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

2014 Final Report




Prepared by:
Linda Barker,
Steve Doctor,
Carrie Kennedy,
Gary Tyler,
Craig Weedon, and
Angel Willey

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Prepared By: ____
Carrie Kennedy, Principal Investigator, Manager Coastal Program Date

Approved By: ____
Tom O'Connell, Director, Fisheries Service Date

Approved By: ____
Anissa Walker, Appointing Authority Date

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The Coastal Bays Fisheries Investigation has been sampling fishes in the Coastal Bays for 42 years. Although the survey began in 1972, it did not have dedicated funding until 1989. Consistent funding allowed staff to specifically dedicate time and make improvements to the sampling protocol that resulted in significant beneficial contributions to the fisheries of the Coastal Bays. We would like to thank the past and present staff that dedicated their careers to the Coastal Bays Fisheries Investigation for having the knowledge, initiative, and dedication to get it started and maintained. Additionally, staff of the Coastal Fisheries Program would like to thank all of the Maryland Department of Natural Resources (MDNR) Fisheries Service employees who assisted with the operations, field work, and annual reports over the years whether it was for a day or a few months. We would also like to extend our gratitude to the numerous volunteers from outside MDNR who assisted with field collection work over the years.

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Preface

Analyses of the Coastal Bay Fisheries Investigations (CBFI) Trawl and Beach Seine Survey data revealed seasonal and temporal biases in the data collection (1972-1988) which significantly effected the analyses of the overall time series dataset (1972-present). These biases resulted from prioritization of resources by the Maryland Department of Natural Resources coupled with limited staff availability and lack of funding prior to 1989.

Beginning in 1989, this survey was performed following a standardized sampling protocol, eliminating the biases of previous years. This report highlights trends resulting from data collected during the standardized (1989-present) time period. No historical data (1972-1988) are included in these analyses.

In 2006, modifications to the sampling protocol were implemented. Changes included:

- using a standardized datasheet;
- collecting GPS coordinates at each sample;
- using a depth finder;
- collecting bottom water quality and using an anemometer;
- identifying macroalgae, sponges, and bryozoans and estimating their percent of the total volume collected per sample;
- measuring the first 20 individuals of all fishes;
- labeling estimates of counts and volume;
- measuring the total volume of comb jellies;
- estimating the percent opening of the beach seine;
- identifying the bottom type at beach seine sites;
- developed a field identification guide of fishes and invertebrates; and
- began a voucher collection. A voucher collection review occurs annually at the beginning of each sampling season.

Beginning in 2010, field data sheets were reviewed by a biologist that did not record the data after the sample workup was completed to reduce errors. The verification process includes checking for completeness, appropriate common names, legibility, and confusing information.

Beginning in 2008, all data from the Trawl, Beach Seine, and Drop Net Surveys were incorporated into a centralized database developed by MDNR Information Technology Services staff. Previously, these data were housed in Dbase, MS Excel, or MS Access. During 2009, all data imported into the new CBFI database from 1989 to the present were verified and cleaned using the original field sheets or related transcribed copies from that time. Since 2009, data from 1972, 1988-1978 have also been verified. Species codes were eliminated and common names plus the ITIS scientific name were used to ensure correct species identification. Additionally since 2009, current data were verified by someone that did not enter the data into the database.

The SAV Habitat Survey was added to the CBFI in 2012. After the 2012 pilot year, the number of monthly samples was reduced from 16 to 12 which resulted from combining the east and west Sinepuxent Bay zones into one for 2013. Further refinements were made to the sampling approach in 2014.

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Chapter 1

Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey

Introduction:

This survey was developed to characterize fishes and their abundances in Maryland's Coastal Bays, facilitate management decisions, and protect finfish habitats. The Maryland Department of Natural Resources (MDNR) Fisheries Service has conducted the Coastal Bays Fisheries Investigations (CBFI) Trawl and Beach Seine Survey in Maryland's Coastal Bays since 1972, sampling with a standardized protocol since 1989. These gears target finfish although bycatch of crustaceans, molluscs, sponges, and macroalgae are common. This report includes data from 1989 – 2014.

Over 130 adult and juvenile species of fishes, 26 molluscs, and 20 macroalgae genera and 2 SAV species have been collected since 1972. This survey was designed to meet the following three objectives:

1. Characterize the stocks and estimate relative abundance of juvenile and adult marine and estuarine species in the Coastal Bays and near-shore Atlantic Ocean.
2. Develop annual indices of age and length, specific relative abundance and other needed information necessary to assist in the management of regional and coastal fish stocks.
3. Delineate and monitor areas of high value as spawning, nursery and/or forage locations for finfish in order to protect against habitat loss or degradation.

Methods:

Study Area

Maryland's Coastal Bays are comprised of Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, Newport Bay, and Chincoteague Bay. Also included are several important tidal tributaries: St. Martins River, Turville Creek, Herring Creek, and Trappe Creek. Covering approximately 363 km^2 (140 mi^2), these bays and associated tributaries average only 0.9 m (3 feet) in depth and are influenced by a watershed of only 453 km^2 (175 mi^2; MDNR 2005). The bathymetry of the Coastal Bays is characterized by narrow channels, shallow sand bars, and a few deep holes.

Two inlets provide oceanic influences to these bays. Ocean City Inlet is formed at the boundaries of south Fenwick Island and north Assateague Island and is located at the convergence of Isle of Wight Bay and Sinepuxent Bay. Chincoteague Inlet, in Virginia (VA), is approximately 56 km (34 mi) south of the Ocean City Inlet.

The Coastal Bays are separated from the Atlantic Ocean to the east by Fenwick Island (Ocean City) and Assateague Island. Ocean City, Maryland is a heavily developed commercial area and the center of a $2 billion dollar tourism industry catering to approximately 12 million visitors annually (CCMP 2005). Assateague Island is owned by the State of Maryland and the National Park Service (NPS). These entities operate one state (Assateague State Park) and two national parks (Assateague Island National Seashore and Chincoteague National Wildlife Refuge). These properties have campgrounds, small buildings, dunes, beach front with some Off Road Vehicle (ORV) access, and marshes.

The Coastal Bays western shoreline habitat consists of forest, *Spartina* spp. marshes, small islands, residential development, and marinas. Assawoman Bay is bordered by Maryland and Delaware and is characterized by farmland, *Spartina* spp. marshes, a few small islands, and commercial/residential development. Isle of Wight Bay south into Sinepuxent Bay is a heavily developed commercial/residential area. Two seafood dealers, a public boat launch, and approximately 20 to 50 transient and permanent commercial fishing vessels utilize the commercial harbor located directly west of the Ocean City Inlet. In addition to the commercial harbor, the majority of marinas in Ocean City are located in Isle of Wight Bay. Residential development expansion has begun moving south into Chincoteague Bay. Vast *Spartina* spp. marshes and numerous small islands characterize Chincoteague Bay.

Submerged Aquatic Vegetation (SAV) and macroalgae (seaweeds) are common plants in these bays that can provide habitat and foraging sites for fishes and shellfish (Beck *et al.* 2003). Two species of SAV are common in Maryland's Coastal Bays: widgeon grass, *Ruppia maritima*, and eelgrass, *Zostera marina* (MDNR 2005). Common species of macroalgae include *Chaetomorpha sp*., *Agardhiella sp*., *Gracilaria sp.*, and *Ulva sp*.

Data Collection

A 25 foot C-hawk with a 225 horsepower Evinrude E-tec engine was used for transportation to the sample sites and gear deployment. Latitude and longitude coordinates (waypoints) in degrees and decimal minutes (ddmm.mmm) were used to navigate to sample locations. A GPS was used for navigation, marking sites, and monitoring speed.

Gears

<u>Trawl</u>

Trawl sampling was conducted at 20 fixed sites throughout Maryland's Coastal Bays on a monthly basis from April through October (Table 1, Figures 1-3). With the exception of June and September, samples were taken beginning the third week of the month. In 2014, samples were taken the first week of October for weather and scheduling reasons. Sampling began the second week in June and September in order to allow enough time to incorporate beach seine collections.

The boat operator took into account 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 of greater than 1.1 m (3.5 ft). Each trawl was a standard 6-minute (0.1 hr) tow at a speed of approximately 2.5 knots. 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 determine the area swept (hectares). Time was tracked using a stopwatch, which was started at full gear deployment.

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<u>*Seine*</u>

Seines were used to sample the shallow regions of the Coastal Bays frequented by juvenile fishes. Shore beach seine sampling was conducted at 19 fixed sites beginning in the second weeks of June and September (Table 2, Figures 1-3).

A 30.5 m X 1.8 m X 6.4 mm mesh (100 ft X 6 ft X 0.25 in. mesh) bag seine was used at 18 fixed sites in depths less than 1.1 m (3.5 ft.) along the shoreline. However, some sites necessitated varying this routine to fit the available area and depth. A 15.24 m (50 foot) version of the previously described net was used at site S019 due to it is restricted sampling area. GPS coordinates were taken at the start and stop points as well as an estimated percent of net open.

Water Quality and Physical Characteristics

For each sampling method, physical and chemical data were documented at each sampling location. Chemical parameters included: salinity (ppt), temperature (°C), and Dissolved Oxygen (DO; mg/L). Physical parameters included: wind direction and speed (knots), water clarity (Secchi disk; cm), water depth (ft), tide state, and weather condition. Data were recorded on a standardized project data sheet printed on Rite in the Rain All Weather paper (Appendices 1 and 2).

Salinity, water temperature, and DO were taken with a Yellow Springs Instrument (YSI) YSI Pro2030 at two depths, 30 cm (1 foot) below the surface and 30 cm (1 foot) from the bottom, at each trawl site. The YSI cord was marked in 1 ft intervals and the probe had a weight attached to it. The weight was used to keep the probe at the proper depth and as vertical as possible. Chemical data were only taken 30 cm below the surface for each seine site due to the shallow depth (<1.1 m). The YSI 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 the user 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 seine sites, depth was estimated by the biologists pulling the seine. Wind speed measurements were acquired using a La Crosse handheld anemometer with digital readout. Measurements were taken facing into the wind. Tidal states were from the GPS tide feature or occasionally estimated by checking the published tide tables for the sampled areas. Difficulties determining tide resulted from inlet influences in Ocean City, MD and Chincoteague, VA, wind driven tidal influences, and lack of appropriate tide stations at some sites.

Sample Processing

Fishes and invertebrates were identified, counted, and measured for Total Length (TL; Table 3) using a wooden millimeter (mm) measuring board with a 90 degree right angle. A meter stick was used for species over 500 mm. At each site, a sub-sample of the first 20 fish (when applicable) of each species were measured and the remainder counted. On occasion, invertebrate species counts were estimated.

Blue crabs were measured for carapace width, sexed, and maturity status was determined. Sex and maturity categories included: male, immature female, mature female (sook), and mature female with eggs. A subsample of the first 50 blue crabs at each site was measured and the rest were counted. Sex and maturity status of non-sub-sampled blue crabs were not recorded.

Jellyfishes, ctenophores, bryozoans, sponges, SAV and macroalgae were measured volumetrically (liters, L) using calibrated containers with small holes in the bottom to drain the excess water. Small quantities (generally ≤ 10 specimens) of invertebrates were occasionally counted. Slightly larger quantities of invertebrates were sometimes visually estimated. Bryozoans and macroalgae were combined for one volume measurement and a biologist estimated the percentage of each species in the sample.

Unknown species were placed in Ziploc bags on ice or kept in a bucket of water and taken to the office for identification. Rare, uncommon, and unrepresented species were fixed and preserved for the voucher collection that was started in 2006 (Appendix 3).

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 and biological significance as forage for adult gamefish and indicators of water quality. Species rarely encountered and/or not considered recreationally important, including forage significance, were removed from the analyses.

The Geometric Mean (GM) was calculated to develop species specific annual trawl and beach seine indices of relative abundance (1989-2014). 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 seine. The GM was calculated from the $\log_e(x+1)$ transformation of the catch data and presented with 95% Confidence Intervals (CIs; Ricker 1975). The GM and CIs 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 (1989-2014) and used as a point estimate for comparison to the annual (2014) estimate of relative abundance.

