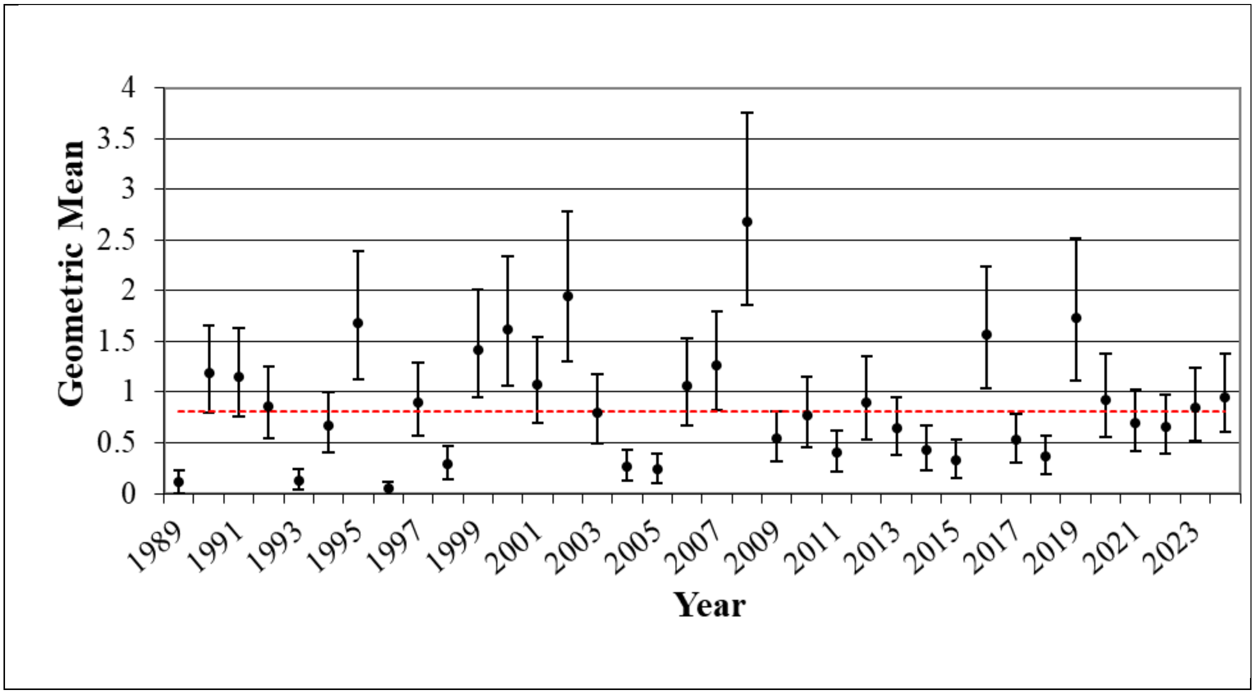

Figure 1.14. Black sea bass (*Centropristis striata*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989-2019,\ 2021-2024}$ = 140/year, n_{2020} = 120).

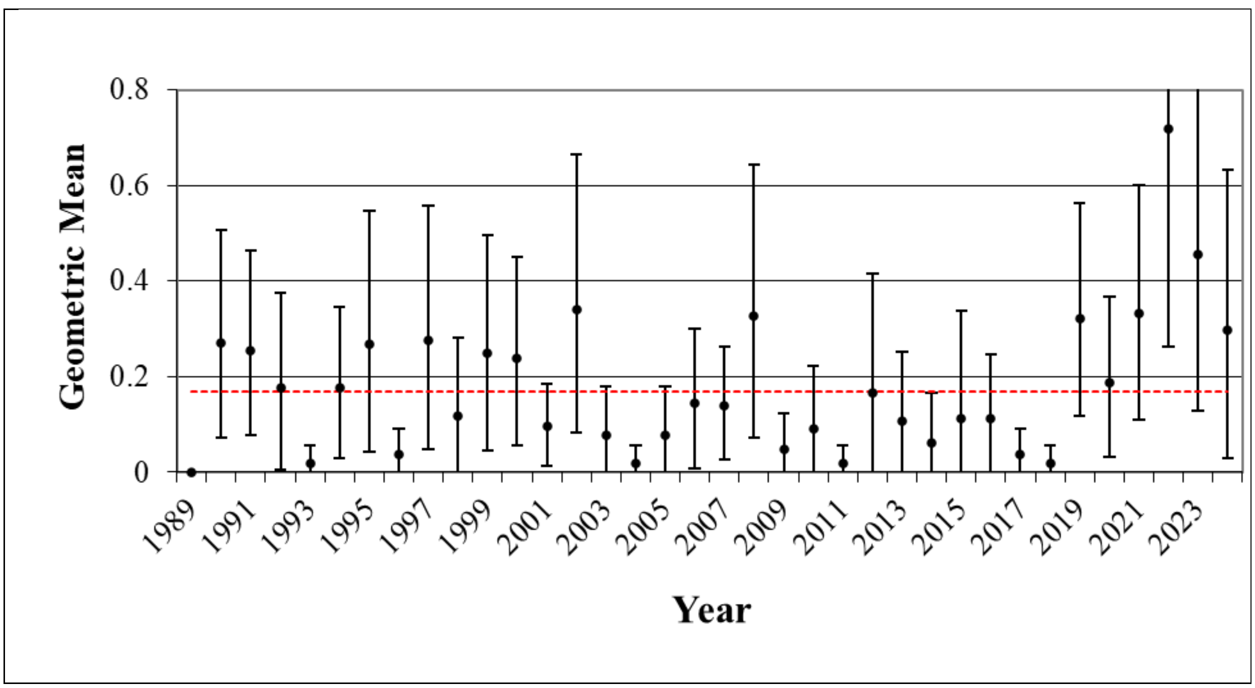

Figure 1.15. Black sea bass (*Centropristis striata*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

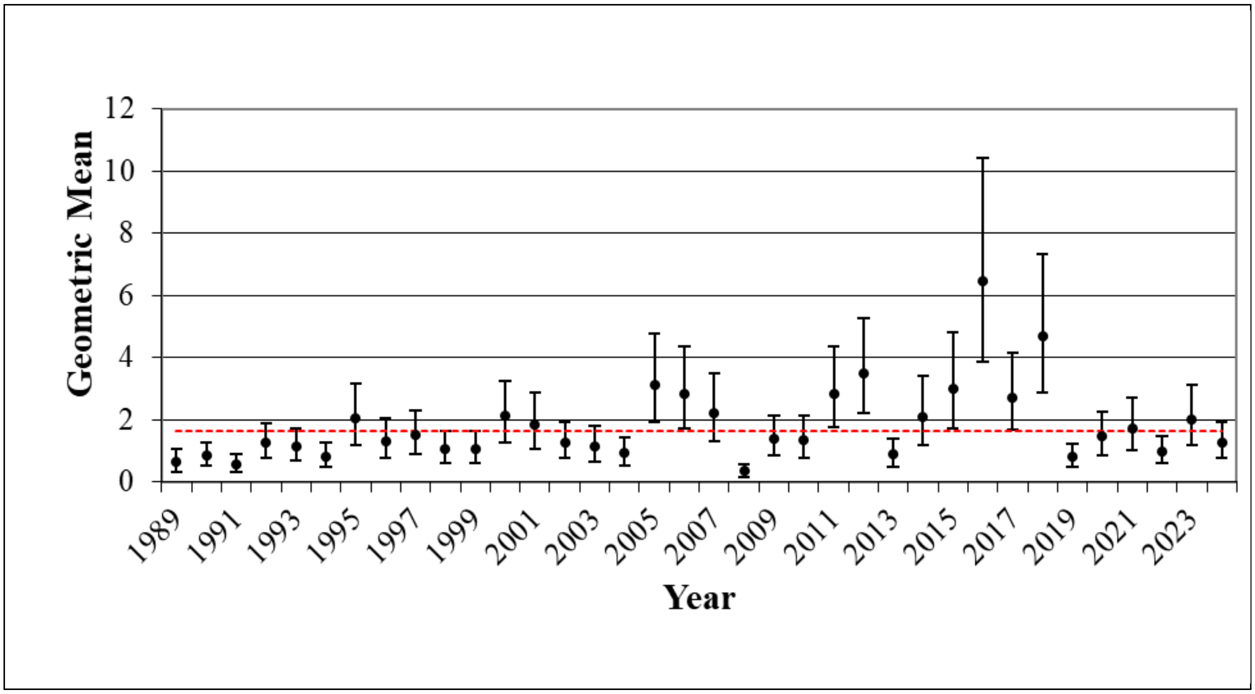

Figure 1.16. Silver perch (*Bairdiella chrysoura*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989\text{ - }2019,\ 2021\text{ - }2024}$ = 140/year, n_{2020} = 120).

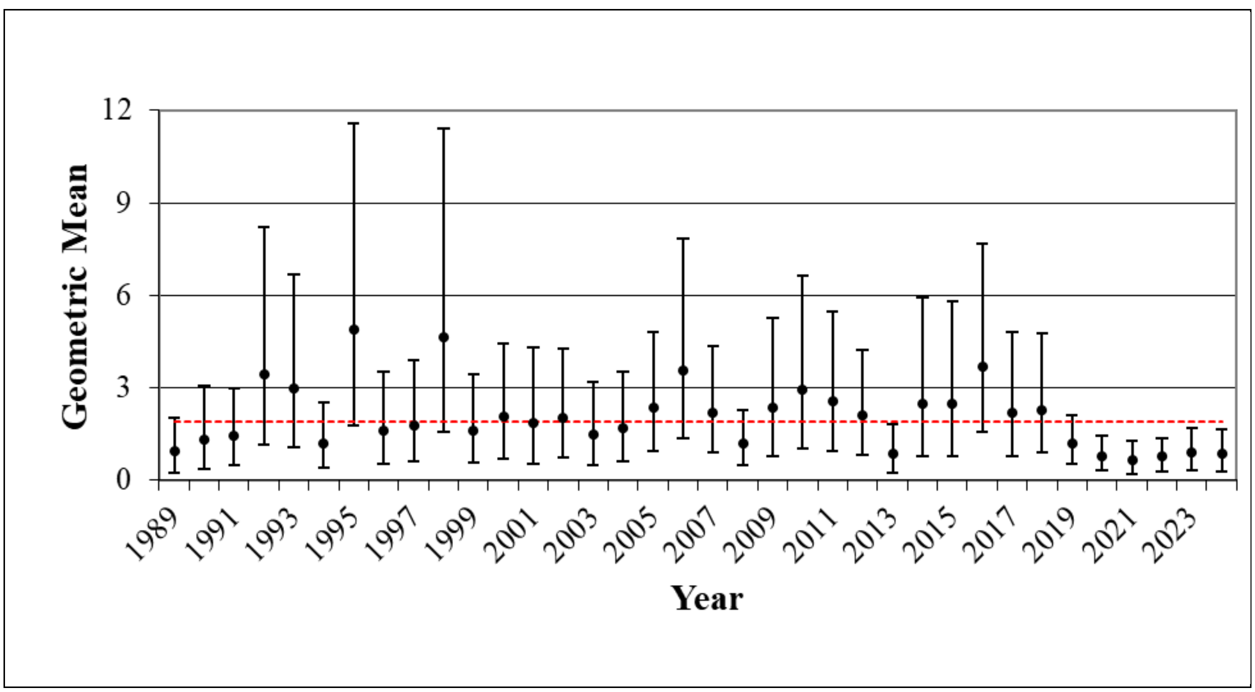

Figure 1.17. Silver perch (*Bairdiella chrysoura*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

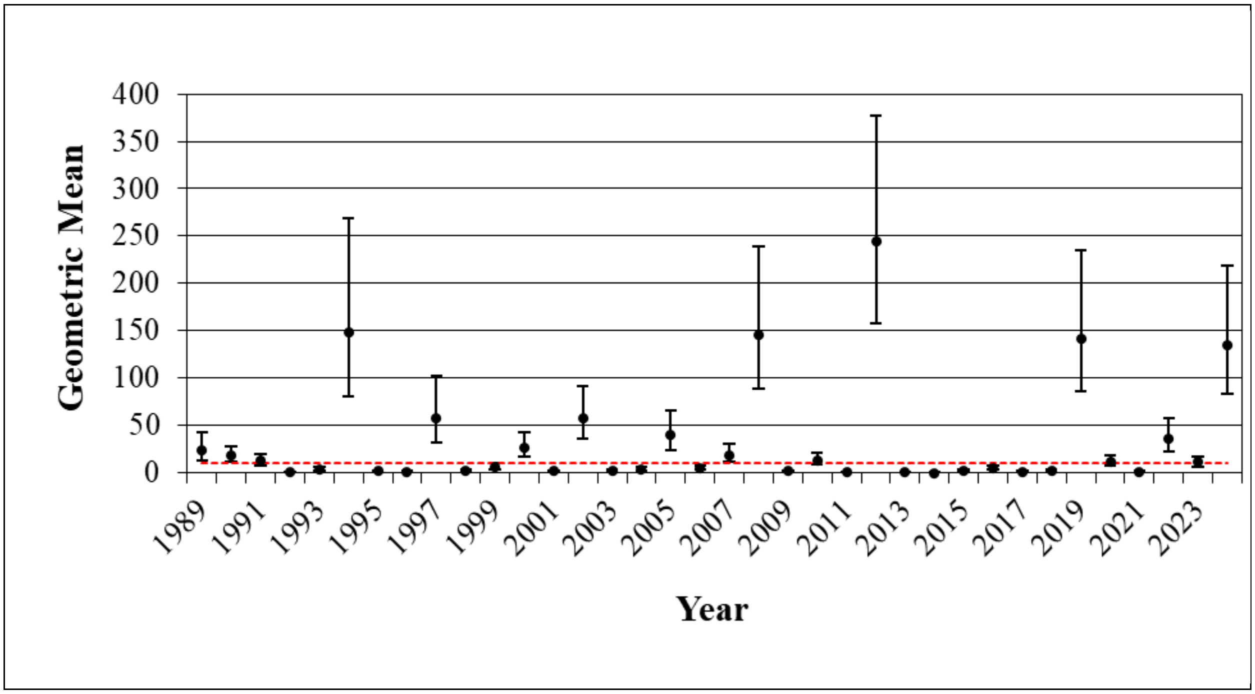

Figure 1.18. Spot (*Leiostomus xanthurus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989-2019, 2021-2024}$ = 140/year, n_{2020} = 120).