To summarize macroalgae presence in the CBFI, statistical analyses were conducted on all species from 2006 to 2014. The measure of abundance (CPUE) for the trawl was mean liters per hectare; the seine was mean liters per haul. An analysis of variance (ANOVA) was performed to determine relationships in CPUE by year, embayment and genus. Annual

CPUE was compared to the time series grand mean and a subsequent multiple pairwise comparison of means test (Duncan's Multiple Range Test) was performed to determine differences by year and embayment. Macroalgae diversity was calculated by the Shannon-Weaver index and a Pearson product-moment correlation coefficient was performed to measure linear correlations between macroalgae and finfish abundance.

To evaluate water quality parameters observed during the CBFI, the combined average for each parameter (temperature, dissolved oxygen, salinity, turbidity) per bay (six systems) was derived from the adding together of both the surface and bottom temperature averages collected while trawling, from April to October, and calculating the mean of this total. The DO averages were reviewed to see if the system overall fell below 5.0 mg/L (critical level of hypoxia).

Results and Discussion:

Finfish were the most abundant taxa captured in the survey. Specifically, they accounted for 60,329 fish caught trawling (7,586) and beach seining (52,093 fish; Table 4) in 2014**.** The total number of fish caught was the highest in the last ten years due mostly to a large increase in the number of Atlantic menhaden collected in the seine. Without the Atlantic menhaden catch the total catch would have been average when compared to the past ten years. The trawl catch was the second lowest of the past ten years due mostly to the low numbers of spot collected in 2014. Collected fishes represented 69 species which is a normal representation of species in a year.

An above average index was produced in 2014 for Atlantic silverside in the trawl. Atlantic menhaden had a record abundance in the seine. However, the catches were located at a few sites and not spread out over a large area so the smoothing of the geometric mean produced a CPUE that was not significantly different than the geometric mean for abundance.

Below average indices were produced for black sea bass, summer flounder, spot, tautog, and winter flounder in trawl and bay anchovy, spot, tautog, and winter flounder in the seine. Nearly all other species of recreational and commercial interest had average indices of abundance.

Crustaceans were the second most abundant taxa captured in this survey. Specifically, they accounted for 10,808 specimens caught trawling (6,068 crustaceans) and beach seining (4,740) crustaceans; Table 5); estimates of these counts are included in the total numbers reported here. Blue crabs substantially increased in abundance from the year before. Fifteen crustacean species were identified, which is similar to the numbers of crustaceans found between 1989 and 2013.

The third most abundant taxa captured in the survey were molluscs. Specifically, they accounted for 530 specimens caught trawling (474 molluscs) and beach seining (56 molluscs; Table 6). Molluscs were represented by 18 different species.

Other types of animals captured trawling and beach seining included: terrapins, horseshoe crabs, ctenophores, tunicates, and sponges (Table 7). Twenty of these species were identified. In addition to animals, plants (SAV and macroalgae) were also captured in the trawls and beach seines (Table 8).

Species Results: American eel (*Anguilla rostrata*)
American eel were captured in eight of 140 trawls (5.7%) and in four of 38 beach seines (10.5%). A total of 38 American eel were collected in trawl (32 fish) and seine (6 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). American eel ranked 30th out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 1.8 fish/hectare and 0.2 fish/haul, respectively.

The indices for the 2014 trawl and seine were not significantly different the grand means (Figures 4 and 5). Since 1989, the trawl relative abundance index rarely (three years) varied from the grand mean, and the seine index also rarely (four years) varied from the grand mean.

Discussion
The abundance indices for trawl and seine not significantly different from the grand mean (1989-2014). Both gears catch a limited number of American eels and may have some value in assessing the abundance of American eel. Both the trawl and seine abundance estimates vary little from year to year. Since American eel spawn in an area north of the Bahamas known as the Sargasso Sea, environmental conditions and ocean currents may be a factor influencing relative abundance (Murdy *et al* 1997).

American eel were most frequently caught in the trawls at three sites that were close to land in protected bays or creeks. Trawl site T006, where many eels are caught, is in Turville Creek where MDNR Fisheries Service's Eel Project does an annual elver survey further up the creek from our sampling site. The elver sampling site is located at a fish ladder and prodigious numbers of elvers are captured at this site every year. We attribute the large numbers of elvers being captured at this site to a moderately sized freshwater source close to the ocean inlet. The elvers are probably drawn to this area in search of fresh water in which to grow to adulthood.

Management
American eel are managed by the State of Maryland in cooperation with Atlantic States Marine Fisheries Commission (ASMFC). Maryland's 2014 recreational American eel regulations were comprised of a 25 fish creel and a 6 inch minimum size limit (Table 9). Commercial restrictions included a six inch minimum size (Table 10). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic croaker (*Micropogonias undulatus*)
Atlantic croakers were captured in 21 of 140 trawls (15%) and in four of 38 beach seines (10.5%). A total of 158 juvenile Atlantic croakers were collected in trawl (151) and seine (7) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Atlantic croakers ranked 12th out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 8.6 fish/hectare and 0.2 fish/haul, respectively.

The 2014 trawl and seine indices were both not significantly different than the grand means (Figures 6 and 7). Since 1989, the trawl relative abundance indices frequently (12 years) varied from the grand mean.

Discussion
The abundance index for trawl was not significantly different than the grand mean. Juvenile Atlantic croakers were more frequently caught in deeper water (trawl). Therefore, trawl indices better represent a more accurate picture of changes in relative abundance when compared to beach seine indices.

Since Atlantic croakers spawn on the continental shelf, environmental conditions and ocean currents may be a factor influencing relative abundance. Winter weather conditions appear to heavily influence abundance by impacting overwintering young of the year more significantly and pushing spawning activity further south on the Atlantic coast in colder years (Murdy *et al* 1997).

Atlantic croakers were located in the relatively protected areas of Assawoman Bay, the St. Martins River, and Newport Bay. Most of the Atlantic croakers caught by the survey are very small and probably do not like the higher currents found in Sinepuxent Bay. Juvenile Atlantic croakers seem to prefer the sheltered coves and creeks, and share a similar pattern of distribution to spot and summer flounder. Atlantic croakers are a known prey item for summer flounder, and may explain the co-occurrence of these species (Latour, 2008).

Management
Atlantic croakers are managed by the State of Maryland in cooperation with ASMFC. Maryland's 2014 recreational Atlantic croakers regulations were comprised of a 25 fish creel and a 9 inch minimum size limit (Table 9). Commercial restrictions included a 9 inch minimum size and an open season year round (Table 10). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic menhaden (*Brevoortia tyrannus*)
Atlantic menhaden were captured in 7 of 140 trawls (5%) and in 19 of 38 beach seines (50.0%). A total of 43,179 Atlantic menhaden were collected in trawl (20 fish) and beach seine (43,159 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Atlantic menhaden ranked first out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 1.1 fish/hectare and 1135.8 fish/haul, respectively.

The 2014 trawl index was below the standardized grand mean and the seine index was not significantly different than the standardized grand mean (Figures 8 and 9). Since 1989, the trawl index occasionally (12 years) varied from the grand mean and beach seine index has varied ten times from the grand mean.

Discussion
The abundance index for trawl was below the grand mean and the seine index was not significantly different than the grand mean. Atlantic menhaden were caught more often in

near shore locations (beach seine). Therefore, beach seine index represent a more accurate picture of changes in relative abundance when compared to trawl indices. The large seine catch was greatly influenced by a catch of 26,020 fish at site S009 in June. Significant changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and/or overfishing.

Turville Creek is known to have high nutrient levels and may attract the prey sources of Atlantic menhaden (Maryland Department of the Environment, 2001). The beach seine site with the most abundant catch (S019) of Atlantic menhaden was located in a muddy protected creek.

Management
Atlantic menhaden are managed by the State of Maryland in cooperation with ASMFC. There was no recreational creel or size limits for this species in 2014. A harvest cap of 109,020 metric-tons was implemented in 2006 in the waters of the Atlantic Ocean, Maryland's Coastal Bays and the Chesapeake Bay (Table 10; ASMFC 2006). Recent action by ASMFC will reduce menhaden commercial harvest by 20% in coming years. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic silverside (*Menidia menidia*)
Atlantic silversides were captured in 19 of 140 (13.6%) trawls and in 29 of 38 beach seines (76.3%). A total of 3,157 Atlantic silversides were collected in trawl (169 fish) and beach seine (2,413 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Atlantic silversides ranked 3rd out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 6.9 fish/hectare and 63.5 fish/haul, respectively.

The 2014 trawl index was above the grand mean and the seine index was not significantly different than the grand mean (Figures 10 and 11). Since 1989, the trawl and seine relative indices seldom (two years trawl, five years seine) varied from the grand means.

Discussion
The abundance index for trawl was above the grand mean and the seine index was not significantly different than equal to the grand mean. Atlantic silversides were caught more frequently in near-shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices. Significant changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in species composition and habitat type. Atlantic silversides are known to be a preferred forage species for larger game fish and have been found co-occurring with spot, summer flounder, and winter flounder at multiple sites in this survey.

Management
No management plan exists for Atlantic silversides. There were no recreational or commercial fishing regulations for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Bay anchovy (*Anchoa hepsetus*)
Bay anchovies were captured in 84 of 140 trawls (60.0%) and in 15 of 38 beach seines (39.4%). A total of 7,330 bay anchovies were collected in trawl (4,887 fish) and (2,443 fish) beach seine samples collected in Maryland's Coastal Bays in 2014 (Table 4). Bay anchovies ranked 2nd out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 278.3 fish/hectare and 64.3 fish/haul, respectively.

The 2014 trawl index was not significantly different than the grand mean and the seine index was below the grand mean (Figures 12 and 13). Since 1989, the relative abundance estimates seldom (six years trawl, five years beach seine) varied from the grand means.

Discussion
The abundance index for trawl index was not significantly different than the grand mean and the seine index was below the grand mean. Bay anchovies were caught in both near-shore and open water locations indicating a wide distribution. Therefore, both indices represent an accurate picture of changes in relative abundance. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in species composition and habitat type. Bay anchovies are known to be a preferred forage species for larger game fish and have been found co-occurring with spot and summer flounder at multiple sites in this survey.

Management
No management plan exists for bay anchovies. There were no recreational or commercial fishing regulations for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Black sea bass (*Centropristis striata*)
Black sea bass were collected in 18 of 140 trawls (12.9%) and two of 38 seines (5.3%). A total of 41 juvenile black sea bass were collected in trawl (36 fish) and beach seine (5 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Black sea bass were ranked 29th out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.0 fish/hectare and 0.1 fish/haul, respectively.

The 2014 trawl index was below the standardized grand mean and the seine index was not significantly different than the standardized mean (Figures 14 and 15). Since 1989, the trawl and seine indices frequently (eight years trawl, five years beach seine) varied from the grand means.

Discussion
The 2014 trawl index was below the grand mean and the beach seine index was not significantly different than the standardized grand mean. Black sea bass are commonly caught in both gears however the trawl gear catches a few more than the seine gear so it is probably a better gear to assess black sea bass. Indices continue to be below average for black sea bass in our survey. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in species composition and habitat type.

As natural and artificial reef increase structure necessary for black sea bass habitat, there may be an increase in black sea bass recruitment to Maryland waters. Many of the preferred sites have a hard shell bottom that provided the needed habitat structure that black sea bass desire (Murdy *et al* 1997).

Management

Black sea bass are managed by the State of Maryland in cooperation with ASMFC, and the Mid-Atlantic Fishery Management Council (MAFMC). Maryland's recreational black sea bass regulations for 2014 included a 12.5 inch total length minimum size limit, 15 fish/day creel limit, and an open season from May 19 until September 21st, and October 18th through December 31st or as determined by NMFS (Table 9). Commercial restrictions included an 11 inch minimum size and required a landing permit with an associated individual fishing quota issued by the State (Table 10). Commercially licensed fishermen without a landing permit were allowed to land 50 pounds per day as bycatch. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Bluefish (*Pomatomus saltatrix*)

Bluefish were collected in six of 140 trawls (4.3%) and in 12 of 38 beach seines (31.6%). A total of 91 juvenile bluefish were collected in trawl (seven fish) and beach seine (84 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Bluefish ranked 15th out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.4 fish/hectare and 2.2 fish/haul, respectively.

The 2014 trawl and beach seine indices were both not significantly different than the grand means (Figures 16 and 17, respectively). Since 1989, the indices occasionally (four years trawl, five years beach seine) varied from the grand means.

Discussion

The 2014 trawl and beach seine indices were both not significantly different than the grand means. Bluefish were caught more frequently in near shore (beach seine) locations. Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type. Bluefish may be drawn to the abundance of forage and the higher flushing rates of the areas close to the inlet.

Management

Bluefish are managed by the State of Maryland in cooperation with ASMFC and the MAFMC. Maryland's 2014 recreational bluefish regulations were comprised of a 10 fish creel and an 8 inch minimum size limit (Table 9). Commercial restrictions included an eight inch minimum size and no seasonal closures (Table 10). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Silver perch (*Bairdiella chrysoura*)
Silver perch were collected in 37 of 140 trawls (26.43%) and 14 of 38 seines (36.8%). A total of 2,554 silver perch were collected in trawl (961 fish) and beach seine (1,593 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Silver perch ranked 4thout of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 54.7 fish/hectare and 41.9 fish/haul, respectively.

The 2014 trawl and beach seine indices were both not significantly different than the grand means (Figures 18 and 19). Since 1989, the indices occasionally (10 years trawl, 1 year beach seine) varied from the grand means, indicating some variability in abundance over the time period.

Discussion
The 2014 trawl index and the beach seine indices were both not significantly different than the grand means. Silver perch were caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance. Since silver perch spawn offshore, environmental conditions including global weather patterns, and ocean currents may be a factor influencing relative abundance (Murdy *et al* 1997). Silver perch were widely dispersed in the Coastal Bays. This indicates that most of the habitat of the Maryland Coastal Bays is favorable nursery habitat for this species.

Management
In the mid-Atlantic, silver perch are not managed. There were no recreational or commercial fishing regulations for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Spot (*Leiostomus xanthurus*)
Spot were collected in 15 of 140 trawls (10.7%) and 15 of 38 seines (39.5%). A total of 263 spot were collected in trawl (36 fish) and beach seine (227 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Spot ranked 8thout of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.0 fish/hectare and 6.0 fish/haul, respectively.

The 2014 trawl and beach seine indices were both below the grand means (Figures 20 and 21). Since 1989, the indices frequently (24 years trawl, 19 years beach seine) varied from the grand means, indicating variability in abundance over the time period.

Discussion
The 2014 trawl index and the beach seine indices were both below the grand means. Spot were caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance. Spot drive the total number of fish caught by trawl in a given year so a low catch of spot is reflected in the low total number of fish captured by trawl in 2014. Since spot spawn offshore, environmental conditions including global weather patterns, and ocean currents may be a factor influencing relative abundance (Murdy *et al* 1997). Spot were widely dispersed in the

Coastal Bays. This indicates that most of the habitat of the Maryland Coastal Bays is favorable nursery habitat for this species.

Management
In the mid-Atlantic, spot were managed by the State of Maryland in cooperation with ASMFC. There were no recreational or commercial fishing regulations for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Summer flounder (*Paralichthys dentatus*)
Summer flounder were collected in 64 of 140 trawls (45.7%) and 17 of 38 seines (44.7%). A total of 331 Summer flounder collected in trawl (233 fish) and beach seine (98 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Summer flounder ranked 7th out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 13.3 fish/hectare and 2.6 fish/haul, respectively.

The 2014 trawl index was below the grand mean and the seine index was not significantly different than the grand mean (Figures 22 and 23, respectively). Since 1989, the trawl index frequently (13 years) varied from the grand mean and the seine index rarely (six years) varied from the grand mean.

Discussion
The 2014 trawl index was below the grand mean and the seine index was not significantly different than the grand mean. Summer flounder are caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data, although not to the extent of some other species like Atlantic croakers and weakfish. Summer flounder are pelagic spawners, so they may have been subject to environmental conditions that may have affected spawning and juvenile success. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in forage species composition and habitat type. Summer flounder were ubiquitous throughout the Coastal Bays, which illustrates their quality as habitat for summer flounder.

Management
Summer flounder are managed by the State of Maryland in cooperation with ASMFC and the MAFMC. Maryland's 2014 recreational summer flounder regulations were comprised of a 4 fish creel and 16.0 inch minimum size limit. The season was open year round (Table 9). Commercial restrictions included a 14 inch minimum size for all gears with the exception of hook-and-line which had size regulations consistent with recreational measures (Table 10). Permitted fishermen in the Atlantic Ocean and Coastal Bays can harvest 5,000 pounds per day while non-permitted fishermen can land 100 or 50 pounds per day in the Atlantic/Coastal Bays and Chesapeake Bay, respectively. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Tautog (*Tautoga onitis*)
Tautogs were captured in zero of 140 trawls (0%) and in zero of 38 seines (0%; Table 4).

The trawl and seine indices for 2014 were below the grand means (Figures 24 and 25). Since 1989, the relative abundance estimates occasionally (six years trawl, six years seine) varied from the grand mean.

Discussion
The abundance indices for trawl and seine were both below the grand means. Sporadic catches indicate that this survey may not be an effective means for determining tautog juvenile abundance. Juvenile tautogs prefer submerged aquatic vegetation (SAV), and adult tautogs prefer structured habitat. The gear used in the CBFI survey, and our survey locations, are not suited to those habitats. However, our survey in past years indicate a site preference for seine sites in the northern bays when they are present, and this may be the preferred habitat for tautog in the Maryland Coastal Bays.

Management
Tautogs are managed by the State of Maryland in cooperation with ASMFC. Maryland's 2014 recreational tautog regulations were comprised of a 16 inch minimum size limit and a four fish creel from January 1st to May 15th and November 1 through November 30, and a two fish creel from May 16th to October 31st. Tautog fishing is closed in Maryland for the month of December (Table 9). Commercial restrictions are consistent with recreational regulations (Table 10).

In 2014, a benchmark stock assessment was performed that indicated a need to evaluate the stock on a regional basis. In all regions, tautog were overfished, however, in the DelMarVa region overfishing was not occurring. There are no biological surveys currently being conducted in our region targeting tautog but the Coastal Fisheries Program does age and growth sampling from the recreational head boat fleet.

Species Results: Weakfish (*Cynoscion regalis*)
Weakfish were collected in 30 of 140 trawls (21.4%) and one of 38 seines (2.6%). A total of 515 juvenile weakfish were collected in trawl (513 fish) and beach seine (five fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Weakfish ranked 6th out of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 29.2 fish/hectare and <0.1 fish/haul, respectively.

The 2014 trawl and seine indices were not significantly different than the grand means (Figures 25 and 26, respectively). Since 1989, the relative abundance trawl estimates occasionally (nine years) varied from the grand mean.

Discussion
The 2014 seine and trawl indices were not significantly different than the grand means. Weakfish were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data. Weakfish are considered depleted but not overfished. The recent declines appear

to be due to natural mortality (NEFC 2009). Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type. Weakfish were located in all bays indicating a broad range of distribution in the Coastal Bays. They show a particular affinity to trawl sites in Assawoman Bay and the St. Martin's River.

Management

Weakfish are managed by the State of Maryland in cooperation with ASMFC. Maryland's 2014 recreational weakfish regulations were comprised of a one fish creel and a 13 inch minimum size limit (Table 9). Commercial regulations in 2014 restricted fisherman to a 12 inch minimum size and included an array of season closures dependent upon the type of gear used and body of water being fished (Table 10). The commercial fishery is managed as a bycatch fishery with a 100 pounds catch limit on the Atlantic coast and a 50 pound limit on the Chesapeake Bay. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Winter flounder (*Pseudopleuronectes americanus*)

Winter flounder were collected in 7 of 140 trawls (5.0%) and four of 38 seines (10.5%). A total of 26 winter flounder were collected in trawl (14 fish) and beach seine (12 fish) samples conducted on Maryland's Coastal Bays in 2014 (Table 4). Winter flounder ranked 33rdout of 69 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.8 fish/hectare and 0.31 fish/haul, respectively.

The 2014 trawl and beach seine indices were both below the grand means (Figures 27 and 28). Since 1989, the indices occasionally (eight years trawl, seven years beach seine) varied from the grand means, indicating variability in abundance over the time period.

Discussion

The 2014 trawl index and the beach seine indices were both below the grand means. Winter flounder were caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance. Since winter flounder spawn offshore, environmental conditions including global weather patterns, and ocean currents may be a factor influencing relative abundance (Murdy *et al* 1997).

Management

Winter flounder are not managed by the State of Maryland. There were no recreational or commercial fishing regulations for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Additional Discussion on Habitat Preference by Bay

Catch per unit effort by trawl was compared by bay for differences in abundance. The northern and southern bay sites were grouped together and Sinepuxent Bay was kept separate. The northern bays typically had the greatest CPUE throughout the time series followed by the southern bays. Sinepuxent Bay had the lowest CPUE in most years. This agrees with the preferred site data as well as more fish species have preferred sites in the northern bays than any other system. In most years all the bays follow similar trends, in that general increase or decrease is seen across all bays. A high CPUE or low CPUE on one bay is accompanies by a similar trend in all the bays. Long term there does not seem to be a shift in trend from one bay to another.

Northern Bays – Assawoman Bay, Isle of Wight Bay (St. Martins River)

All species had preferred sites for either trawl or seine in these bays. All sites in these bays were preferred for Atlantic croakers, bay anchovy, summer flounder, and weakfish for trawl, and winter flounder for seine. There were many preferred seine sites in these bays indicating good habitat quality in the shallow waters of the northern bays. T002 and T005 had the most species prefer these trawl sites with nine species preferring these sites. S006 was a most preferred seine sites with ten species preferring these site. The combination of the habitat type, temperature, forage, tidal current, salinities, and dissolved oxygen make this area desirable for juvenile finfish production.

Sinepuxent Bay

Atlantic silversides preferred all sites for seine samples in Sinepuxent Bay. Seine site S010 had the greatest species diversity. It is located in a shallow, muddy, protected cove which is an ideal habitat for juvenile finfish. High tidal velocities probably inhibit abundance of Atlantic croaker, Atlantic menhaden, bluefish, silver perch and weakfish in this bay's trawl sites.

Newport Bay and Chincoteague Bay

A wide variety of species had preferred sites for both trawl and seine samples in these bays, which is to be expected as the bays are large with a variety of habitats. Trawl site T012 showed the greatest trawl site fish species diversity in the southern bays with seven species preferring this site. It is a narrow gut between two marshes that funnels Trappe Creek. Seine site S012 had the most diversity of the seine sites with seven species showing a preference for the site. It has great habitat with sand beach surrounded by marsh. Seine site S017 also had seven species that preferred this site. It is located in a shallow, muddy, protected cove which is an ideal habitat for juvenile finfish. It is a location where southern stingrays are often found, as well as black drum, red drum, and spotted sea trout. Summer flounder appear to be the species that most preferred use of Newport and Chincoteague Bays as they had the most combined preferred trawl and seine sites in these bays.

Macroalgae

This time series spans nine-years from 2006 to 2014. To date, 20 genera and over 39 thousand liters of macroalgae have been collected in the Coastal Bays by the trawl and seine. Since this time series began, *Rhodophyta* (Red macroalgae) have been the dominant macroalgae in both trawl and seine collections.

The most frequently encountered genus by trawl, Agardh's red weed, has contributed 45.6% in the times series, and 55.7% in 2014 (Table 8). The 2014 trawl survey Shannon index of diversity (evenness) among genera in the Coastal Bays (H = 1.5) was similar to the time series mean, which has remained stable at around H = 1.6. The 2014 trawl CPUE (170.7 L/ha) was not different from the grand mean (223 L/ha; Figure 30).