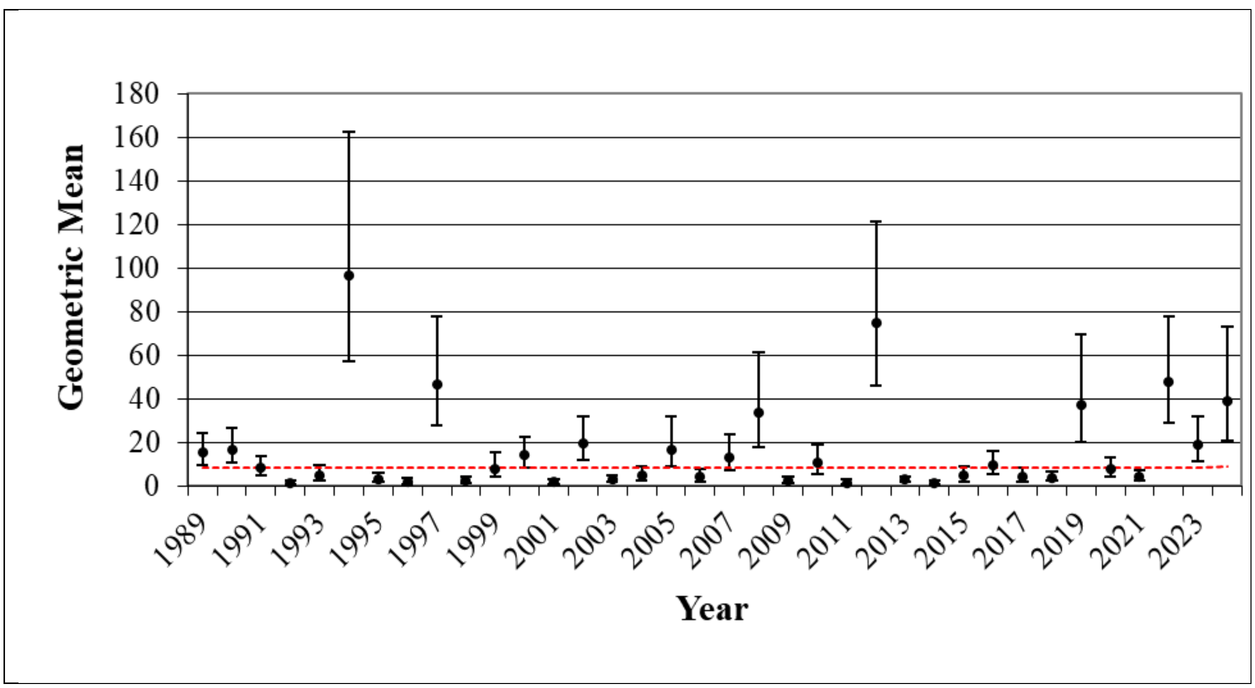

Figure 1.19. Spot (*Leiostomus xanthurus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

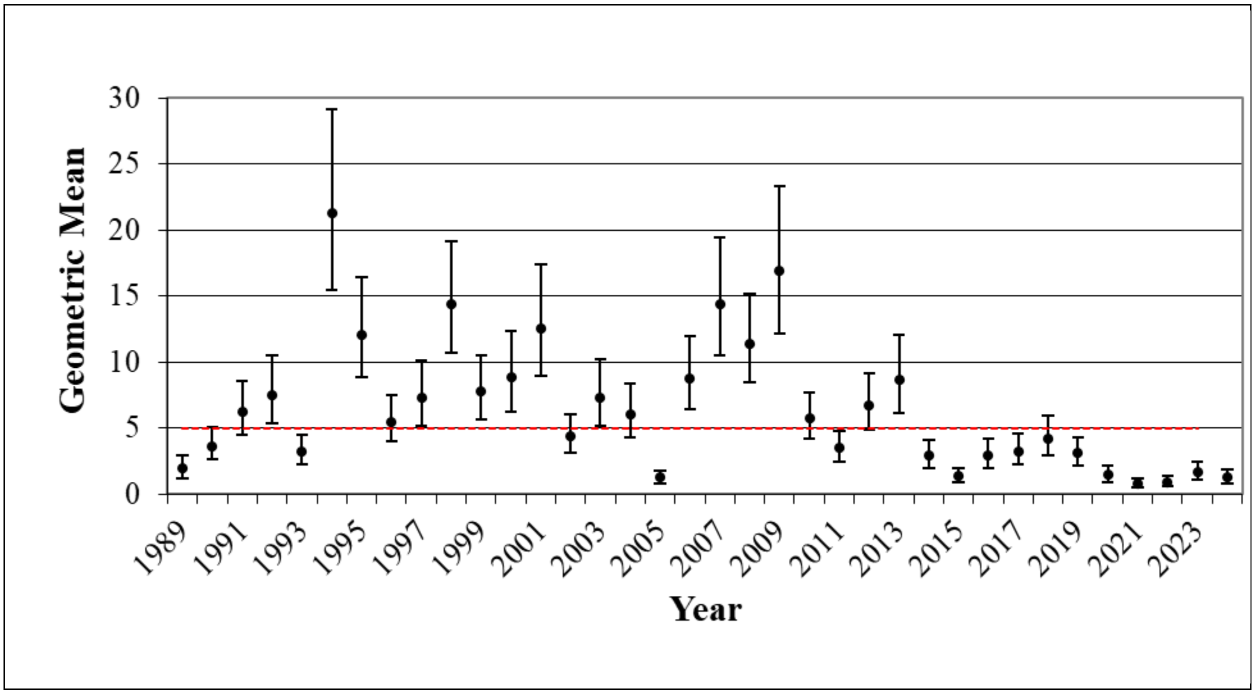

Figure 1.20. Summer flounder (*Paralichthys dentatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989\text{ - }2019,\ 2021\text{ - }2024}$ = 140/year, n_{2020} = 120).

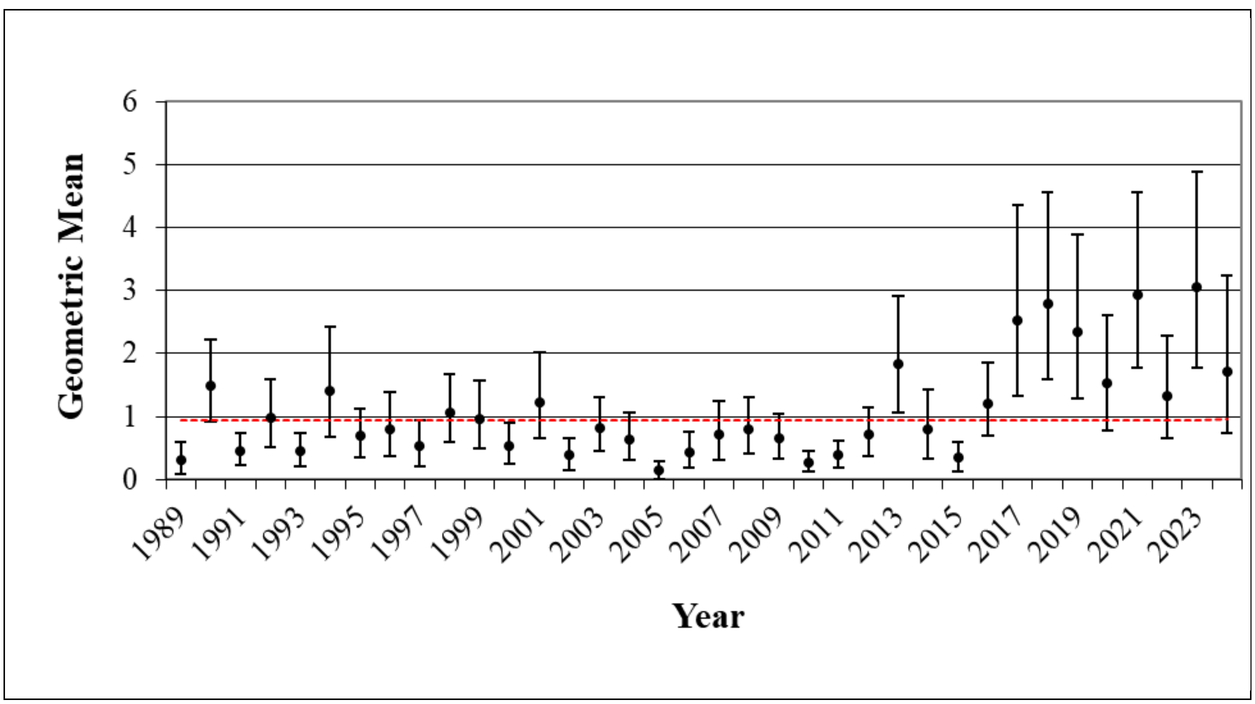

Figure 1.21. Summer flounder (*Paralichthys dentatus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean (n = 38/year).

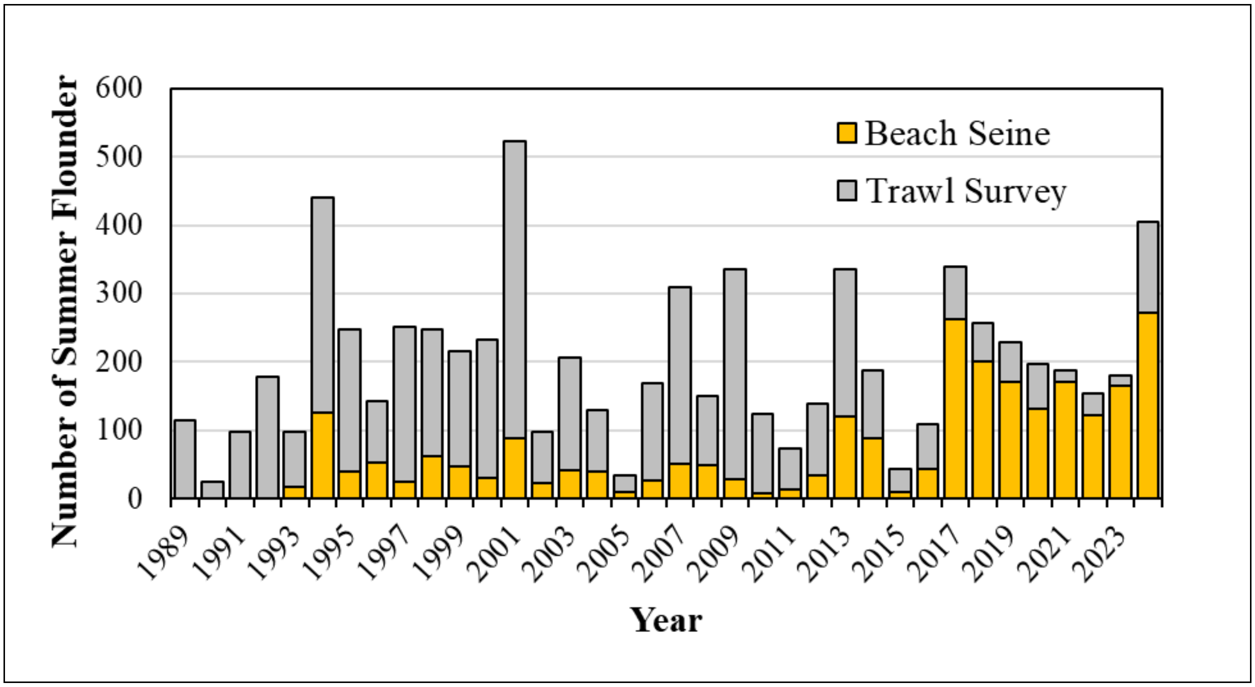

Figure 1.22. Summer flounder (*Paralichthys dentatus*) relative abundance shift toward shallow water in June.

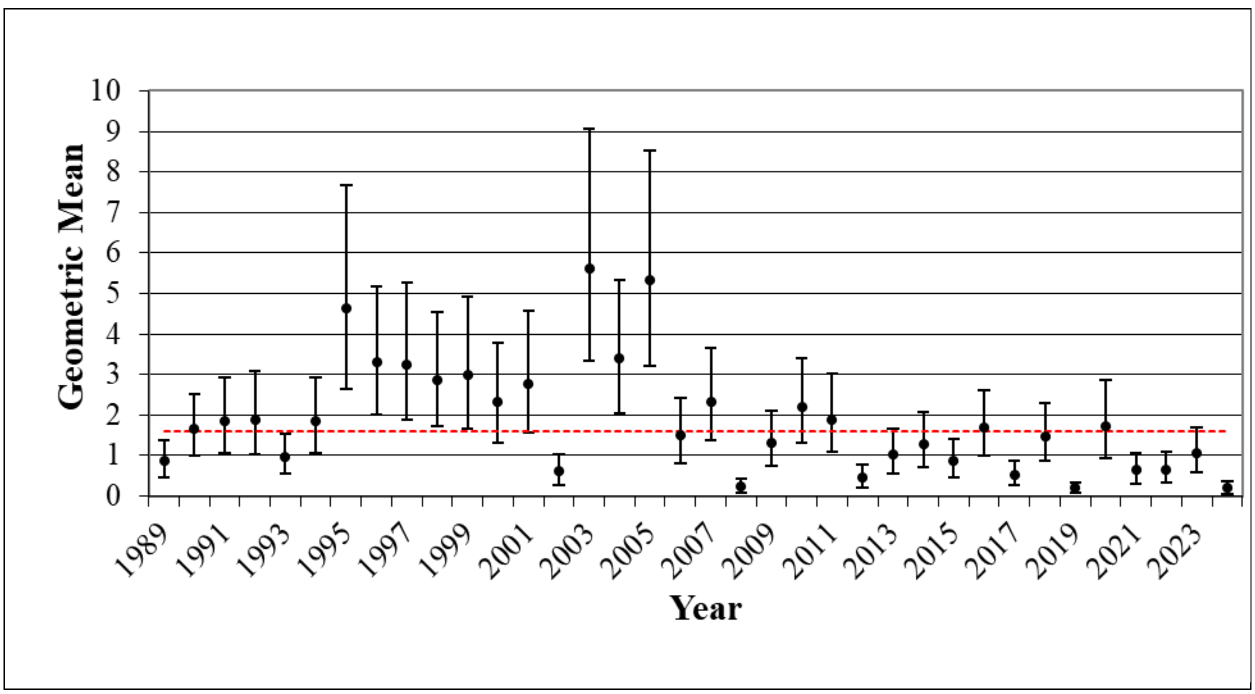

Figure 1.23. Weakfish (*Cynoscion regalis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989 - 2024). Dotted line represents the 1989 - 2024 time series grand mean ($n_{1989\text{ - }2019,\ 2021\text{ - }2024}$ = 140/year, n_{2020} = 120).