The seine results showed that Agardh's red weed comprised 55.3% in the time series and increased to 72.4% in 2014 (Table 8). The Shannon index of diversity (evenness) among genera in the Coastal Bays seine survey did not remain stable, and decreased in 2014 (H = 1.0) from the time series (H = 1.6). The only other genera that contributed more than 5% of the sample population in 2014 were tubed weeds (11.5%). The 2014 seine CPUE (50.6 L/haul) was higher than the grand mean (28.3 L/haul; Figure 31).

The areas that comprise the Coastal Bays in this report were from north to south: Assawoman Bay, St. Martins River, Isle of Wight Bay, Sinepuxent Bay, Newport Bay and Chincoteague Bay. Over the trawl time series, mean CPUE was higher in the embayments north of Ocean City Inlet. However, these areas had lower average Shannon index values than areas south of the inlet (Figure 32). The seine time series showed a similar trend in CPUE, while the Shannon index was variable among those areas's littoral zone (Figure 33).

Assawoman Bay: This embayment has been dominated by *Rhodophyta* (Red macroalgae) since sampling began in 2006. Twelve different genera of macroalgae were collected by trawl in 2014, which was above the average (8.2) for this embayment in the time series. However, the Shannon index of diversity (evenness) among genera within this embayment in 2014 was below average (H = 0.74). The strong hold of Agardh's red weed (82%) was evident; sea lettuce (7%) and green hair algae (5.9%) were the only genera that contributed more that 5% of the sample population. Agardh's red weed had been in constant competition for dominance with graceful red weed until 2012. The following year (2013), macroalgae abundance (CPUE) was lower than the grand mean (26 L/ha vs. 718.3 L/ha). During this unstable year, sea lettuce (42.5%) and banded weeds (16.7%) competed with Agardh's red weed (33.7%), which resulted in the strong hold of Agardh's red weed and single species dominance the following year in 2014. The 2014 CPUE (296.1 L/ha) was not different from the grand mean (Figure 34).

The seine results showed the same trend as the trawl results in 2014; above the average (7.1) richness (9 genera sampled) but low diversity evenness among genera (H = 0.61). Agardh's red weed (84%) was the most abundant; sea lettuce (11.5%) was only other genera that contributed more that 5% of the sample population. The seine CPUE (83.7 L/haul) was not different from the grand mean (35.8 L/haul; Figure 35).

Isle of Wight Bay: This embayment has been dominated by *Rhodophyta* (red macroalgae) since sampling began in 2006. Eight different genera of macroalgae were collected by the trawl in 2014, which was above the average (6.7) for this embayment in the time series. However, the Shannon index of diversity among genera within this embayment in 2014 was below average (H = 0.49). The strong hold of Agardh's red weed (86.2%) was expected; sea lettuce (11.1%) was the only other genera that contributed more than 5% of the sample population. Agardh's red has been dominant since 2009, and prior to that year was in constant competition for dominance with graceful red weed. The trawl CPUE (364.2 L/ha) was not different from the grand mean (545.2 L/ha; Figure 36).

The seine results showed the same trend as the trawl in 2014 with above the average (7) richness (8 genera sampled) and average diversity evenness among genera (H = 0.96). Agardh's red weed (70.1%) was the most abundant; green tufted seaweed (14.7%) and sea lettuce (8.8%) were the only other genera that contributed more than 5% of the sample population. The 2014 seine CPUE (25 L/haul) was lower than the grand mean (63 L/haul; Figure 37).

St. Martins River: This river has been dominated by *Rhodophyta* (Red macroalgae) since sampling began in 2006, except in 2013, when *Chlorophyta* (Green macroalgae) were dominant in the deeper water sampled by the trawl. Nine different genera of macroalgae were collected by trawl in 2014, the time series average was 5.7. Shannon index of diversity among genera in 2014 was above average (H = 1.05). Agardh's red weed (22.9%) was out-competed by sea lettuce (70.7%) in 2013 which also occurred in Assawoman Bay that year, but regained dominance in 2014 (55%). Sea lettuce, reduced to (34.9%) and green haired algae (5.9%) were the only other genera that contributed more that 5% of the sample population. Trawl CPUE (92.6 L/ha) in 2014 was not different from the grand mean (134.1 L/ha; Figure 38).

The seine results revealed average richness (4 genera sampled), but overall low diversity evenness among genera (H = 0.69). Agardh's red weed (73.8%) was the most abundant and graceful red weed (23%) was the only other genera that contributed more that 5% of the sample population. The 2014 seine CPUE (160.3 L/haul) was not different from the grand mean (75.8 L/haul; Figure 39).

Sinepuxent Bay: This embayment has been dominated by *Rhodophyta* (Red macroalgae) in seven of the nine years since sampling began in 2006. *Chlorophyta* (Green macroalgae) were dominant in 2008 and 2009. Ten different genera of macroalgae were collected by trawl in 2014, which was an average richness value for this embayment in the time series. The Shannon index of diversity among genera within this embayment in 2014 was average and relatively stable (H = 1.4). Agardh's red weed (49.2%); sea lettuce (25.1%), tubed weeds (10.4%) and green hair algae (8.9%) were the only genera that contributed more that 5% of the sample population. The CPUE (22.54 L/ha) in 2014 was lower than grand mean (49.6L/ha; Figure 40).

The 2014 seine results showed average richness (8 genera sampled) and average diversity evenness among genera (H = 0.62). Agardh's red weed (86.2%) was most abundant and the only genera that contributed more that 5% of the sample population. The 2014 seine CPUE (43.25 L/haul) was not different from the grand mean (21.6 L/haul; Figure 41).

Newport Bay: This embayment has been dominated by *Rhodophyta* (Red macroalgae) in six of the nine years since sampling began in 2006. *Chlorophyta* (Green macroalgae) were dominant in 2008-2010. Six different genera of macroalgae were collected by trawl in 2014, which was below the average (7.3) richness value for this embayment in the time series. The Shannon index of diversity among genera within this embayment in 2014 was above average and relatively stable (H = 1.4). Agardh's red weed (50.8%); banded weeds (15.6%), green hair algae (13.9%), sea lettuce (10.6%) and tubed weeds (8%) were the only genera that contributed more that 5% of the sample population. The CPUE (133.8 L/ha) was not different from the grand mean (99.2 L/ha; Figure 42).

The 2014 seine results revealed above average richness (5 genera sampled) but below average diversity evenness among genera (H = 0.4 vs. H = 0.19). Agardh's red weed (96.7%) was most abundant and the only genera that contributed more that 5% of the sample population. The 2014 seine CPUE (62.6 L/haul) was not different from the grand mean (14.7 L/haul; Figure 43).

Chincoteague Bay: This embayment has seen major shifts in dominance from *Rhodophyta* (Red macroalgae) in 2006-2007, *Phaeophyta* (Brown macroalgae) in 2008, *Chlorophyta* (Green macroalgae) in 2009-2010 and back to *Rhodophyta* from 2011-2014. Chincoteague Bay richness (16 genera) was the highest of all embayments in the Coastal Bays for this time series. Fifteen different genera of macroalgae were collected by trawl in 2014. Shannon index of diversity among genera within this embayment in 2014 was above average and relatively stable (H = 1.9). Banded weeds (21.9%), Agardh's red weed (21.5%), tubed weeds (20.4%) green hair algae (16.3%), hairy basket weed (6.4%) and sea lettuce (6.1%) were the only genera that contributed more that 5% of the sample population. The CPUE (158.7 L/ha) was higher than the grand mean (74.8 L/ha; Figure 44).

The 2014 seine results revealed above average richness (8 genera sampled) and above average diversity evenness among genera (H = 1.2). Tubed weeds (48.6%) were the most abundant; Agardh's red weed (36.8%) and hairy basket weed (7.7%) were the only other genera that contributed more that 5% of the sample population. The 2014 seine CPUE (36.3 L/haul) was not different from the grand mean (11.5 L/haul; Figure 45).

Relationship Between Fish and Macroalgae Abundance

These data do not show a relationship between fish abundance and macroalgae abundance (r = 0.03).

Discussion

Macroalgae abundance the Coastal Bays was dominated by *Rhodophyta,* specifically Agardh's red weed, with the exception of Chincoteague Bay, where banded weeds and tubed weeds were comparable in percent composition in the deeper waters collected by the trawl. Tubed weeds were more abundant along the beaches collected by the seine. The embayments north of the Ocean City Inlet showed single species dominance of Agardh's red weed, and subsequently had the highest CPUE when compared to the southern embayments. This stronghold of abundance must be driven by the environmental conditions that favor this genus. *Chlorophyta*, specifically sea lettuce abundance was variable, and appeared able to compete with the *Rhodophytes* when the environmental conditions presented themselves. Chincoteague Bay was the most rich and diverse embayment. This may be due to the remote location from human population density, or other factors such water clarity and competition with established SAV beds.

It has often been conjectured that fish use macroalgae as essential habitat, especially in the absence of SAV. However, these data do not show any overall relationship between fish and macroalgae (r = 0.03). Because the trawl and beach seine surveys were designed to assess abundance and diversity of fish, this lack of relationship may be an artifact of the data.

The CBFI is in the process of reviewing and making changes to the habitat surveys: the SAV survey and the macroalgae portion of the trawl and beach seine surveys in order to ensure that the data collected are able to provide useful information to answer fisheries questions about fish assemblages in the Coastal Bays.

Management

Macroalgae were not managed by the State of Maryland in 2014. There were no recreational or commercial harvesting regulations for these genera. A collection permit must be issued by the state and harvesters are subject to other state and federal laws and regulations for the resale for human consumption of macroalgae. There was a permit request in 2015 for the harvest of macroalgae from the Coastal Bays for human consumption and agricultural products. That permit application is pending approval.

Water Quality and Physical Characteristics Results

Temperature

Analysis of the 2014 CBFI Trawl Survey water quality data beginning in April showed increasing average water temperature for Assawoman Bay, St. Martins River, and Newport Bay through July. The combined average temperatures were highest for those systems during that month. In Isle of Wight and Sinepuxent Bays, the combined average temperatures achieved their zenith in June. This measurement was highest in Chincoteague for August (Figure 46). For 2013, the combined average temperatures were highest in July for all six systems. In 2014, the highest surface temperature (29.4 C) was recorded at site T005 on 7/14. Both the lowest surface temperature (9.3 C) and lowest bottom temperature (9.0 C) for all bays were recorded in April at site T008. The lowest temperatures (surface and bottom) for 2013 also occurred in April, but at site T009.

The overall average from all samples was 22.0, which was similar to 2013 (22.4 C). St. Martin's River was the warmest with a combined average of 23.0 C, and the system with the lowest combined average water temperature was Sinepuxent (21.2 C). Because the seine component comprises two months of the sampling season, related water quality information does not show the gradual progression of measurements (temperature, salinity, DO and turbidity) possible from graphically representing data. The June 2014 seine sites had an average temperature range of 6.1 C (23.1 C to 29.2 C). Three months later in September of 2014, the range was slightly lower at 3.2 C (21.4 C to 24.6 C). Average temperatures saw little change between the June seine sampling and the re-visiting of the same sites in September for Isle of Wight, Assawoman Bays, and the St. Martin's River. Isle of Wight and Assawoman saw slight decreases while St. Martin's experienced a small increase. Change in these systems ranged from 0.7 to 2.1 C. The most abrupt changes were seen at the Sinepuxent, Chincoteague and Newport Bay sites in September with decreases in temperature ranging from 3.6 to 4.1 C (Figure 47).

Dissolved Oxygen
The dissolved oxygen (DO) patterns for each system are seen in Figure 48. As expected, DO levels generally decreased as water temperatures increased. Four systems, Assawoman Bay, St. Martins River, Isle of Wight Bay and Chincoteague Bays, all experienced decreases in DO through June, after which, DO mainly rose. Isle of Wight saw average DO levels remain steady from July through September. October showed an increase for this bay. Sinepuxent Bay exhibited a decrease in DO for May trawls and this measurement changed little through June. July sampling showed an increase in this metric, a trend that continued largely through season's end, despite a slight dip in August. Newport Bay reached a low combined average DO in May. After increasing for June, DO once again dropped for July, but rose thereafter. For beach seine, two bays, Newport and Chincoteague, showed marked increases in DO from June to September. The other systems did not display as much variation between the two months (Figure 49).

Salinity
While both Assawoman and Sinepuxent Bays experienced a drop in average salinity from April to May, overall, salinity increased as the season progressed (Figure 50). When all the salinity averages were analyzed for each bay using trawl survey data, Sinepuxent Bay had the highest combined average at 28.3 ppt and the St. Martin's River had the lowest (23.6 ppt). For the beach seine component of the survey, salinity noticeably increased at all sites from June to September (Figure 51).

For 2014, the overall average salinity for all bays combined was 26.0 ppt which is not much lower than the 27.1 ppt obtained from 2013 data.

Turbidity
Results of Secchi analysis showed variations for turbidity levels from April to October for all systems (Figure 52). For trawls, the most turbid water system was St. Martin's River with an overall average Secchi reading of 58.1 cm. The least turbid bay was Chincoteague Bay returning an overall average of 120.4 cm. Over the course of the trawl survey, visibility in all systems followed a decreasing pattern as the summer progressed. Out of all turbidity measurements, bottom was visible 17 times (12.1%). For beach seines, all systems, except for Isle of Wight and Chincoteague Bays, experienced an increase in visibility when the sites were visited in September (Figure 53). Isle of Wight sites actually retuned less visibility while Chincoteague's combined average Secchi Depth remained unchanged. The most turbid system was the St. Martin's River with a combined Secchi average of 39.5 cm. Visibility was far better for both Isle of Wight and Assawoman Bays with combined averages of 66.8 cm and 65.4 cm, respectively.

A review of Secchi data from the years, 2014 and 2013 demonstrates a decrease in visibility across the warmer months. This metric is subject to variability as there are occasions when light penetration will experience improvement in the middle of summer. Upon viewing a combination of turbidity averages from every month for all bays, it is clear that 2014 was very close in turbidity to 2013 with a turbidity of 90.0 cm compared to 92.2 cm.

Discussion

Differences in temperature, dissolved oxygen, salinity and turbidity were influenced by the flushing times of these systems. Lung (1994) presented data from two summers indicating flushing times of 21.1 to 21.3 days for Assawoman Bay and 8.0 to 15.8 days for the St. Martin's River. Flushing rates of the Isle of Wight Bay were reported to be 9.3 to 9.6 days. It was predicted by Prichard (1960) that Chincoteague Bay required 62 days to replace 99 percent of its water. Flushing rates for both Sinepuxent Bay and Newport Bay are not known (Wazniak, et al. 2004). Given the proximity to the Ocean City Inlet, one can assume that flushing rates for Sinepuxent Bay would be relatively fast (more like Isle of Wight Bay) while the flushing rate in Newport Bay would be much longer (more like Chincoteague Bay).

Of the water quality parameters, dissolved oxygen concentrations (DO) have the greatest immediate impact on fisheries resources. Some of the DO concentrations give rise to the concern that hypoxia is occurring in the Maryland Coastal Bays during the summer months. In a report by the Committee on Environmental Natural Resources (2000), hypoxia exists when dissolved oxygen levels can no longer support the majority of life; the DO level for this condition usually set below 2 mg/L. One quarter of the Virginian Province (the mouth of the Chesapeake Bay north to Cape Cod) suffers exposure to DO concentrations of ≤ 5 mg/L according to Strobel et al. (1995). In this area, hypoxia generally is associated with warmer water and therefore DO can experience a decline between May through October in the southern reaches of the Province. When temperatures decrease, mixing of top and bottom water occurs more frequently, eliminating the hypoxic regions that grew during the summer (EPA, 2000). For organisms in the Chesapeake Bay, 5.0mg/L is usually accepted as necessary for life, but can vary based on the organism. For example, a DO of 6mg/L is necessary for larvae and eggs of migratory fish, however, some animals such as crabs and bottom dwelling fish (Bay Anchovies) can tolerate DO levels as low as 3 mg/L (Chesapeake Bay Program, 2007). Of concern is the combined bottom average of 4.6 mg/L for the St. Martin's River in June due to readings of 4.7 mg/L and 4.5 mg/L at sites T004 and T005, respectively. During the same month, Isle of Wight Bay had a low combined bottom average of 4.5 from two sites there.

Research concerning low DO impact on various species was conducted in western Long Island Sound (Howell et al, 1994). Species abundance and diversity suffered noticeable reductions in relation to low bottom DO. When bottom DO ranged from 2.9 to 2.0 mg/L, the occurrence of Windowpane Flounder, Butterfish, and Winter Flounder was reduced significantly. As DO decreased, overall total catch per tow and the total species number also decreased. Sites where DO is above 3 mg/L can support more fish and other species compared to areas where bottom DO is below this value. Our data have not been examined to determine if this pattern holds true for our survey; however, based on results of the site preference analysis, species diversity does not appear to be affected by embayment (Figure 6).

Dissolved oxygen typically decreases from April through the warmer months and then increases again in the fall. Certainly, 2014 was no exception to this seasonal pattern. In 2012, precipitation during that time period was examined as far back as the 2010 season for possible impact on water quality parameters. Precipitation was not obviously the driving factor for DO, turbidity, temperature or salinity and it is assumed to be the case for 2014. Evidence appeared to point at some other factor, such as algal blooms, wind, or rain, in influencing these parameters. Visibility can be substantially lowered by a bloom of brown algae. In 2004, chlorophyll and turbidity data from Turville Creek (April to October) were compared with the National Park Service precipitation data for the same period. Precipitation did not follow turbidity to the extent that chlorophyll *a* did. It is possible that there are parts of the Coastal Bays where precipitation or other influences could produce more of an impact than seen in Turville Creek (Dennison *et al*. 2009). For 2012, it seemed apparent that DO and turbidity were most likely influenced by phytoplankton abundance increasing in the summer months and decreasing in the early spring and fall. Presumably, this was expected to be the same explanation for these water quality parameters during the 2014 sampling season.

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Table 1. MDNR Coastal Bays Fisheries Investigation trawl 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's River, mouth	38 23.527	75 07.327
T005	Isle of Wight Bay	St. Martin's River, in lower Shingle Ldg. Prong	38 24.425	75 10.514
T006	Isle of Wight Bay	Turville Creek, below the race track	38 21.291	75 08.781
T007	Isle of Wight Bay	mid-Isle of Wight Bay, N. of the shoals in bay (False Channel)	38 22.357	75 05.776
T008	Sinepuxent Bay	#2 day marker, S. for 6 minutes (North end of Sinepuxent Bay)	38 19.418	75 06.018
T009	Sinepuxent Bay	#14 day marker, S. for 6 minutes (Sinepuxent Bay N. of Snug Harbor)	38 17.852	75 07.310
T010	Sinepuxent Bay	#20 day marker, S. for 6 minutes (0.5 mile S. of the Assateague Is. 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, opp. Gibbs Pond to Buddy Pond, in marsh cut	38 15.281	75 11.603
T013	Chincoteague Bay	Between #37 & #39 day marker	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 Is. (AKA Jim's Gut)	38 06.370	75 12.454
T016	Chincoteague Bay	300 yds off E. end of Great Bay Marsh, W. of day marker (a.k.a. S. of #20 day marker)	38 04.545	75 17.025
T017	Chincoteague Bay	Striking Marsh, S. end about 200 yds	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, N end.	38 03.125	75 21.110
T020	Chincoteague Bay	Parallel to and just N. of the MD/VA line, at channel	38 01.328	75 20.057

Table 2. MDNR Coastal Bays Fisheries Investigation beach seine site descriptions.

Site Number	Bay	Site Description	Latitude	Longitude
S001	Assawoman Bay	Cove behind Ocean City Sewage Treatment Plant, 62nd St.	38 23.273	75 04.380
S002	Assawoman Bay	Bayside of marsh at Devil's Island, 95th St.	38 24.749	75 04.264
S003	Assawoman Bay	Small cove, E. side, small sand beach; Sandspit, bayside of Goose Pond	38 24.824	75 06.044
S004	Isle of Wight Bay	N. side, Skimmer Island (AKA NW side, Ocean City Flats)	38 20.259	75 05.299
S005	Isle of Wight Bay	Beach on sandspit N. of Cape Isle of Wight (AKA in cove on marsh spit, E. and S. of mouth of Turville Creek)	38 21.928	75 07.017
S006	Isle of Wight Bay	Beach on W. side of Isle of Wight, St. Martins River (AKA Marshy Cove, W. side of Isle of Wight, N. of Rt. 90 Bridge)	38 23.627	75 06.797
S007	Isle of Wight Bay	Beach, 50th St. (next to Seacrets)	38 22.557	75 04.301
S008	Sinepuxent Bay	Sandy beach, NE side, Assateague Is. Bridge at Nat'l. Seashore	38 14.554	75 08.581
S009	Sinepuxent Bay	Sand beach1/2 mile S. of Inlet on Assateague Island,	38 19.132	75 06.174
S010	Sinepuxent Bay	Grays Cove, in small cove on N. side of Assateague Pointe development's fishing pier	38 17.367	75 07.977
S011	Chincoteague Bay	Cove, 800 yds NW. of Island Pt.	38 13.227	75 12.054
S012	Chincoteague Bay	Beach N. of Handy's Hammock (AKA N. side, mouth of Waterworks Cr.)	38 12.579	75 14.921
S013	Chincoteague Bay	Cove at the mouth of Scarboro Cr.	38 09.340	75 16.426
S014	Chincoteague Bay	SE of the entrance to Inlet Slew	38 08.617	75 11.105
S015	Chincoteague Bay	Narrow sand beach, S. of Figgs Ldg.	38 07.000	75 17.578
S016	Chincoteague Bay	Cove, E. end, Great Bay Marsh (AKA Big Bay Marsh)	38 04.482	75 17.597
S017	Chincoteague Bay	Beach, S. of Riley Cove in Purnell Bay	38 02.162	75 22.190
S018	Chincoteague Bay	Cedar Is., S. side, off Assateague Is.	38 02.038	75 16.619
S019	Chincoteague Bay	Land site - Ayers Cr. At Sinepuxent Rd.	38 18.774	75 09.414

Table 3. Measurement types for fishes and invertebrates captured during the 2013 Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey.