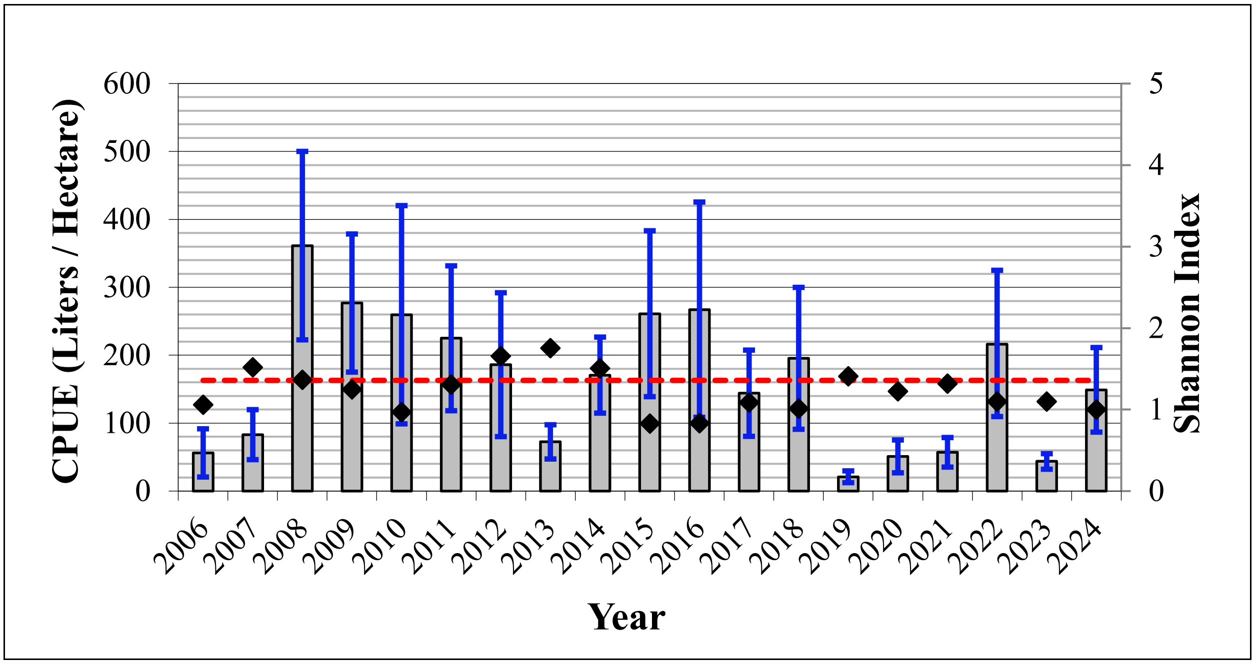

Figure 1.24. Coastal bays trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006 - 2024). Red line represents the 2006 - 2024 time series CPUE grand mean ($n_{1989\text{ - }2019,\ 2021\text{ - }2024}$ = 140/year, n_{2020} = 120). Black diamond represents the Shannon index of diversity.

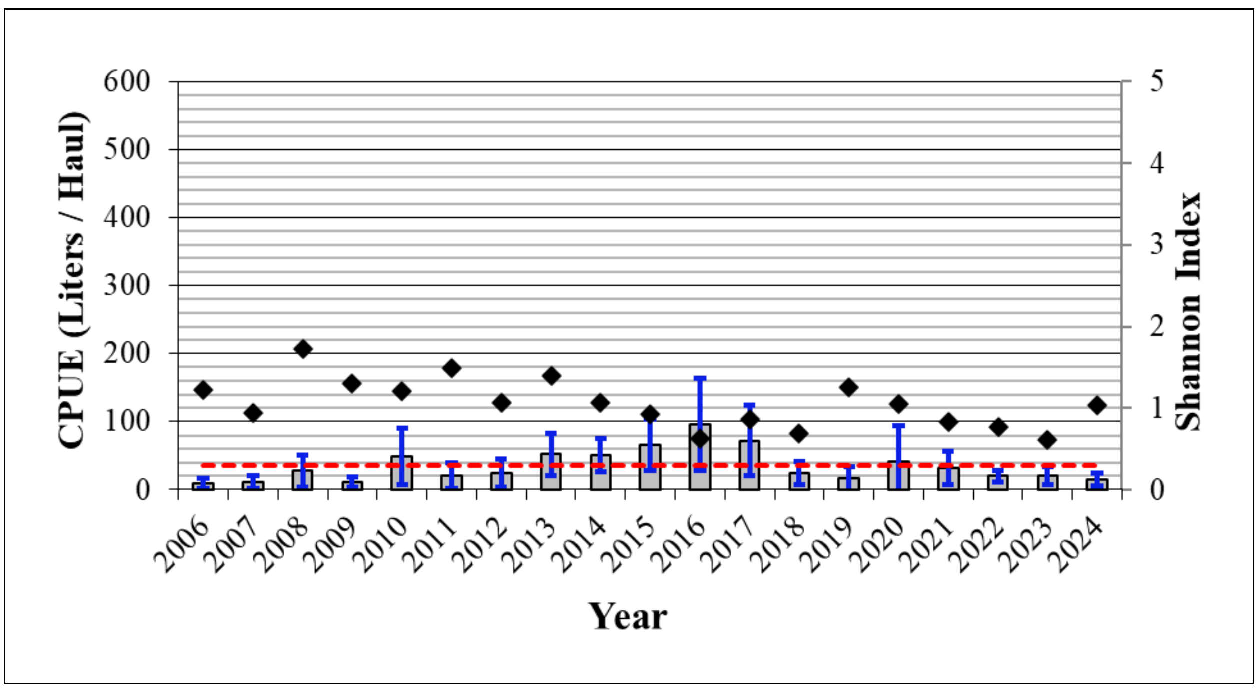

Figure 1.25. Coastal bays beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006 - 2024). Red line represents the 2006 - 2024 time series CPUE grand mean (n = 38/year). Black diamond represents the Shannon index of diversity.

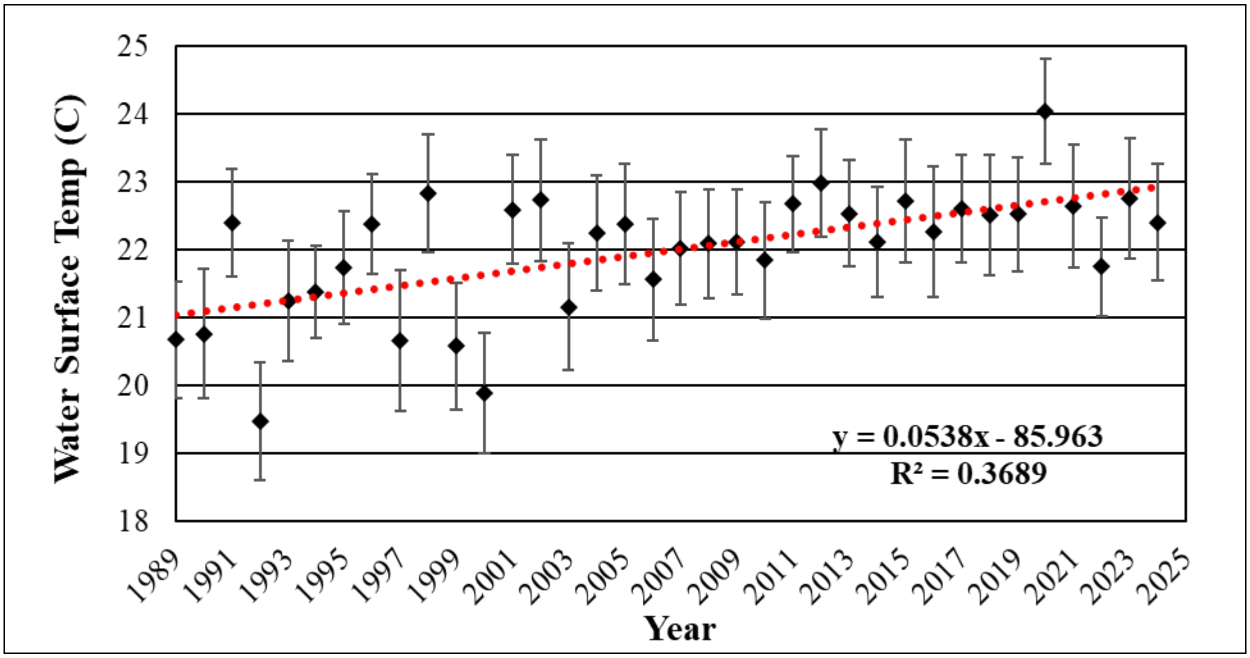

Figure 1.26. Distribution of annual (April - October) mean surface water temp (C) with 95% confidence intervals from the Trawl Survey (1989 - 2024).

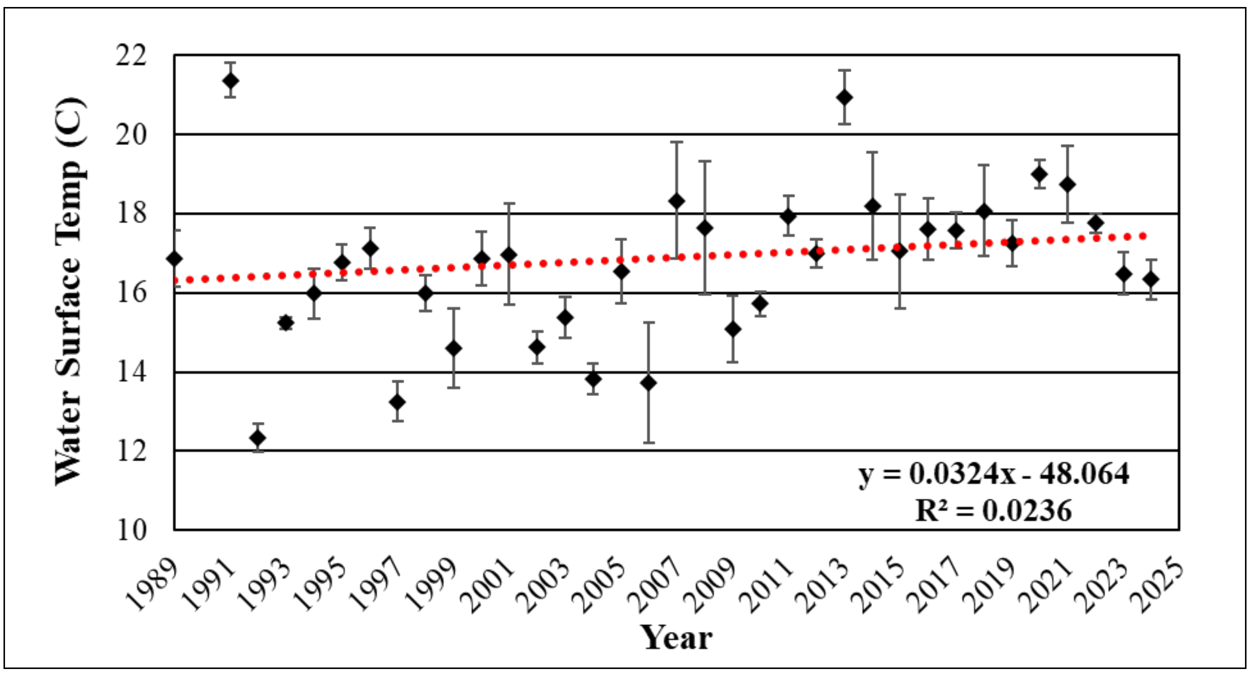

Figure 1.27. Distribution of October mean surface water temp (C) with 95% confidence intervals from the Trawl Survey (1989 - 2024).

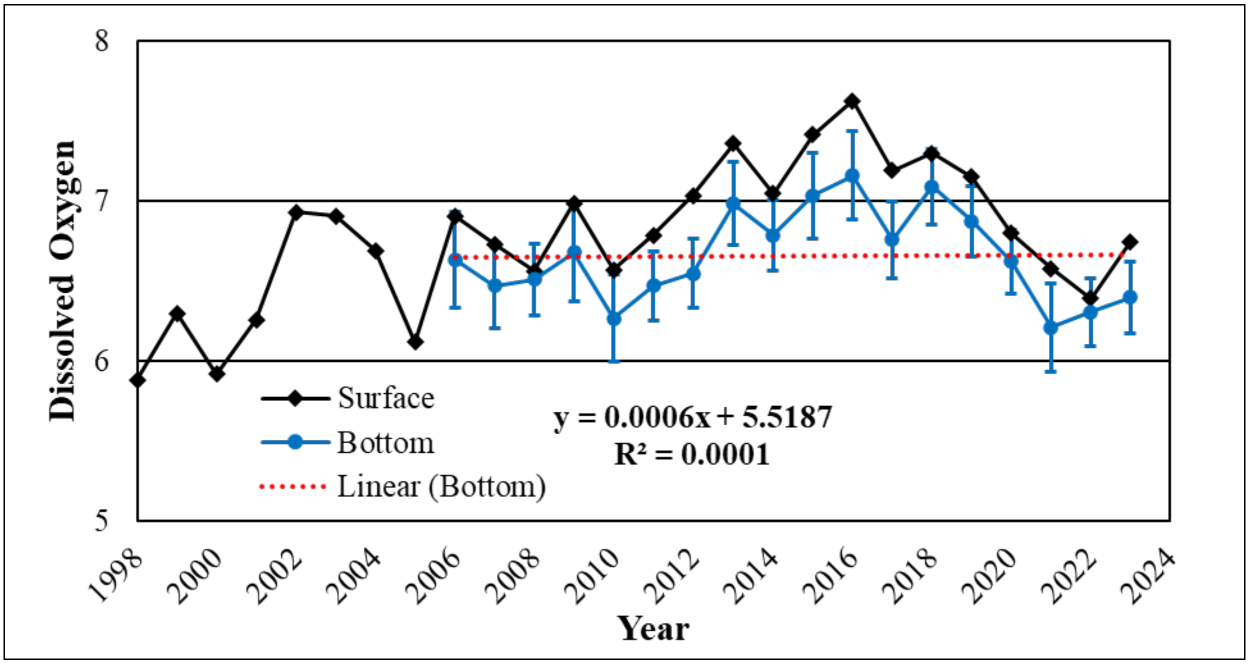

Figure 1.28. Distribution of annual (April - October) mean surface and bottom dissolved oxygen (mg/L) with 95% confidence intervals for bottom data from the Trawl Survey (1998 - 2024).