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

Table 4. List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2014. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	CPUE (T) #/Hect.	CPUE (S) #/Haul
Atlantic Menhaden	*Brevoortia tyrannus*	43,179	20	43,159	1.1	1135.8
Bay Anchovy	*Anchoa mitchilli*	7,330	4,887	2,443	278.3	64.3
Atlantic Silverside	*Menidia menidia*	3,157	169	2,413	9.6	63.5
Silver Perch	*Bairdiella chrysoura*	2,554	961	1,593	54.7	41.9
Striped Killifish	*Fundulus majalis*	669		594		15.6
Weakfish	*Cynoscion regalis*	515	513	2	29.2	<0.1
Summer Flounder	*Paralichthys dentatus*	331	233	98	13.3	2.6
Spot	*Leiostomus xanthurus*	263	36	227	2.0	6.0
Mummichog	*Fundulus heteroclitus*	247	7	240	0.4	6.3
Golden Shiner	*Notemigonus crysoleucas*	225		225		5.9
Rough Silverside	*Membras martinica*	193	2	191	0.1	5.0
Atlantic Croaker	*Micropogonias undulatus*	158	151	7	8.6	0.2
Rainwater Killifish	*Lucania parva*	124	11	113	0.6	3.0
Atlantic Needlefish	*Strongylura marina*	108		108		2.8
Bluefish	*Pomatomus saltatrix*	91	7	84	0.4	2.2
Northern Pipefish	*Syngnathus fuscus*	89	56	33	3.2	0.9
Striped Anchovy	*Anchoa hepsetus*	89	48	41	2.7	1.1
Pinfish	*Lagodon rhomboides*	83		83		2.2
Hogchoker	*Trinectes maculatus*	71	61	10	3.5	0.3
Dusky Pipefish	*Syngnathus floridae*	69	29	40	1.6	1.1
Spotted Hake	*Urophycis regia*	66	65	1	3.7	<0.1
White Mullet	*Mugil curema*	63		63		1.6
Oyster Toadfish	*Opsanus tau*	59	25	34	1.4	0.9
Northern Searobin	*Prionotus carolinus*	52	51	1	2.9	<0.1
Sheepshead Minnow	*Cyprinodon variegatus*	46		46		1.2
Northern Puffer	*Sphoeroides maculatus*	43	29	14	1.6	0.4
Smallmouth Flounder	*Etropus microstomus*	42	41	1	2.3	<0.1
Striped Blenny	*Chasmodes bosquianus*	42	9	33	0.5	0.9
Black Sea Bass	*Centropristis striata*	41	36	5	2.0	0.1
American Eel	*Anguilla rostrata*	38	32	6	1.8	0.2
Naked Goby	*Gobiosoma bosc*	35	27	8	1.5	0.2
Spotfin Mojarra	*Eucinostomus argenteus*	27		27		0.7
Winter Flounder	*Pseudopleuronectes americanus*	26	14	12	0.8	0.3
Pigfish	*Orthopristis chrysoptera*	25	3	22	0.2	0.6
Inland Silverside	*Menidia beryllina*	24		24		0.6
Black Drum	*Pogonias cromis*	22		22		0.6
Blackcheek Tonguefish	*Symphurus plagiusa*	11	6	5	0.3	0.1

Table 4. List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2014. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	CPUE (T) #/Hect.	CPUE (S) #/Haul
Sheepshead	*Archosargus probatocephalus*	10		10		0.3
Windowpane	*Scophthalmus aquosus*	10	10		0.6	
Southern Kingfish	*Menticirrhus americanus*	9	8	1	0.5	<0.1
Striped Burrfish	*Chilomycterus schoepfii*	9	6	3	0.3	<0.1
Lined Seahorse	*Hippocampus erectus*	7	6	1	0.3	<0.1
Green Goby	*Microgobius thalassinus*	6	6		0.3	
Northern Kingfish	*Menticirrhus saxatilis*	6	2	4	0.1	0.1
Banded Killifish	*Fundulus diaphanus*	5		5		0.1
Pumpkinseed	*Lepomis gibbosus*	5		5		0.1
Striped Bass	*Morone saxatilis*	5	1	4	0.1	0.1
Striped Mullet	*Mugil cephalus*	5		5		0.1
Atlantic Thread Herring	*Opisthonema oglinum*	4		4		0.1
Blue Runner	*Caranx crysos*	4	2	2	0.1	<0.1
Harvestfish	*Peprilus paru*	4		4		0.1
Halfbeak	*Hyporhamphus unifasciatus*	3		3		<0.1
Lookdown	*Selene vomer*	3	1	2	0.1	<0.1
Seaweed Pipefishes	*Syngnathus sp.*	3	3		0.2	
Southern Stingray	*Dasyatis americana*	3		3		<0.1
Striped Searobin	*Prionotus evolans*	3	3		0.2	
Bluegill	*Lepomis macrochirus*	2		2		<0.1
Inshore Lizardfish	*Synodus foetens*	2	2		0.1	
Pipefishes	*Gasterosteiformes*	2		2		<0.1
Unknown Juvenile Fish	*Unknown Juvenile Fish*	2	2		0.1	
White Perch	*Morone americana*	2		2		<0.1
Atlantic Herring	*Clupea harengus harengus*	1	1		0.1	
Bluespotted Cornetfish	*Fistularia tabacaria*	1	1		0.1	
Clearnose Skate	*Raja eglanteria*	1	1		0.1	
Gizzard Shad	*Dorosoma cepedianum*	1		1		<0.1
Gray Snapper	*Lutjanus griseus*	1		1		<0.1
Northern Stargazer	*Astroscopus guttatus*	1		1		<0.1
Red Hake	*Urophycis chuss*	1	1		0.1	
Smooth Butterfly Ray	*Gymnura micrura*	1	1		0.1	
	Total Finfish	**60,329**	**7,586**	**52,093**		

Table 5. List of crustaceans collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2014. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 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*	5,057	3,176	1,881			180.9	49.5
Grass Shrimp	*Palaemonetes sp.*	2,810	176	277	422	1,935	34.0	58.2
Sand Shrimp	*Crangon septemspinosa*	2,431	395	5	1,551	480	110.8	12.8
Say Mud Crab	*Dyspanopeus sayi*	170	159	11			9.1	0.3
Long-armed Hermit Crab	*Pagurus longicarpus*	107	32	75			1.8	2.0
Lady Crab	*Ovalipes ocellatus*	98	44	54			2.5	1.4
Barnacles	*Cirripedia*	75			75		4.3	
Brown Shrimp	*Farfantepenaeus aztecus*	28	13	15			0.7	0.4
White Shrimp	*Litopenaeus setiferus*	24	21	3			1.2	<0.1
Atlantic ghost crab	*Ocypode quadrata*	2		2				<0.1
Spider Crabs	*Libinia*	2	2				0.1	
Bigclaw Snapping Shrimp	*Alpheus heterochaelis*	1	1				0.1	
Flatclaw Hermit	*Pagurus pollicaris*	1		1				<0.1
Green Crab	*Carcinus maenas*	1		1				<0.1
Mantis Shrimp	*Squilla empusa*	1	1				0.1	
	Total Crustaceans	**10,808**	**4,020**	**2,325**	**2,048**	**2,415**		

Table 6. List of molluscs collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2014. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	Scientific Name	Total Number Collected	No. Collec (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 Vol. (T) #/Hect	CPUE Vol. (S) #/Haul
Solitary Glassy Bubble Snail	*Haminoea solitaria*	391	66		325						22.3			
Atlantic Brief Squid	*Lolliguncula brevis*	51	51								2.9			
Eastern Mudsnail	*Nassarius obsoletus*	32		32								0.8		
Bruised Nassa	*Nassarius vibex*	29	5	24							0.3	0.6		
Convex Slippersnail	*Crepidula convexa*	4	4								0.2			
Thick-lip Drill	*Eupleura caudata*	4	4								0.2			
Dwarf Surfclam	*Mulinia lateralis*	3	3								0.2			
Atlantic Awningclam	*Solemya velum*	2	2								0.1			
Atlantic Jackknife	*Ensis directus*	2	2								0.1			
Atlantic Oyster Drill	*Urosalpinx cinerea*	2	2								0.1			
Lemon Drop	*Doriopsilla pharpa*	2	2								0.1			
Threeline Mudsnail	*Nassarius trivittatus*	2	2								0.1			
Channeled Whelk	*Busycotypus canaliculatus*	1	1								0.1			
Eastern White Slippersnail	*Crepidula plana*	1	1								0.1			
Elongate Macoma	*Macoma tenta*	1	1								0.1			
False Angelwing	*Petricolaria pholadiformis*	1	1								0.1			
Purplish Tagelus	*Tagelus divisus*	1	1								0.1			
Stout Tagelus	*Tagelus plebeius*	1	1								0.1			
	Total Molluscs	**530**	**149**	**56**	**325**									

Table 7. List of other species collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2014. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 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*	1,633	15	3	1,615		47.8				92.8	<0.1	2.7	
Comb Jellies	*Ctenophora*	951	38	3	910		221.7	2.0	1.0	1.0	54.0	<0.1	12.7	<0.1
Sea Nettle	*Chrysaora quinquecirrha*	462	66		396		6.1				26.3		0.3	
Moon Jelly	*Aurelia aurita*	123	113	10							6.4	0.3		
Hairy Sea Cucumber	*Sclerodactyla briareus*	35	29	6							1.6	0.2		
Horseshoe Crab	*Limulus polyphemus*	26	24	2							1.4	<0.1		
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	17	5	12							0.3	0.3		
Common Sea Cucumber	*Cucumaria pulcherrima*	8	8								0.5			
Lions Mane	*Cyanea capillata*	4	4								0.2			
Sand Dollar	*Echinarachnius parma*	2	2								0.1			
Forbes Asterias	*Asterias forbesi*	1	1								0.1			
Goldstar Tunicate	*Botryllus schlosseri*						15.3	19.2					0.9	0.5
Sea Pork	*Aplidium sp.*						55.4	0.1					3.2	
Bryozoans	*Ectoprocta*						216.3	19.1					12.3	0.5
Rubbery Bryozoan	*Alcyonidium sp.*						90.9	8.1					5.2	0.2
Fig Sponge	*Suberites ficus*						1.9						0.1	
Halichondria Sponge	*Halichondria sp.*						242.2	17.1					13.8	0.5
Red Beard Sponge	*Microciona prolifera*						88.8						5.1	
Sulphur Sponge	*Cliona celata*						105.8						6.0	
Serpulid Worms	*Hydroides dianthus*								0.3				<0.1	
	Total Other	**3,262**	**305**	**36**	**2,921**		**1,092.3**	**65.6**	**1.3**	**1.0**				

Table 8. 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, 2014. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	Genus	Specific Volume (L) (T)	Specific Volume (L) (S)	Estimated Volume (L) (T)	Estimated Volume (L) (S)
SAV					
Eel Grass	*Zostera*	13.4	41.6		
Widgeongrass	*Ruppia*	0.8	13.7		
	Total SAV	**14.2**	**55.3**		
Macroalgae					
Brown					
Common Southern Kelp	*Laminaria*	3.6			
Sour Weeds	*Desmarestia*	0.4			
Rockweed	*Fucus*	0.1			
Brown Bubble Algae	*Colpomenia*	0.1			
		4.1			
Green					
Sea Lettuce	*Ulva*	290.6	94.8		
Green Hair Algae	*Chaetomorpha*	282.8	20.1		
Hollow Green Weed	*Enteromorpha*	20.1	16.8		
Green Tufted Seaweed	*Cladophora*	14.7	29.8		
Green Fleece	*Codium*	7.0	0.7		
Green Sea Fern	*Bryopsis*	2.5			
		617.8	**162.2**		
Red					
Agardh's Red Weed	*Agardhiella*	1,670.9	1,392.8		
Banded Weeds	*Ceramium*	300.9	23.6		
Tubed Weeds	*Polysiphonia*	258.1	221.0		
Hairy Basket Weed	*Spyridia*	72.3	33.6		
Graceful Red Weed	*Gracilaria*	17.8	83.4		
Barrel Weed	*Champia*	8.8	0.1		
		2,328.8	**1,754.4**		
Yellow-Green					
Water Felt	*Vaucheria*	47.2	6.9		
		47.2	**6.9**		
Unknown					
Unknown Macroalgae	*Unknown*			0.1	
				0.1	
	Total Macroalgae	**2,997.8**	**1,923.6**	**0.1**	

Table 9. Summary of Maryland recreational fishing regulations for 2014.

Species	Area	Minimum Size Limit (inches)	Creel (person/day)	Season
American Eel	A	9	25	Open Year Round
Atlantic Croaker	A	9	25	Open Year Round
Black Sea Bass	A	12.5	15	May 19 thru Sept.18 Oct. 18 thru Dec. 31
Black Drum	A	16	1 6/boat	Open Year Round
Bluefish	A	8	10	Open Year Round
Red Drum	A	18 to 27	1	Open Year Round
Scup	A	8	50	Open Year Round
Spotted Seatrout	A	14	4	Open Year Round
Striped Bass	B	28	2	Open Year Round
Summer Flounder	A	16	4	Open year Round
Tautog	A	16	4	Jan. 1 thru May 15 and Nov. 1 thru Nov. 26
			2	May 16 thru Oct. 31
Weakfish	A	13	1	Open Year Round

A- Includes Atlantic Ocean, Coastal Bays, Chesapeake Bay, & all tributaries

B- Includes Atlantic Ocean & Coastal Bay

Table 10. Summary of Maryland commercial fishing regulations for 2014.