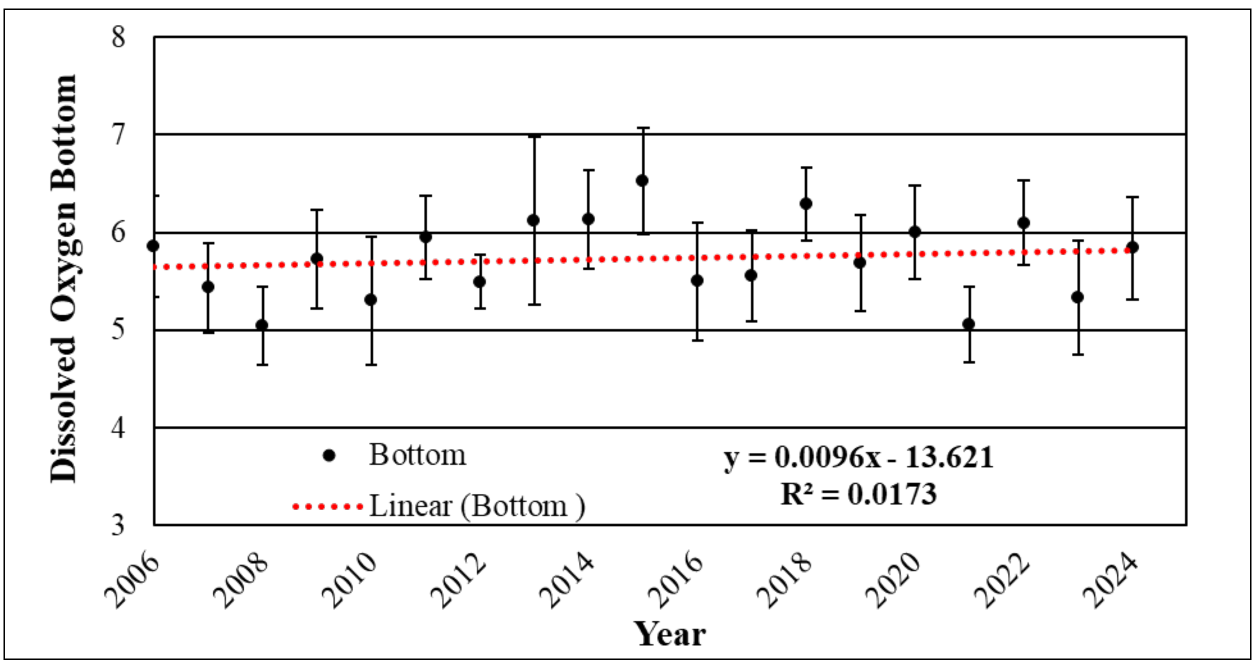

Figure 1.29. Distribution of July mean bottom dissolved oxygen (mg/L) with 95% confidence intervals from the Trawl Survey (1998 - 2024).

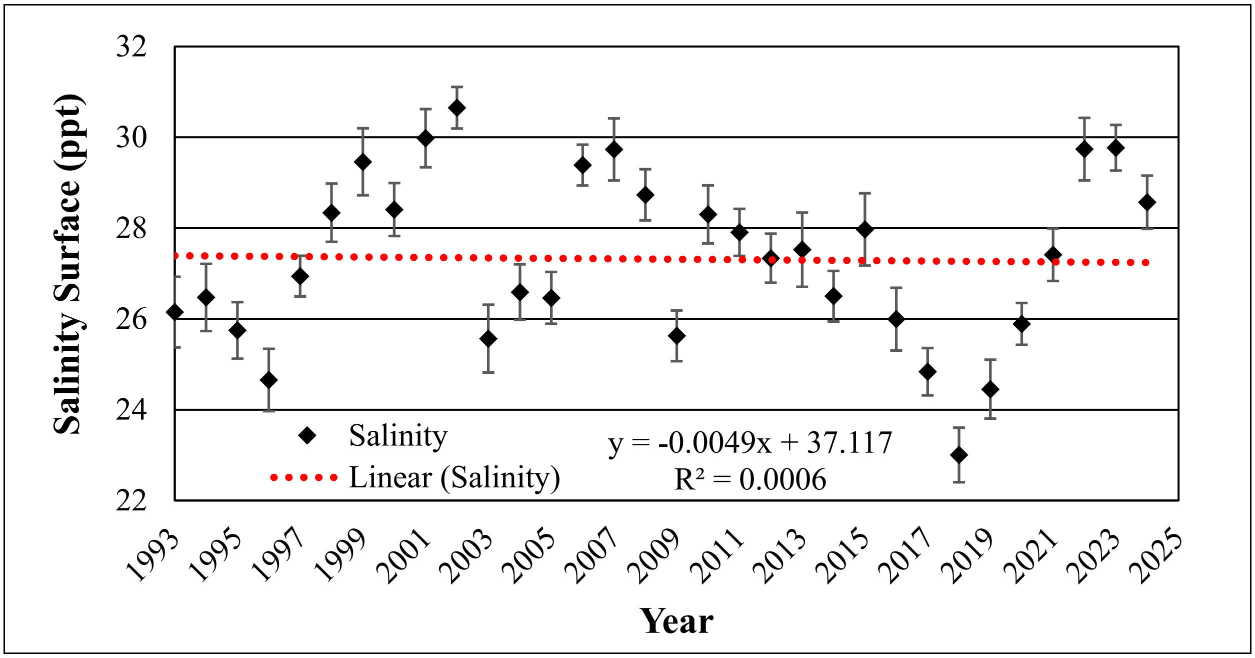

Figure 1.30. Distribution of annual (April - October) mean surface salinity with 95% confidence intervals from the Trawl Survey (1993 - 2024).

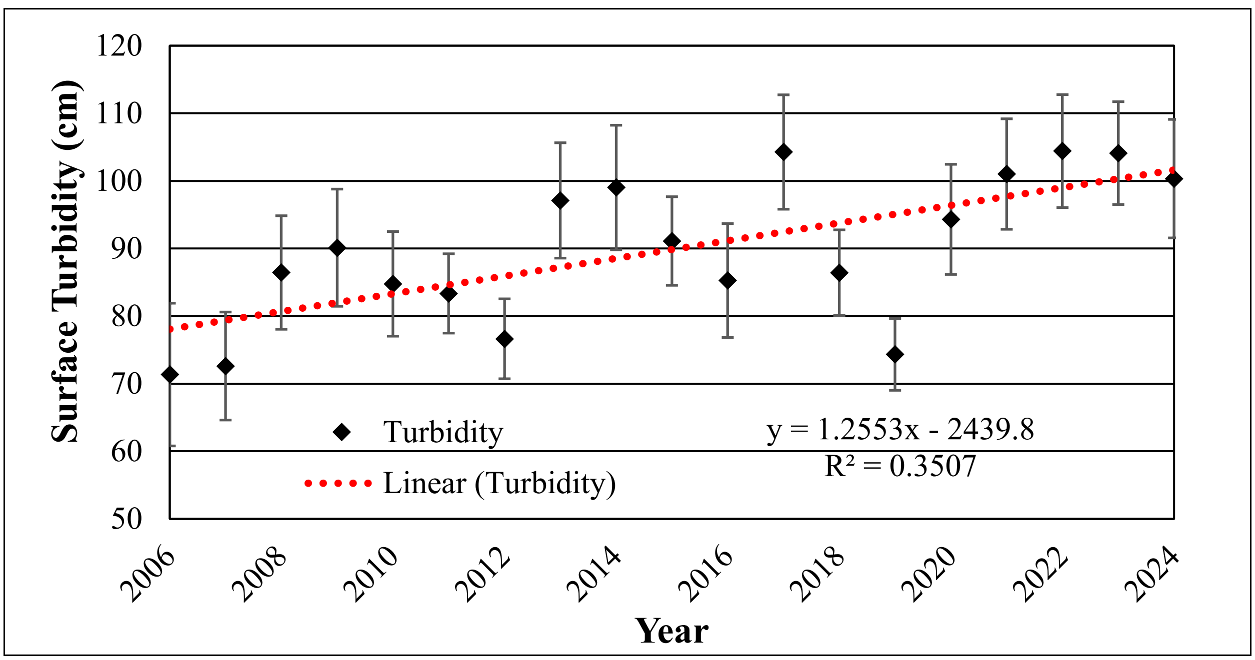

Figure 1.31. Distribution of annual (April - October) mean turbidity (cm) with 95% confidence intervals from the Trawl Survey (2006 - 2024).

Chapter 2 Submerged Aquatic Vegetation Habitat Survey

Introduction

Two species of Submerged Aquatic Vegetation (SAV) are found in Maryland's coastal bays: eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). SAV beds were found were located in Sinepuxent and Chincoteague bays. SAV species provide a wide variety of functions essential to the ecological health of the bays; foremost among them is prime nursery habitat. The young of many species depend upon the grass beds for protection and feeding at some point in their life cycle (Coastal Bays Sensitive Areas Technical Task Force, 2004). With SAV playing such a significant role in the life cycle of many fishes and its susceptibility to anthropogenic perturbations, the characterization of fisheries resources within these areas is important (Connolly & Hindell, 2006). As a result, the department began sampling SAV beds in 2012 with standardization in 2015. This survey was designed to meet the following two objectives:

1. characterize SAV habitat usage by fish assemblages in Maryland's coastal bays; and
2. incorporate the results to guide management decisions.

Methods

Sinepuxent Bay was selected in 2015 because it had the most readily available SAV beds in proximity with our established Trawl and Beach Seine surveys sites discussed in Chapter 1 (Table 2.1, Figure 2.1). Potential sites were selected when the water was clear from the boat to ensure SAV was present, when it was not possible to delineate from a boat, the vegetation was checked by a snorkeler before the beach seine haul. The SAV coverage (density), vegetative species, and bottom substrate were determined after the haul was completed. The SAV coverage was defined by quartiles and categorized as low, medium, medium-high, and high coverage.

A 25 ft C-hawk center console boat with a 250 horsepower Yamaha engine was used for transportation to sample sites during daylight in September. Latitude and longitude coordinates were used to identify sample grid locations. Visual and physical determination of the SAV percent coverage was estimated in quartiles and confirmed throughout the beach seine haul by two staff. A GPS was used to obtain coordinates at the start and stop points of each beach seine haul. Water quality and physical characteristics were collected using the same method and parameters described in Chapter 1.

The SAV beach seine with a zippered bag measured 15.24 m X 1.8 m X 6.4 mm mesh (50 ft X 6 ft X 0.25 in mesh). Staff estimated the percentage of net open, and a rangefinder was used to quantify the 35-meter seine hauls. Staff ensured that the lead line remained on the bottom until the catch was enclosed in the bag. Samples were processed using the same methods described in Chapter 1.

Data Analysis

The Generalized Linear Model (GLM) procedure, and post hoc Duncan's Multiple Range Test (DMRT) were used to measure and compare relative abundance and size variation of fish and crustacean communities within different SAV beds. The maximum alpha value of 0.05 was used for all tests. Fish diversity was calculated using the Shannon index. An annual index of relative abundance was developed using the geometric mean and confidence intervals calculated as the antilog [$\log_e$-mean (x + 1)] and antilog [$\log_e$-mean (x + 1) ± standard error * (t value: $\alpha = 0.05$, n

- 1)], respectively. A geometric grand mean was calculated for the time series (2015 - 2024) and used as a point estimate for comparison to the annual (2024) estimate of relative abundance. Catch per unit of effort (CPUE) was calculated as number of individuals per beach seine haul and could be further normalized for survey comparisons per hectare with some caution based on catchability of different gear types. The area swept for this survey was estimated as 0.04004919 ha/seine haul. The Beach Seine Survey was estimated as 0.0906704 ha/seine haul, and the Trawl Survey was 0.125415 ha/trawl.

Results and Discussion

Sample Size and Distribution

These results were based on all samples collected in Sinepuxent Bay in early September from 2015 - 2024 (Table 2.1, Figure 2.1). In 2024, sixteen samples stratified by SAV coverage were collected within four sampling grids. Over time, widgeon grass beds were more difficult to locate than eelgrass, resulting in an uneven sample distribution regarding seagrass species as a dependent variable (Table 2.2). Therefore, only richness and diversity were calculated by seagrass species, and while widgeon grass has not been sampled since 2019, these data clearly demonstrated the value of this habitat. Over time, SAV coverage quadrants were unpredictable to determine ahead of sampling because SAV beds gradually shifted in both location and coverage and typically were not consistent across the area swept with well-defined edges. Therefore, targeting SAV beds with at least medium-high coverage provided flexibility when encountering sparse areas and bare patches of sand during the haul. The survey year 2019 had 42% (8/19) of the samples in low SAV coverage. While these low coverage samples were informative regarding the seagrass edges that were transitioning to mud and sand habitats, they were not the focus of the survey. It should be noted that other agencies have defined SAV density/coverage as barren/sparse (1 - 10% cover), low (11 - 25%), moderate (26 - 50%), and high (> 50%) (USACE, 2016) The SAV Habitat Survey data could be easily transformed to those definitions because the survey's low coverage samples were all above the 11% threshold and should not be considered as barren/sparse SAV habitat as defined in the Joint Federal Agency Submerged Aquatic Vegetation Survey Guidance for the New England Region, 2016.