Species	Area	Size (inches) gear	Commercial Season, Days, Times, & Area Restrictions	Quota/Creel/Special Conditions/Comments
American Eel	A	9 All gear	Jan. 1-Aug. 31 Mon. thru Sun.	If pot mesh < ½" x ½", 4"X4"escape panel required.
	A	9 Spear, baited trap or pot only	Sept. 1-Dec. 31 Mon. thru Sun.	If pot mesh < ½" x ½", 4"X4"escape panel required. Closed to all other gear.
Atlantic Croaker	A	9 All gear	Mar. 16-Dec. 31 Mon. thru Sun.	
Atlantic Menhaden	A	None All gear	Jan. 1 – Dec. 31	Unlimited Fishery is open until Statewide quota is met. After this, it switches to the permitted fishery. Commercial quota of 5,185,729 pounds.
Black Sea Bass	B	11	Open Year Round	Quotas by permit; without permit catch limit is 50 lbs. Except for individual possessing less than 50 lbs of black sea bass per trip, may not use trawl with mesh less than 4-1/2" stretched mesh throughout net or minimum of 75 meshes in codend. May not use roller rig trawl with roller diameter greater than 18". Pot or trap shall have hinges on one panel/door made of untreated hemp or jute string 3/16" diameter or smaller, magnesium alloy fasteners or ungalvanized/uncoated iron wire of 0.094" diameter.
Black Drum	A	16 All gear	Open Year Round	Commercial quota of 1,500 lbs. May only land Black Drum from waters of the Atlantic Ocean, not including Coastal Bays.
Bluefish	A	8 All gear	Open Year Round	Commercial quota of 218,000 lbs
Red Drum	A	18-25 All gear	Open Year Round	5 fish/person/day

Table 10 (con't). Summary of Maryland commercial fishing regulations for 2014.

Species	Area	Size (inches) gear	Commercial Season, Days, Times, & Area Restrictions	Quota/Creel/Special Conditions/Comments
Scup	A	9 All gear	Open Year Round	Except for an individual possessing less than 500 pounds of scup from Nov. 1 – April 30 or 100 pounds of scup from May 1 – Oct. 31, may not use trawl with mesh less than 4-1/2" stretched mesh throughout net or minimum of 75 meshes in codend. May not use roller rig trawl with roller diameter greater than 18". Pot/trap shall have hinges on one panel/door made of untreated hemp/jute string 3/16" diameter or smaller, magnesium alloy fasteners or ungalvanized/uncoated iron wire of 0.094" diameter.
Spotted Sea Trout	A	14 All gear	Open Year Round	Catch limit of 150 lbs/day, Trawl mesh min. 3-3/8 inches square or 3-3/4 inches diamond stretched mesh. Gill net mesh min. 3" stretched.
Striped Bass	B	24 Trawl and gill net	Nov. 1 – April 30	Commercial quota of 126, 396 lbs
Summer Flounder	B	14 All gear other than hook and line 16 Hook & line	Open Year Round Mon. thru Sun.	Quotas by permit. Without a Permit: 100 lbs/person/day.
Summer Flounder	B	14 All gear	May 1 – May 15 and October 16 – October 31	Summer Flounder Study Area 1-3 miles off the coast All rules other than Hook & Line size limit are the same
Tautog	A	16 All gear	Jan. 1 - May 15, Nov. 1 – Nov. 26 Mon. thru Sun.	4 fish; A pot and trap shall have hinges on one panel/door made of untreated hemp or jute string 3/16" diameter or smaller, magnesium alloy fasteners or ungalvanized/uncoated iron wire of 0.094" diameter.
Tautog	A	16 All gear	May 16 – Oct. 31 Mon. thru Sun.	2 fish; A pot and trap shall have hinges on one panel/door made of untreated hemp or jute string 3/16" diameter or smaller, magnesium alloy fasteners or ungalvanized/uncoated iron wire of 0.094" diameter.
Weakfish	B	12 All gear other than hook & line	Year Round (Mon. thru Fri.) 100 lbs./day or trip-whichever is longer.	The weight of the catch of the other species on board the vessel cannot be exceeded by weight of weakfish. Trawl mesh min. 3-3/8 inches square or 3-3/4 inches diamond stretched mesh. Gill net mesh min. 3" stretched.

A- Includes Atlantic Ocean, Coastal Bays, Chesapeake Bay, & all tributaries

B- Includes Atlantic Ocean & Coastal Bay

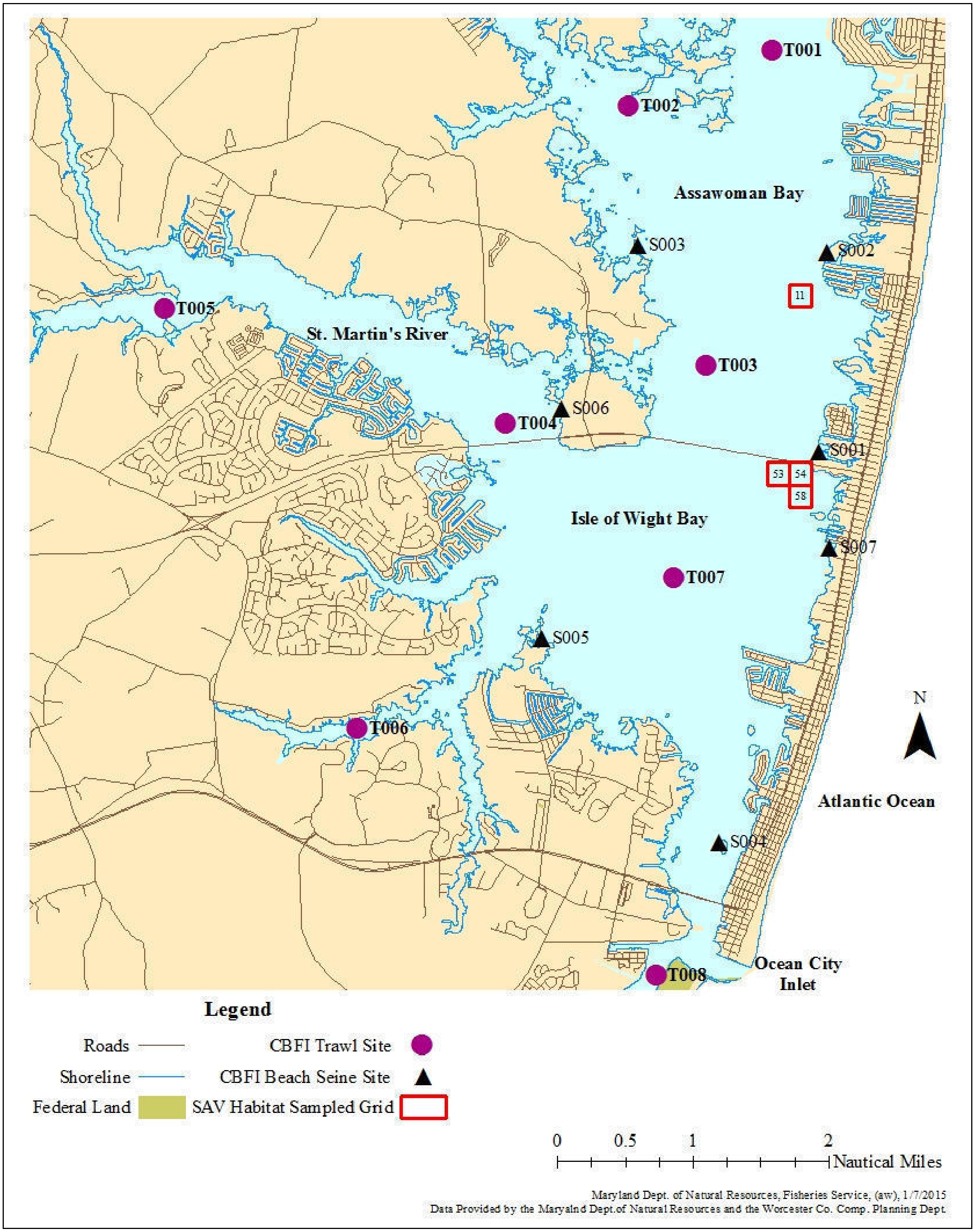

Figure 1. Coastal Bays Fisheries Investigation 2014 sampling locations in the Assawoman and Isle of Wight Bays, Maryland.

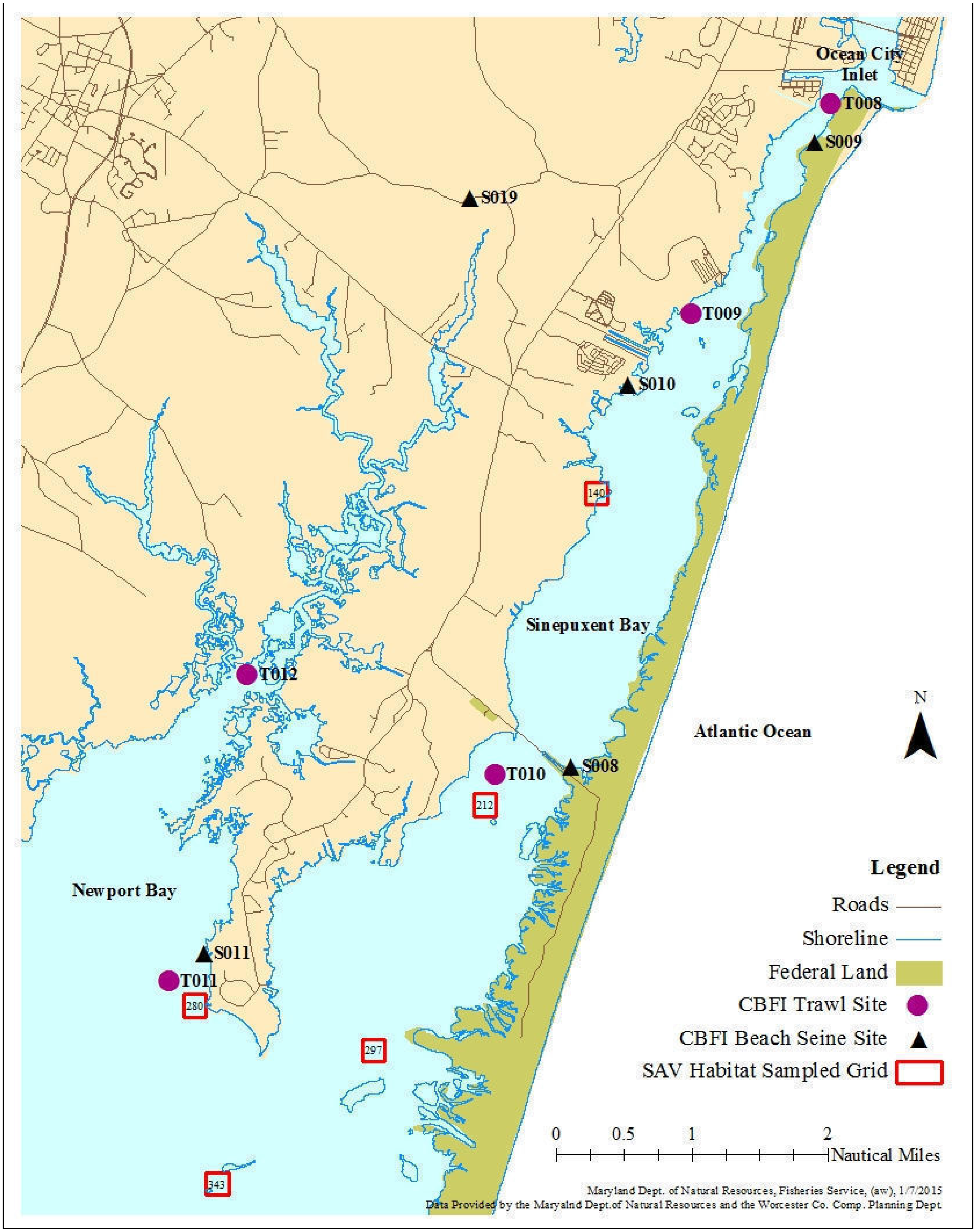

Figure 2. Coastal Bays Fisheries Investigation 2014 sampling locations in the Sinepuxent and Newport Bays, Maryland.