Abundance by Habitat Category

The survey's 2024 sampling collected 30 fishes and 2,692 fish (Table 2.3). The most abundant species were Atlantic silverside (*Menidia menidia*), silver perch (*Bairdiella chrysoura*), bay anchovy (*Anchoa mitchilli*), and tautog (*Tautoga onitis*). Species present for the first time in this survey in 2024 were Atlantic thread herring (*Opisthonema oglinum*), rough silverside (*Membras martinica*), orange filefish (*Aluterus schoepfii*), mummichog (*Fundulus heteroclitus*), and trunkfish (*Lactophrys trigonus*). The most abundant crustaceans were blue crab (*Callinectes sapidus*) and grass shrimp (*Palaemon sp*.) (Table 2.4).

Over the time series, a total of 59 fishes and 22,267 fish were collected (Table 2.3). In 2024, Tautog relative abundance (6.4 fish/haul) was above the time series mean (6.1 fish/haul). Atlantic silverside (95.5 fish/haul) was above the time series mean (57.9 fish/haul). Bay anchovy (6.8 fish/haul), sheepshead (0.2 fish/haul), black sea bass (*Centropristis striata*) (1.6 fish/haul), and pigfish (*Orthopristis chrysoptera*) (0.3 fish/haul) were all below the time series means (Table 2.3).

Relative abundance comparisons among the three independent surveys using area swept was not straight forward due to gear bias (e.g. gear size, catchability); therefore, fish per haul was used to calculate CPUE. This comparison of abundance across the three surveys during September from 2015 - 2024 clearly showed more tautog, black sea bass, and sheepshead in SAV habitat (Table 2.5). Sheepshead relative abundance in the time series was driven by the strong-year class observed in 2021. An area swept comparison, rather than fish/haul, could have doubled or tripled the magnitude of abundance for these fishes in SAV because the effort (area swept) was the least in the SAV Habitat Survey.

GLM results comparing fishes' relative abundance among the SAV coverage quadrats showed significant results for pinfish ($F_{3,164} = 4.2$, $p < 0.01$), and tautog ($F_{3,164} = 3.2$, $p < 0.05$). The GLM results also showed insignificant F-values for black sea bass, pigfish, sheepshead, silver perch, blue crab, and grass shrimp. Duncan's Multiple Range Test results showed significant results of higher relative abundance within high coverage SAV for tautog. Non-significant results indicated a higher abundance of black sea bass, pigfish, sheepshead, silver perch, and grass shrimp within medium - high SAV coverage (Table 2.6). These results show that SAV habitat is essential to sustain juvenile tautog in Maryland and the mature stock in the Delmarva management region.

In preparation for the next Atlantic States Marine Fisheries Commission regional tautog benchmark stock assessment, indices of relative abundance using geometric means, 95% confidence intervals and a calculated grand mean were provided. This analysis was also calculated for black sea bass and sheepshead because they showed higher relative abundance within SAV (Figure 2.2, Figure 2.3, Figure 2.4). The tautog relative abundance was above the time series grand mean in 2024, with the 2022 year class remaining the strongest in the time series. Black sea bass relative abundance was equal to the grand mean in 2024, and 2021 remained the highest in the time series. The sheepshead indices had a unimodal distribution when abundance peaked in 2021, it was below the grand mean in 2024. The overall increase in juvenile tautog abundance may be a direct result from the 45 day fishing season spawning closure that started in 2019, and the availability of SAV habitat. While black sea bass and sheepshead were more abundant in SAV, they were also present and abundant in other habitat types that provided some structure such as macroalgae and natural contour lines sampled by the other surveys.

Fish Species Richness and Diversity by Habitat Category

Fish richness (number of species) was generally high (59 fishes total, 27 average per year) throughout the time series. Silver perch, Atlantic silverside, and tautog were the most frequently caught fishes. Silver perch were present in 95% (157/165) of the beach seine hauls throughout the survey, and in 100% of the hauls in 2024 (16/16). Atlantic silverside were present in 81% (134/165) of the beach seine hauls throughout the survey, and 100% of the hauls in 2024 (16/16). Tautog were present in 69% (114/165) of the beach seine hauls throughout the survey, and in 100% of the hauls in 2024 (16/16). Over the time series, richness was the highest in medium - high SAV coverage (48 fishes) while diversity was highest in medium SAV coverage (H = 1.8). These rankings remain the same for eelgrass beds, which were in most of the samples, while widgeon grass showed more richness and diversity in lower coverage than eelgrass. (Table 2.7) (Table 2.8).

Fish Length Composition by SAV Coverage

Relationships of total length and SAV coverage were investigated for significant interactions. Black sea bass, silver perch, and tautog were selected for GLM and DMRT analysis (Table 2.9). Results indicated significant differences in length for silver perch ($F_{3,3222} = 47.1$ $p < 0.001$) and tautog ($F_{3,1001} = 20.5$, $p < 0.001$). The black sea bass results were not significant. Silver perch were larger in low coverage SAV beds. Tautog were the largest in medium - high and high SAV and smaller in the low coverage categories. Denser SAV coverage may be more suitable tautog habitat for growth and protection as size selective predation influences natural mortality (Meekan & Fortier, 1996) (Searcy & Sponaugle, 2001) (Bergenius, Meekan, Robertson, & McCormick, 2002) (Grorud-Colvert & Sponaugle, 2006) (Searcy, Eggleston, & Hare, 2007).

Water Quality

These data were taken annually in September in depths of less than four feet. The tidal flushing, wave action and shallow depths allowed and provided for productive water habitat throughout the survey. Water temperature, salinity, DO, turbidity, and pH results showed significant interannual variation and were within acceptable limits for Mid-Atlantic fishes and forage crustaceans (2015 - 2024).

The water temperature GLM results comparing annual means across the time series indicated significant interannual variability ($F9,164 = 87.6$, $p < 0.0001$). Results showed five temperature regimes, with 2024 the coolest in the survey. The 2015 - 2024 linear regression results showed no predictive relationship ($R2 = 0.08$) (Figure 2.5. Distribution of surface water temperature from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).

Salinity GLM results comparing annual means across the time series indicated significant interannual variability ($F9,164 = 521.37$, $p < 0.001$). The linear regression results showed no predictive relationship ($R2=0.16$) (Figure 2.6. Distribution of surface salinity from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).
Figure 2.6).

Dissolved oxygen GLM results comparing annual means across the time series indicated significant interannual variability ($F_{9,164} = 22.26$, $p < 0.001$). The linear regression results showed a weak relationship ($R^2 = 0.03$) and a slight negative slope. In 2018, high water temperatures coincided with the lowest levels of dissolved oxygen in the survey (Figure 2.7).

Water clarity GLM results comparing annual means across the time series indicated significant interannual variability ($F_{9,164} = 18.78$, $p < 0.0001$). The linear regression analysis showed a weak-medium relationship ($R^2 = 0.35$) of improvement over time (Figure 2.8). Deeper sunlight penetration was a benefit to SAV, as many samples had the Secchi disk was on the bottom.

This was the third year (2024) of monitoring pH in these surveys. The results were slightly alkaline. The range of values in the time series were 7.79 to 8.65. In 2024, the pH range among the samples was 7.79 to 8.05.

Table 2.1. Sinepuxent Bay Submerged Aquatic Vegetation Habitat Survey site descriptions, location and frequency (2015 - 2024).

Grid Number	Site Description	Latitude	Longitude	Number of Samples
092	Between Eagles Nest and OC Airport; W side of channel	38 18.263	75 06.987	8
095	SAV beds vicinity Castaways, West of Tiki Bar	38 17.980	75 07.311	12
096	SAV beds vicinity Castaways Jackspot Waterfront Tiki bar	38 18.019	75 07.177	31
109	East of Snug Harbor Road, middle of Sinepuxent Bay, South of small island	38 17.622	75 07.376	4
120	East of Gray's Cove and south of Frontier Town	38 17.130	75 07.724	3
121	East of Snug Harbor, west of small island	38 17.221	75 07.651	27
122	East of Snug Harbor, west of small island; pulled towards the south	38 17.167	75 07.523	6
126	Northeast of Day Marker #13	38 17.114	75 07.734	5
127	Southeast of Devils Island, near channel edge on east side of marsh	38 17.075	75 07.793	4
128	South of duck blind, east of green marker	38 17.061	75 07.659	22
160	700 meters northeast of Potfin Road along the shoreline	38 15.900	75 08.761	21
212	South of Verrazano Bridge, west of Sandy Point Island; on channel edge	38 14.295	75 09.404	9
217	Northwest shoreline along Rum Point	38 14.116	75 10.160	3
221	Southwest of small island, south of Verrazano Bridge	38 14.147	75 09.402	9
227	Southwest shoreline along Rum Point	38 13,953	75 10.217	1
				Total 165

Table 2.2. Submerged Aquatic Vegetation Habitat Survey sample size by percent coverage and dominate SAV species (2015 - 2024).

	Percent SAV Coverage					
	Low < 25%	Medium 26 - 50%	Medium - High 51 - 75%	High 76 - 100%	Total by Characteristic	Grand Total
Eelgrass (*Zostera marina*)	14	30	44	50	138	165
Widgeon grass (*Ruppia maritima*)	8	8	7	4	27	

Table 2.3. List of fishes collected from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).

Specimen Name	2015 - 2024 (n = 165)			2024 (n = 16)		
	Count	x̄ CPUE	x̄ length	Count	CPUE	x̄ length
Atlantic silverside (*Menidia menidia*)	9,553	57.9	84	1528	95.5	87
Silver perch (*Bairdiella chrysoura*)	8,068	48.9	84	664	41.5	93
Tautog (*Tautoga onitis*)	1,004	6.1	80	102	6.4	71
Sheepshead (*Archosargus probatocephalus*)	463	2.8	72	3	0.2	57
Striped anchovy (*Anchoa hepsetus*)	447	2.7	81			
Black sea bass (*Centropristis striata*)	437	2.6	98	25	1.6	87
Pigfish (*Orthopristis chrysoptera*)	311	1.9	81	5	0.3	33
Halfbeak (*Hyporhamphus unifasciatus*)	258	1.6	146			
Dusky pipefish (*Syngnathus floridae*)	239	1.4	149	45	2.8	148
Northern pipefish (*Syngnathus fuscus*)	216	1.3	175	71	4.4	179
Pinfish (*Lagodon rhomboides*)	215	1.3	122	2	0.1	116
Bay anchovy (*Anchoa mitchilli*)	181	1.1	66	109	6.8	65
Spotfin mojarra (*Eucinostomus argenteus*)	139	0.8	81			
Spot (*Leiostomus xanthurus*)	108	0.7	127	33	2.1	122
Striped blenny (*Chasmodes bosquianus*)	108	0.7	65			
Oyster toadfish (*Opsanus tau*)	103	0.6	81	2	0.1	155
Rough silverside (*Membras martinica*)	51	0.3	74	51	3.2	74
Bluespotted cornetfish (*Fistularia tabacaria*)	41	0.2	319	10	0.6	293
Northern puffer (*Sphoeroides maculatus*)	37	0.2	128			
Summer flounder (*Paralichthys dentatus*)	31	0.2	183	2	0.1	157
Striped burrfish (*Chilomycterus schoepfii*)	28	0.2	167	1	0.1	204
Gray snapper (*Lutjanus griseus*)	24	0.1	76			
Lined seahorse (*Hippocampus erectus*)	22	0.1	109	6	0.4	101
Spotfin butterflyfish (*Chaetodon ocellatus*)	20	0.1	59			
Atlantic needlefish (*Strongylura marina*)	16	0.1	295	3	0.2	363
Atlantic menhaden (*Brevoortia tyrannus*)	12	0.1	113	1	0.1	100
Gag (*Mycteroperca microlepis*)	12	0.1	127	9	0.6	119
White mullet (*Mugil curema*)	12	0.1	168	2	0.1	121
Rainwater killifish (*Lucania parva*)	9	0.1	43			
Feather blenny (*Hypsoblennius hentz*)	8	0.0	62			

Table 2.3 continued. List of fishes collected from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).

Specimen Name	2015 - 2024 (n = 165)			2024 (n = 16)		
	Count	x̄ CPUE	x̄ length	Count	CPUE	x̄ length
Lookdown (*Selene vomer*)	8	0.0	92	2	0.1	105
American eel (*Anguilla rostrata*)	7	0.0	318			
Spotted seatrout (*Cynoscion nebulosus*)	7	0.0	116	1	0.1	52
Bluefish (*Pomatomus saltatrix*)	6	0.0	120			
Naked goby (*Gobiosoma bosc*)	6	0.0	37			
Inshore lizardfish (*Synodus foetens*)	5	0.0	138			
Northern sennet (*Sphyraena borealis*)	5	0.0	92	3	0.2	89
Southern kingfish (*Menticirrhus americanus*)	5	0.0	104			
Blackcheek tonguefish (*Symphurus plagiusa*)	4	0.0	81			
Northern kingfish (*Menticirrhus saxatilis*)	4	0.0	125			
Orange filefish (*Aluterus schoepfii*)	4	0.0	151	4	0.3	151
Striped mullet (*Mugil cephalus*)	4	0.0	180			
Atlantic croaker (*Micropogonias undulatus*)	3	0.0	57			
Black drum (*Pogonias cromis*)	3	0.0	134			
Mummichog (*Fundulus heteroclitus*)	3	0.0	79	3	0.2	79
Atlantic spadefish (*Chaetodipterus faber*)	2	0.0	83			
Conger eel (*Conger oceanicus*)	2	0.0	220			
Short bigeye (*Pristigenys alta*)	2	0.0	63	2	0.1	63
Smallmouth flounder (*Etropus microstomus*)	2	0.0	64	1	0.1	68
Southern stingray (*Dasyatis americana*)	2	0.0	420			
Striped bass (*Morone saxatilis*)	2	0.0	481			
Atlantic thread herring (*Opisthonema oglinum*)	1	0.0	110	1	0.1	110
Cobia (*Rachycentron canadum*)	1	0.0	147			
Harvestfish (*Peprilus paru*)	1	0.0	30			
Skilletfish (*Gobiesox strumosus*)	1	0.0	46			
Smooth puffer (*Lagocephalus laevigatus*)	1	0.0	78			
Spanish mackerel (*Scomberomorus maculatus*)	1	0.0	170			
Striped killifish (*Fundulus majalis*)	1	0.0	107			
Trunkfish (*Lactophrys trigonus*)	1	0.0	12	1	0.1	12

Table 2.4. List of forage crustaceans collected from the Sinepuxent Bay Submerged Aquatic Vegetation Habitat Survey (2015 - 2024). Catch per unit of effort (CPUE) was calculated as fish/haul.

Specimen Name	2015 - 2024 (n =165)			2024 (n = 16)		
	Count	x̄ CPUE	x̄ length	Count	CPUE	x̄ length
Blue crab (*Callinectes sapidus*)	4,728	28.7	97.2	101	6.3	85.9
Grass shrimp (*Palaemon sp.*)	2,602	15.7		28	1.8	
Brown shrimp (*Penaeus aztecus*)	772	4.7	92.5	0		

Table 2.5. September species abundance survey comparisons in Maryland's coastal bays (2015 - 2024). Catch per unit of effort (CPUE) was calculated as fish per beach seine or fish per trawl.

Specimen Name	SAV Habitat Survey September n = 165		Beach Seine Survey September n = 190		Trawl Survey September n = 200	
	Count	x̄ CPUE	Count	x̄ CPUE	Count	x̄ CPUE
Atlantic silverside (*Menidia menidia*)	9,533	57.0	16,567	87.2	21	0.1
Silver perch (*Bairdiella chrysoura*)	8,068	48.9	5,597	29.5	2,139	10.7
Tautog (*Tautoga onitis*)	1,004	6.1	20	0.1	6	0.0
Sheepshead (*Archosargus probatocephalus*)	463	2.8	217	1.1	6	0.0
Striped anchovy (*Anchoa hepsetus*)	447	2.7	1,749	9.2	219	1.1
Black sea bass (*Centropristis striata*)	437	2.6	34	0.2	114	0.6
Pigfish (*Orthopristis chrysoptera*)	311	1.9	301	1.6	61	0.3
Pinfish (*Lagodon rhomboides*)	215	1.3	332	1.7	53	0.3
Bay anchovy (*Anchoa mitchilli*)	181	1.1	21,791	114.7	7,307	36.5
Spot (*Leiostomus xanthurus*)	108	0.7	2,920	15.4	5,148	25.7
Summer flounder (*Paralichthys dentatus*)	31	0.2	330	1.7	179	0.9
Atlantic menhaden (*Brevoortia tyrannus*)	12	0.1	39,188	206.3	103	0.5
Atlantic croaker (*Micropogonias undulatus*)	3	0.0	37	0.2	53	0.3
Blue crab (*Callinectes sapidus*)	4,728	28.7	4,192	22.1	2,689	13.4
Grass shrimp (*Palaemon sp.*)	2,602	15.8	3,569	18.8	383	1.9
Brown shrimp (*Penaeus aztecus*)	772	4.7	511	2.7	849	4.2
White shrimp (*Penaeus setiferus*)	62	0.4	877	4.6	1,336	6.7

Table 2.6. Submerged Aquatic Vegetation Habitat Survey (2015 - 2024) Generalized Linear Model and Duncan's multiple range test for relative abundance (fish/haul) by quartile SAV coverage (results greater than 0.05 were not significant (n.s.)).

Specimen Name	Percent SAV Coverage: Low < 25%	Medium 26 - 50%	Medium - High 51 - 75%	High 76 - 100%
Black sea bass (*Centropristis striata*)	$(F_{3,164} = 1.07$, p = n.s.)			
	$\bar{x} = 0.7$	$\bar{x} = 2.7$	$\bar{x} = 3.6$	$\bar{x} = 2.4$
	A	A	A	A
Pigfish (*Orthopristis chrysoptera*)	$(F_{3,164} = 1.48$, p = n.s.)			
	$\bar{x} = 0.3$	$\bar{x} = 2.2$	$\bar{x} = 2.4$	$\bar{x} = 1.9$
	B	A / B	A	A / B
Pinfish (*Lagodon rhomboides*)	$(F_{3,164} = 4.2, p < 0.01)$			
	$\bar{x} = 1.3$	$\bar{x} = 0.8$	$\bar{x} = 0.7$	$\bar{x} = 2.2$
	A / B	A / B	B	A
Sheepshead (*Archosargus probatocephalus*)	$(F_{3,164} = 1.70$, p = n.s.)			
	$\bar{x} = 1.0$	$\bar{x} = 1.4$	$\bar{x} = 4.4$	$\bar{x} = 3.1$
	A	A	A	A
Silver perch (*Bairdiella chrysoura*)	$(F_{3,164} = 1.14$, p = n.s.)			
	$\bar{x} = 15.6$	$\bar{x} = 49.6$	$\bar{x} = 57.7$	$\bar{x} = 53.7$
	A	A	A	A
Tautog (*Tautoga onitis*)	$(F_{3,164} = 3.2, p < 0.05)$			
	$\bar{x} = 3$	$\bar{x} = 3.6$	$\bar{x} = 6.5$	$\bar{x} = 8.7$
	B	B	A / B	A
Blue crab (*Callinectes sapidus*)	$(F_{3,164} = 0.93$, p = n.s.)			
	$\bar{x} = 19.5$	$\bar{x} = 28.1$	$\bar{x} = 27.1$	$\bar{x} = 34.3$
	A	A	A	A
Grass shrimp (*Palaemon sp.*)	$(F_{3,164} = 1.72$, p = n.s.)			
	$\bar{x} = 2.7$	$\bar{x} = 14.4$	$\bar{x} = 21.0$	$\bar{x} = 17.1$
	B	A / B	A	A / B

Table 2.7. Submerged Aquatic Vegetation Habitat Survey (2015 - 2024) richness of fishes by habitat category.

	Percent SAV Coverage			
	Low < 25%	Medium 26 - 50%	Medium - High 51 - 75%	High 76 - 100%
Combined (All SAV)	32	44	48	40
Eelgrass (*Zostera marina*)	24	38	42	38
Widgeon grass (*Ruppia maritima*)	27	26	28	15

Table 2.8. Submerged Aquatic Vegetation Habitat Survey (2015 - 2024) Shannon - Index Diversity H values of fishes by habitat category.

	Percent SAV Coverage			
	Low < 25%	Medium 26 - 50%	Medium - High 51 - 75%	High 76 - 100%
Combined (All SAV)	1.5	1.8	1.6	1.5
Eelgrass (*Zostera marina*)	1.5	2.0	1.7	1.5
Widgeon grass (*Ruppia maritima*)	1.4	1.1	1.2	1.0

Table 2.9. Results of the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024) Generalized Linear Model and Duncan's multiple range test for mean length and percent SAV coverage (results greater than 0.05 were not significant (n.s.)).

	Percent SAV Coverage			
Specimen Name	Low < 25%	Medium 26 - 50%	Medium - High 51 - 75%	High 76 - 100%
Black sea bass (*Centropristis striata*)	($F_{3,428}$ = 1.97, p = n.s.)			
	$\bar{x}$ = 86.2	$\bar{x}$ = 74.7	$\bar{x}$ = 80.8	$\bar{x}$ = 82.4
	A	A	A	A
Silver perch (*Bairdiella chrysoura*)	($F_{3,3222}$ = 47.1 p < 0.001)			
	$\bar{x}$ = 85.5	$\bar{x}$ = 78.0	$\bar{x}$ = 79.3	$\bar{x}$ = 73.1
	A	B	B	C
Tautog (*Tautoga onitis*)	($F_{3,1001}$ = 20.5, p < 0.001)			
	$\bar{x}$ = 63.7	$\bar{x}$ = 70.2	$\bar{x}$ = 79.7	$\bar{x}$ = 77.4
	C	B	A	A

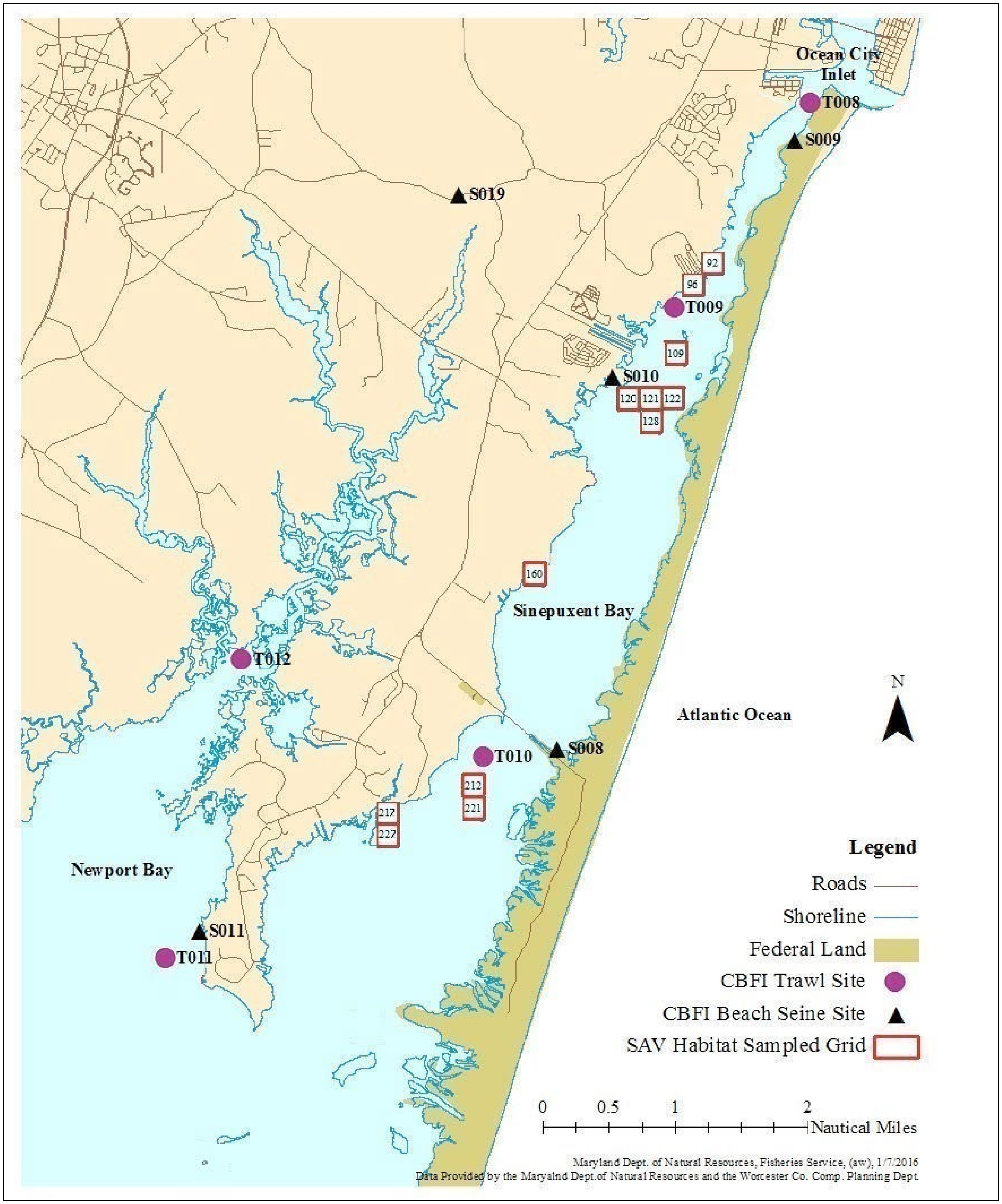

Figure 2.1. Sinepuxent Bay Submerged Aquatic Vegetation Habitat Survey and Trawl and Beach Seine surveys sample site locations (2015 - 2024).

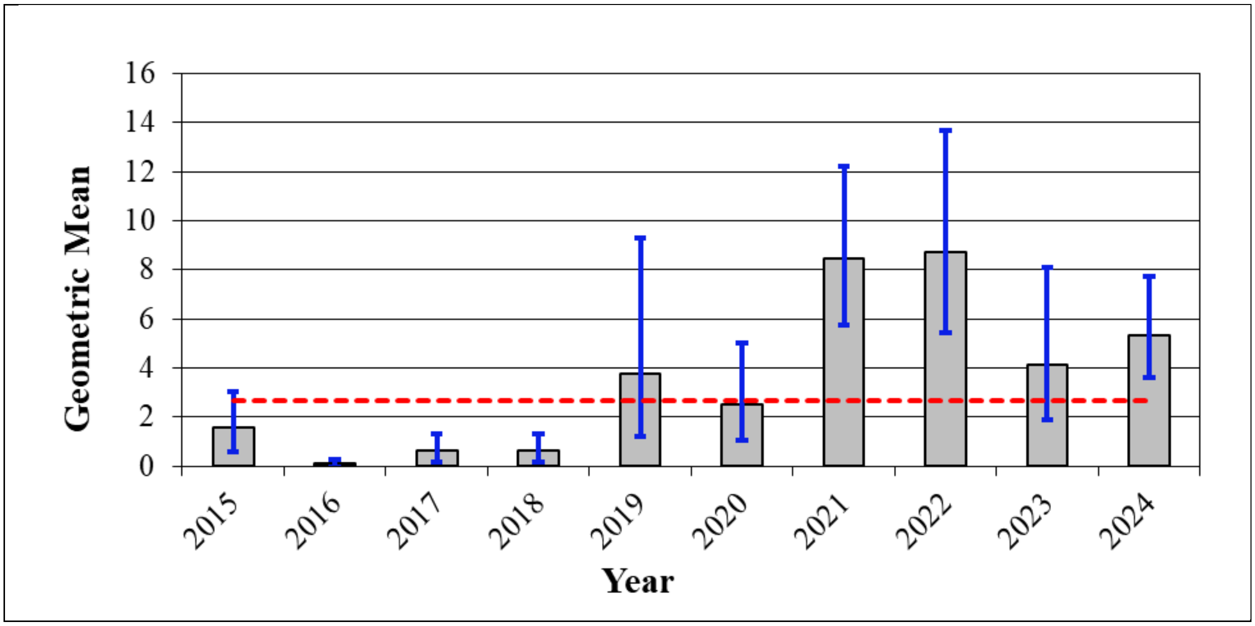

Figure 2.2. Tautog Submerged Aquatic Vegetation Habitat Survey beach seine index of relative abundance (geometric mean) with 95% confidence intervals (2015 - 2024). Dotted line represents the 2015 - 2024 time series grand mean (n = 165, average 16/year).

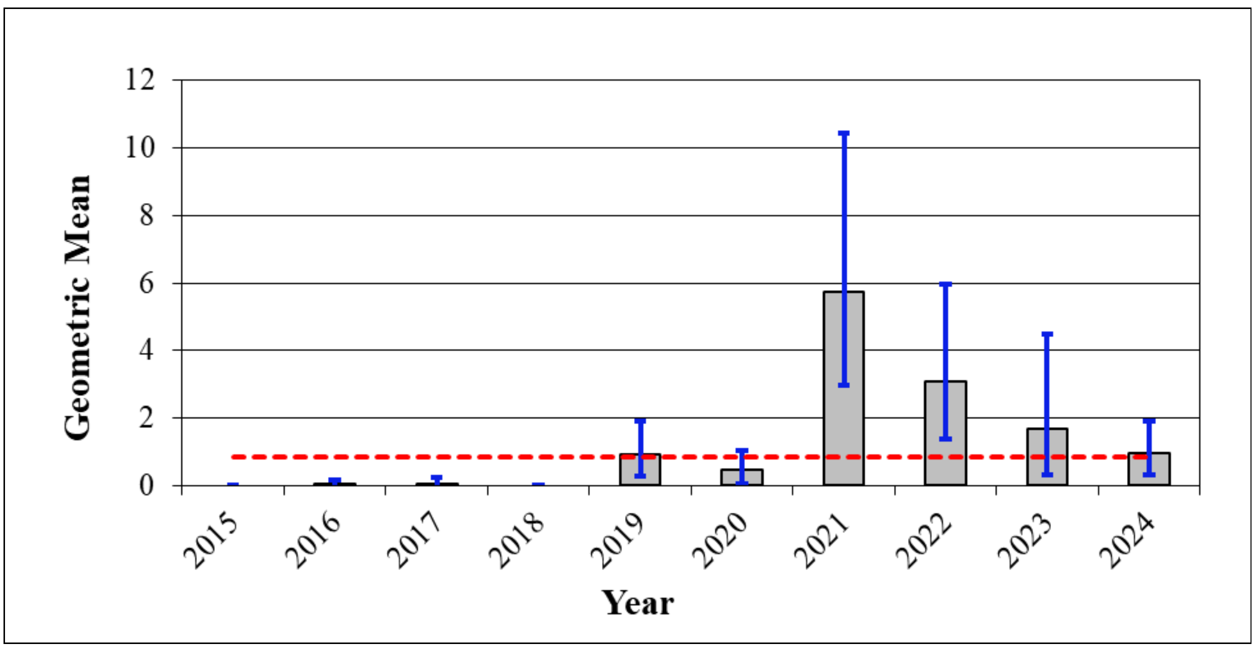

Figure 2.3. Black sea bass Submerged Aquatic Vegetation Habitat Survey beach seine index of relative abundance (geometric mean) with 95% confidence intervals (2015 - 2024). Dotted line represents the 2015 - 2024 time series grand mean (n = 165, average 16/year).

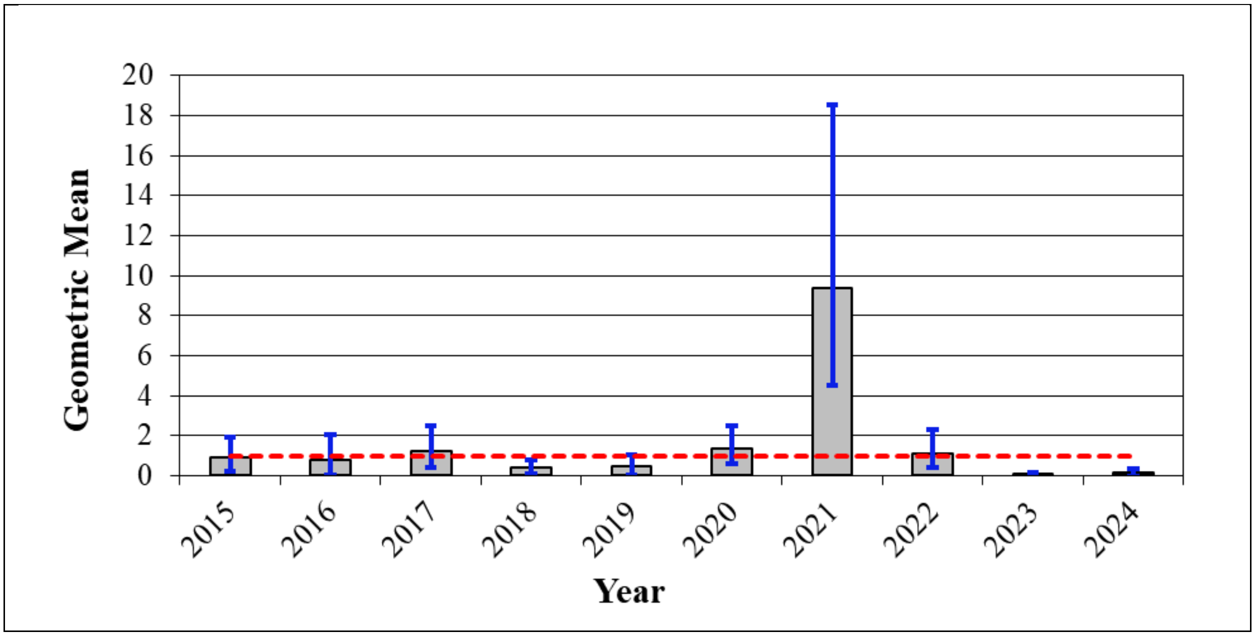

Figure 2.4. Sheepshead Submerged Aquatic Vegetation Habitat Survey beach seine index of relative abundance (geometric mean) with 95% confidence intervals (2015 - 2024). Dotted line represents the 2015 - 2024 time series grand mean (n = 165, average 16/year).

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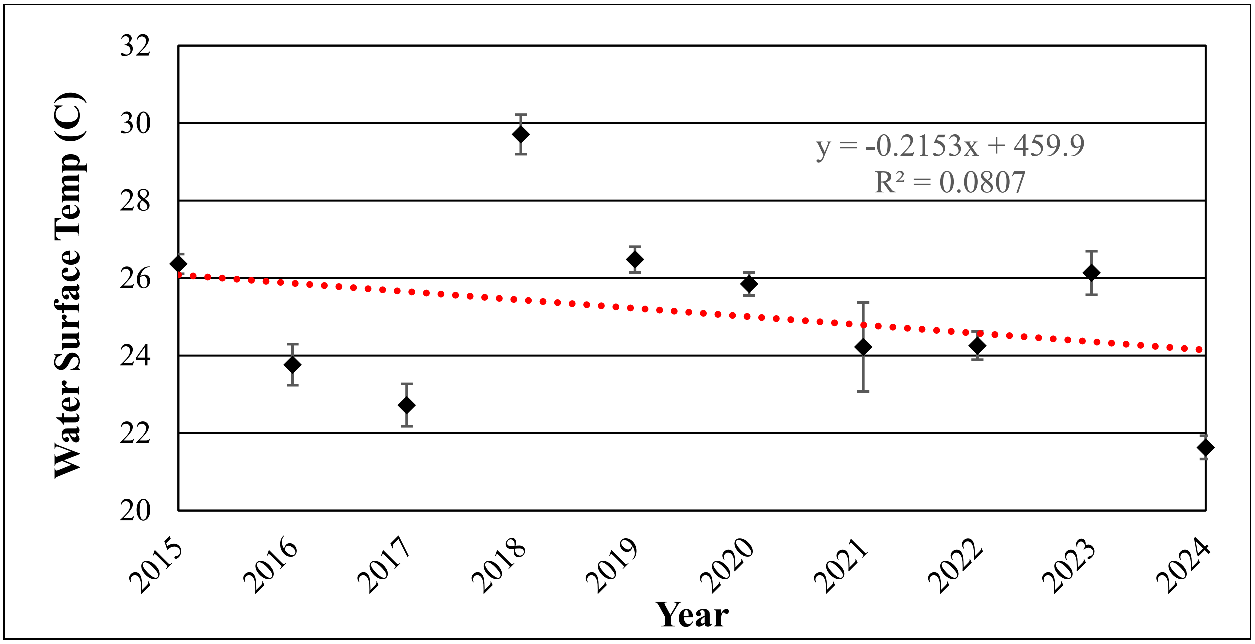

Figure 2.5. Distribution of surface water temperature from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).

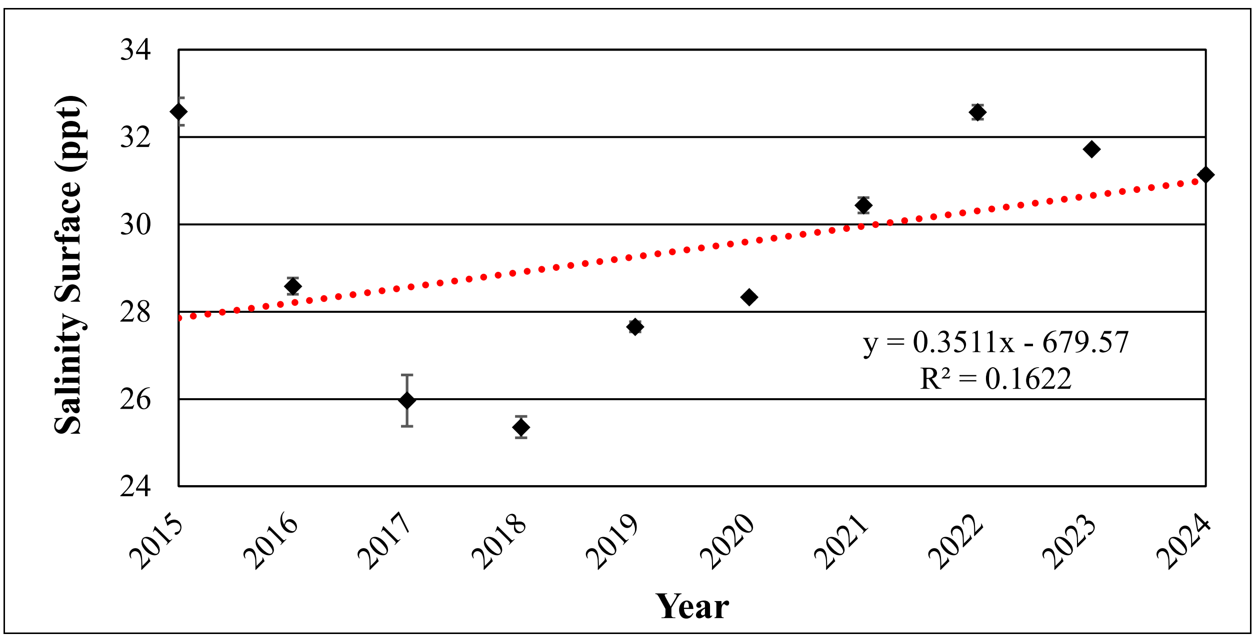

Figure 2.6. Distribution of surface salinity from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).

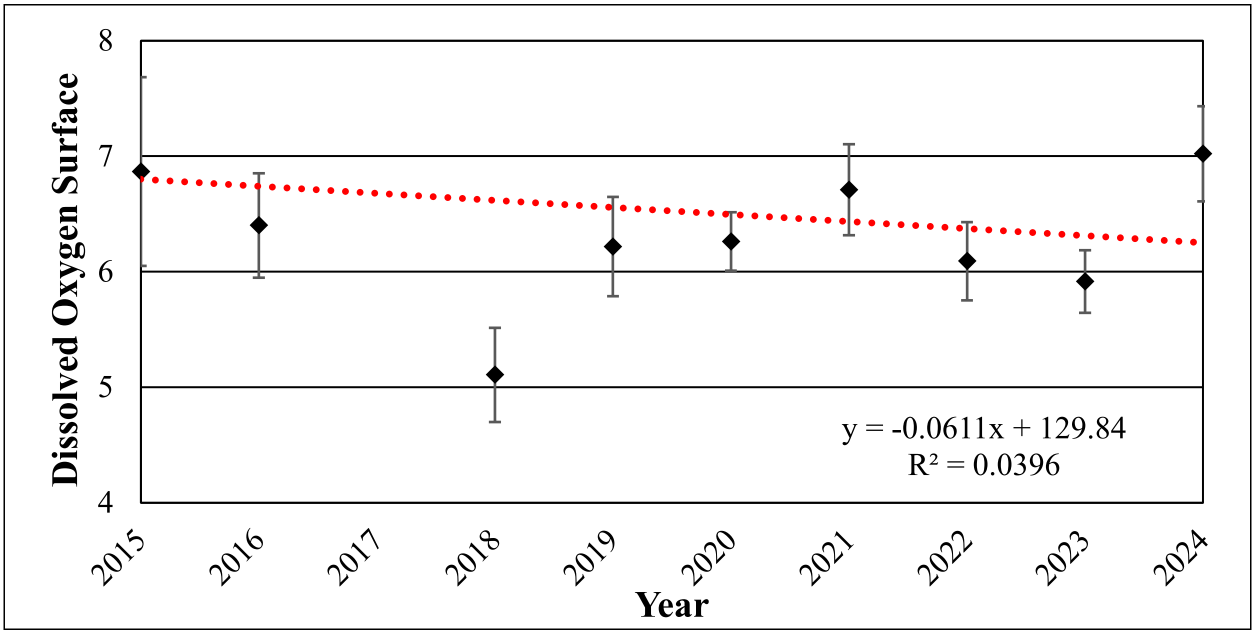

Figure 2.7. Distribution of surface dissolved oxygen from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).

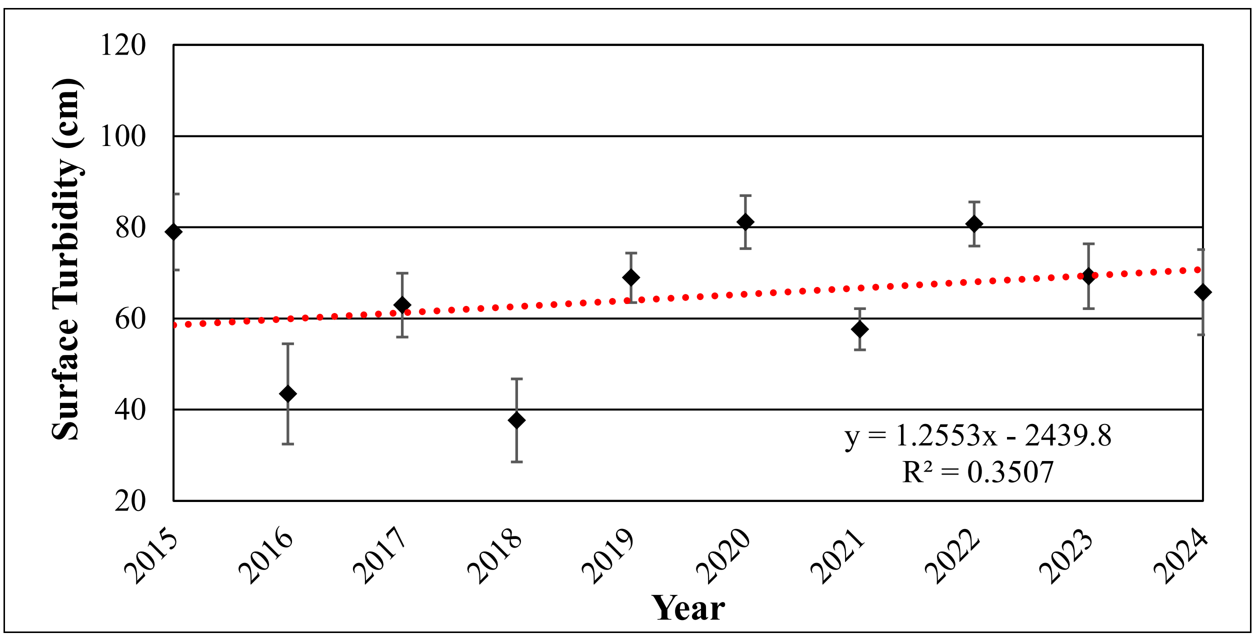

Figure 2.8. Distribution of turbidity from the Submerged Aquatic Vegetation Habitat Survey (2015 - 2024).

Chapter 3 Fisheries Dependent Tautog (*Tautoga onitis*) Data Collection (2021 - 2024)

Tautog biological collections in 2024 were obtained from seven dockside trips (80%) and one at sea charter trip (20%). Length, sex, and opercula were collected from 202 tautog. Those samples represented the range of fish lengths commonly caught in the recreational fishery in Maryland. Age data was determined on 200 tautog and were combined with the historical state data. Those were submitted to the Atlantic States Marine Fisheries Commission Tautog Stock Assessment Subcommittee for the Delmarva Regional Age Length Key.

The 2024 aged sample lengths ranged from 268 mm to 590 mm, the mean length was 420 mm, and median length was 420 mm for both sexes combined. Female fish aged comprised 67% (n = 134) and the mean length was smaller (412 mm) than the male mean length (434 mm; 33%; n = 66). Tautog were placed into one inch length bins, and the 406.4 mm/16 inch had the highest proportion (29%; Table 3.1). Tautog ages ranged from three to 17 years, the mean age was 6 years, and the median age was six years by sex and combined sexes. Age five tautog comprised 28% of the samples and was the largest age bin (Table 3.2). The age range for the recruit size tautog (406 mm/16 in) ranged from four to nine years old for both sexes.

The combined sex age frequency results from 2021 - 2024 (n = 803) included both legal and sublegal fish. These results indicated that seven year old tautog were most abundant (19.5%) in the recreational catch over that time series (Figure 3.1). The von Bertalanffy growth curve was fitted to the 2021 - 2024 length-age data using three parameter estimates (m = 3): asymptotic length in centimeters (Linf ∞), growth rate (K), and age at zero size (t0). The growth curve estimate results were like the previous estimates (Linf, 712.9; k, 0.10 and t0, -2.38; Figure 3.2).

Overall, the Maryland recreational tautog population has a broad range of year classes. The large variance for length at age for the tautog under age ten should continue to be monitored.

Table 3.1. Tautog proportion at length of samples collected from Ocean City, Maryland (2024; n = 200). Red cells indicate undersized fish (> 406.4 mm/16 in).

Length (mm)	254	279.4	304.8	330.2	355.6	381	406.4	431.8	457.2	482.6	508	533.4	558.8	584.2	609.6	*Over*
Length (in)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Percent	0	4	4	5	1.5	3	29	27	11.5	6.5	4.5	3.5	0	0.5	0	0

Table 3.2. Tautog proportion at age of samples collected from Ocean City, Maryland (2024; n = 200).

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	*Over*	17
Percent	0	1	9	28	21	17	12	6	2	3.5	0	0	0		0.5

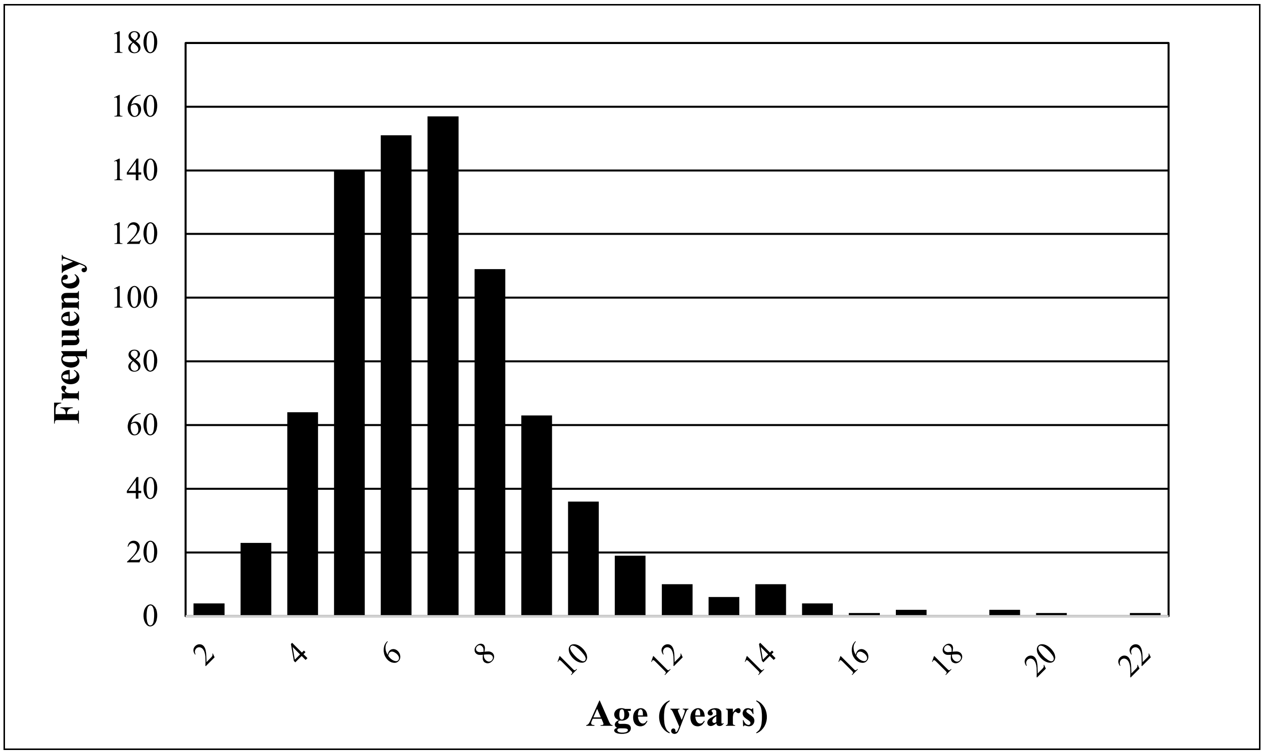

Figure 3.1. Tautog age frequency representing fish commonly caught in the recreational fishery in Ocean City, Maryland, (2021 - 2024; n = 803).

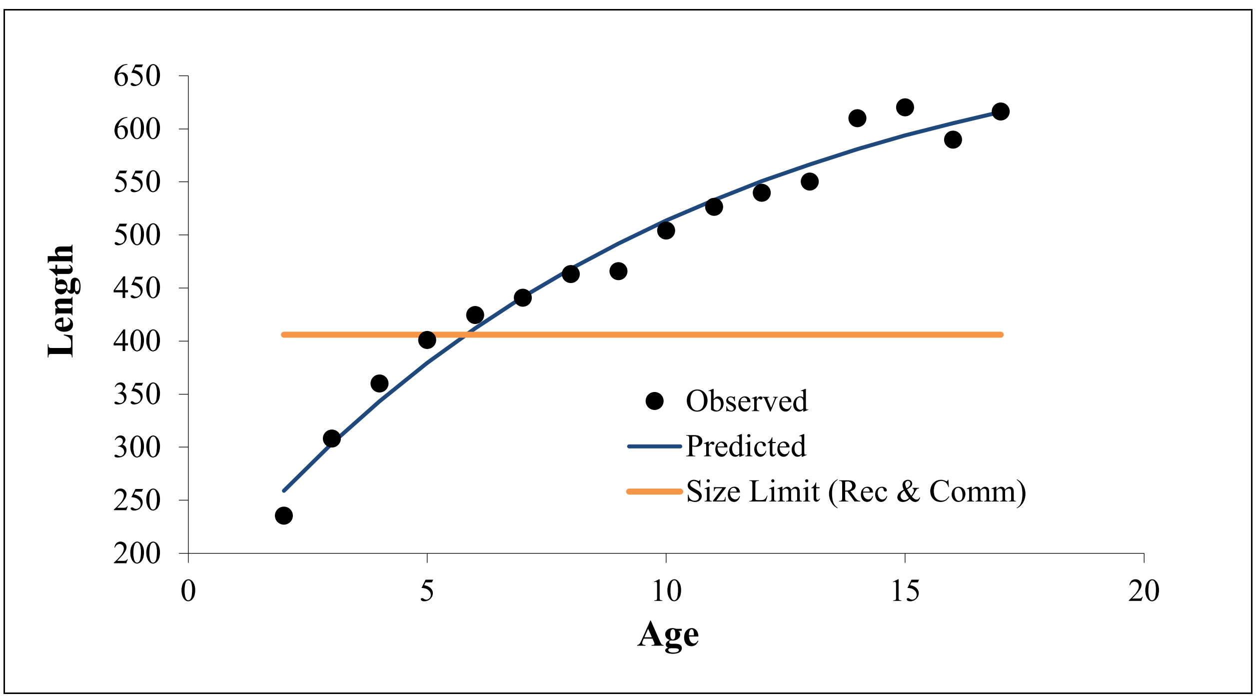

Figure 3.2. Tautog length-at-age and von Bertalanffy growth curve results with 95% confidence intervals, Ocean City, Maryland (2021 - 2024; n = 803).

Chapter 4 Technical Assistance

One of the grant objectives was to contribute technical expertise and field observations from surveys to various research and management forums regarding finfish species found in the Maryland coastal bays and near shore Atlantic waters. With the passage of the Atlantic Coastal Fisheries Cooperative Management Act, various entities such as the Atlantic States Marine Fisheries Commission (ASMFC), Mid-Atlantic Fishery Management Council (MAFMC) and the National Marine Fisheries Service (NMFS) require stock assessment information to assess management measures.

Direct participation by Survey personnel as representatives to these various management entities provided effective representation of Maryland interests through the development, implementation, and refinement of management options for Maryland as well as coastal fisheries management plans. In addition, survey information was used to formulate management plans and provided evidence of compliance with state and federal fisheries management plans. A summary of participation and contributions are presented in Table 4.1.

Table 4.1. Summary of technical assistance for July 1, 2024 - June 30, 2025.

Data Requested	Committee Participation F-50 Support	Data included in the ASMFC Compliance Report	ASMFC Compliance Report F-50 Support	Data Provided for Assessment/Update	Data Provided to Researchers
Atlantic croaker		Trawl	Yes		
Atlantic menhaden		Trawl			
Black drum		Beach Seine	Yes	Considered	
Black sea bass	ASMFC/MAFMC	Trawl/Beach Seine	Yes	Yes	
Bluefish		Trawl/Beach Seine	Yes		
Coastal sharks	ASMFC		Yes		
Cobia		Trawl/Beach Seine	Yes		
Pinfish		Trawl			Yes
Horseshoe Crab	ASMFC	Trawl/Beach Seine		Yes	Yes
Longfin Squid		Trawl			Yes
Scup	ASMFC/MAFMC		Yes		
Spot		Trawl/Beach Seine	Yes		
Spotted seatrout		Beach Seine	Yes		
Summer flounder	ASMFC/MAFMC	Trawl/Beach Seine	Yes	Yes	

Tautog	ASMFC	Trawl/Beach Seine/SAV Habitat/Dependent Collection	Yes		
Weakfish		Trawl	Yes	Yes	
Other Technical Committee Expertise					
ASMFC, Northeast Area Monitoring and Assessment Program					
National Estuary Program, Maryland Coastal Bays Program Science and Technical Advisory Committee					
National Oceanic and Atmospheric Administration Highly Migratory Species Advisory Panel					

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