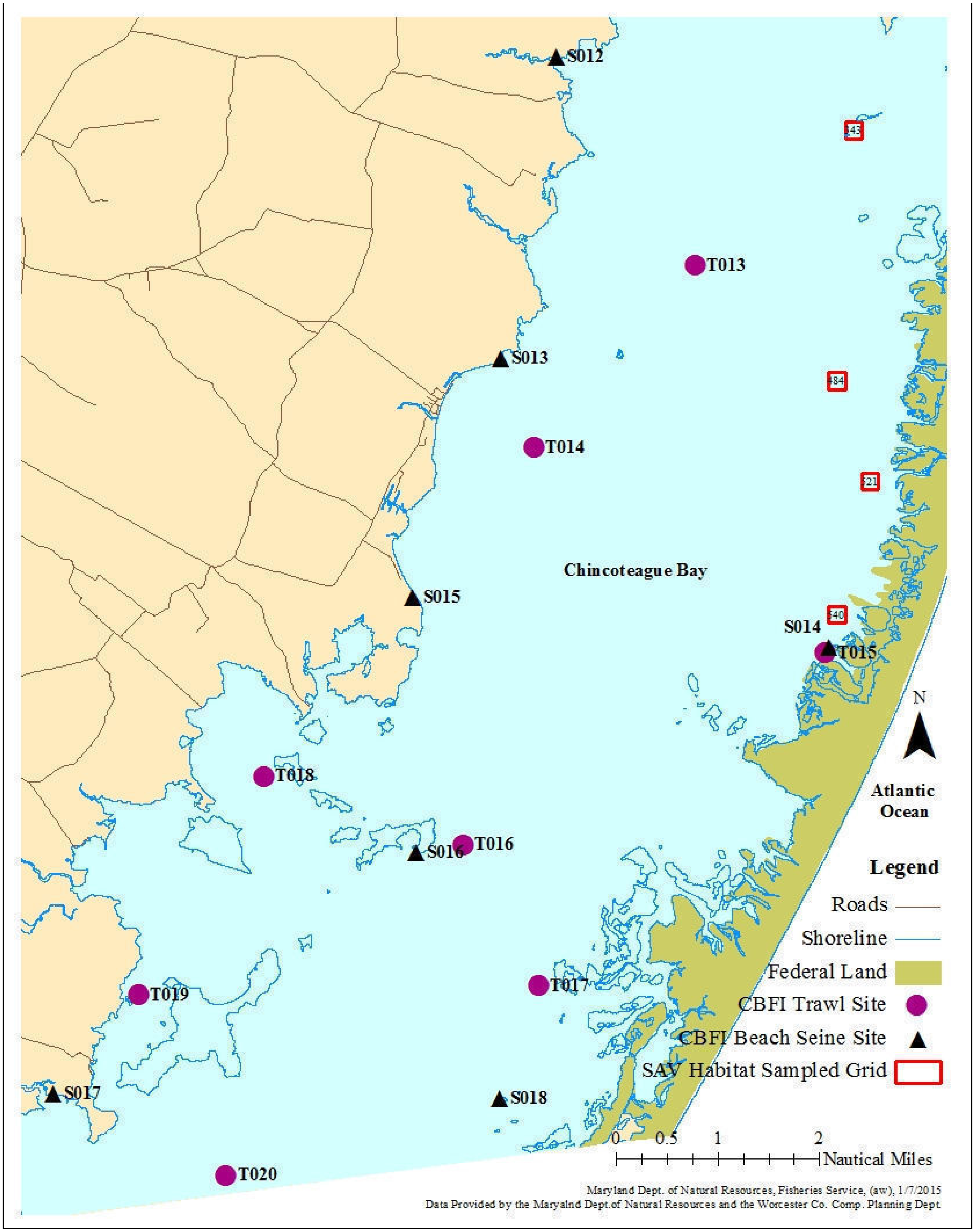

Figure 3. Coastal Bays Fisheries Investigation 2014 sampling locations in Chincoteague Bay, Maryland.

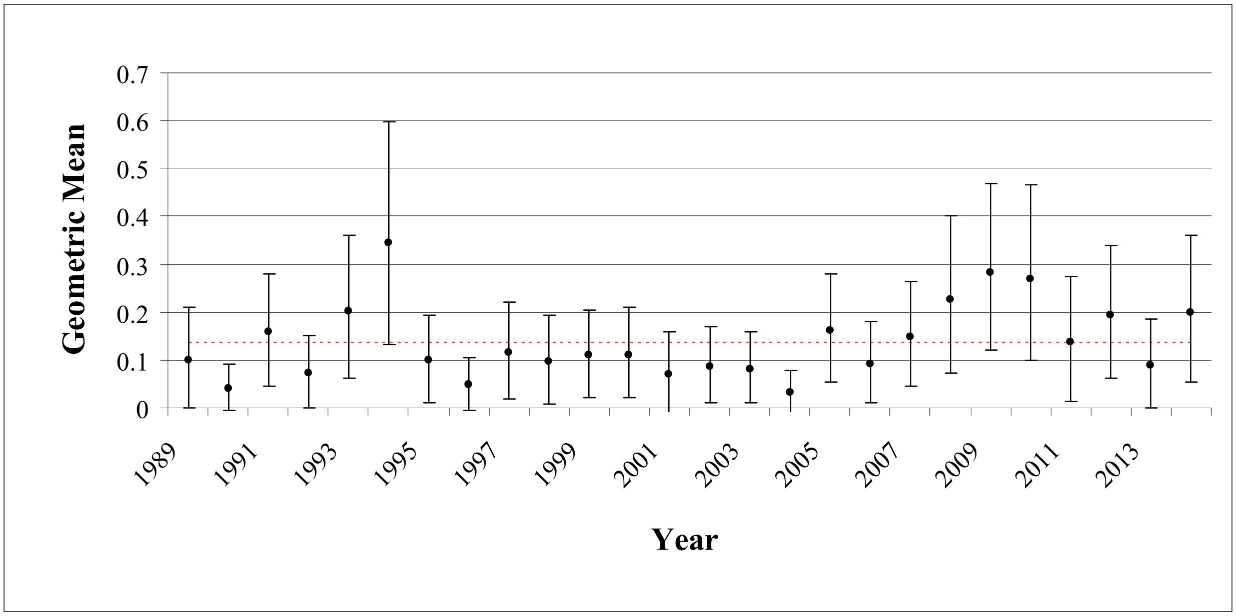

Figure 4. American eel (*Anguilla rostrata)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

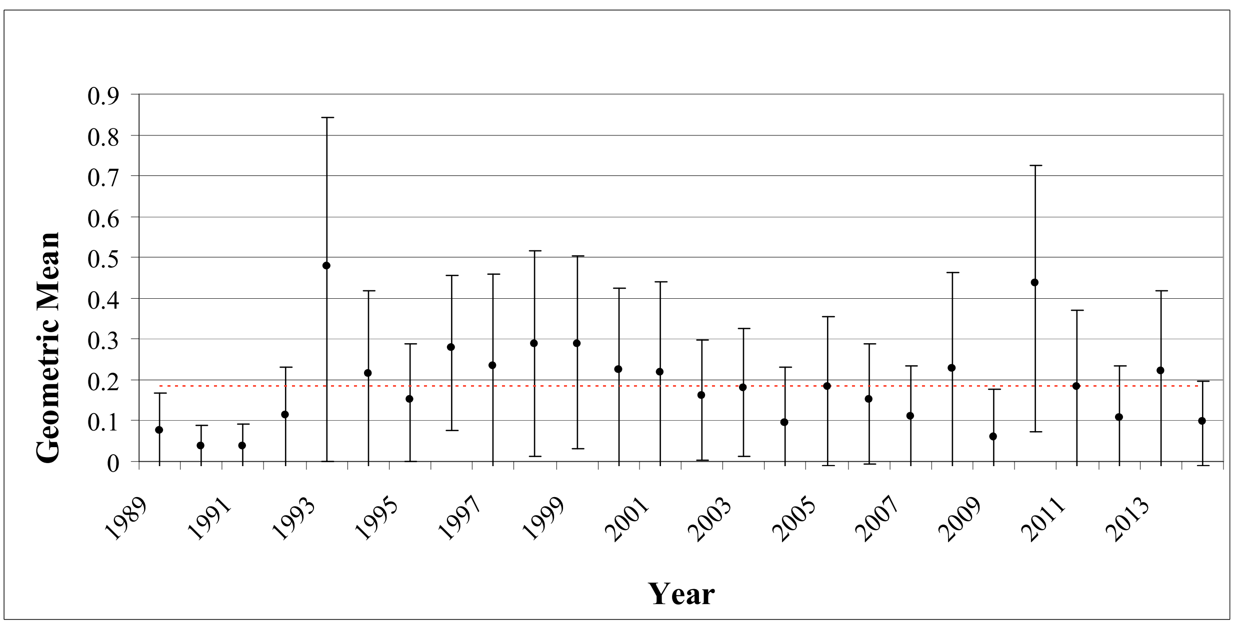

Figure 5. American Eel (*Anguilla rostrata)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

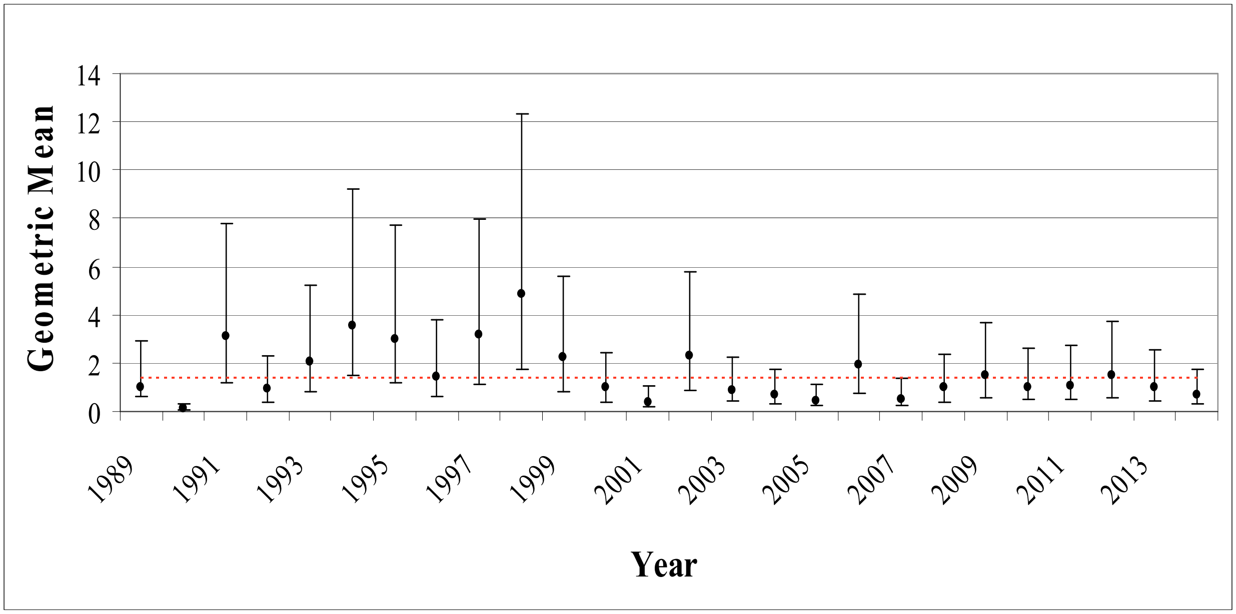

Figure 6. Atlantic croaker (*Micropogonias undulates*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

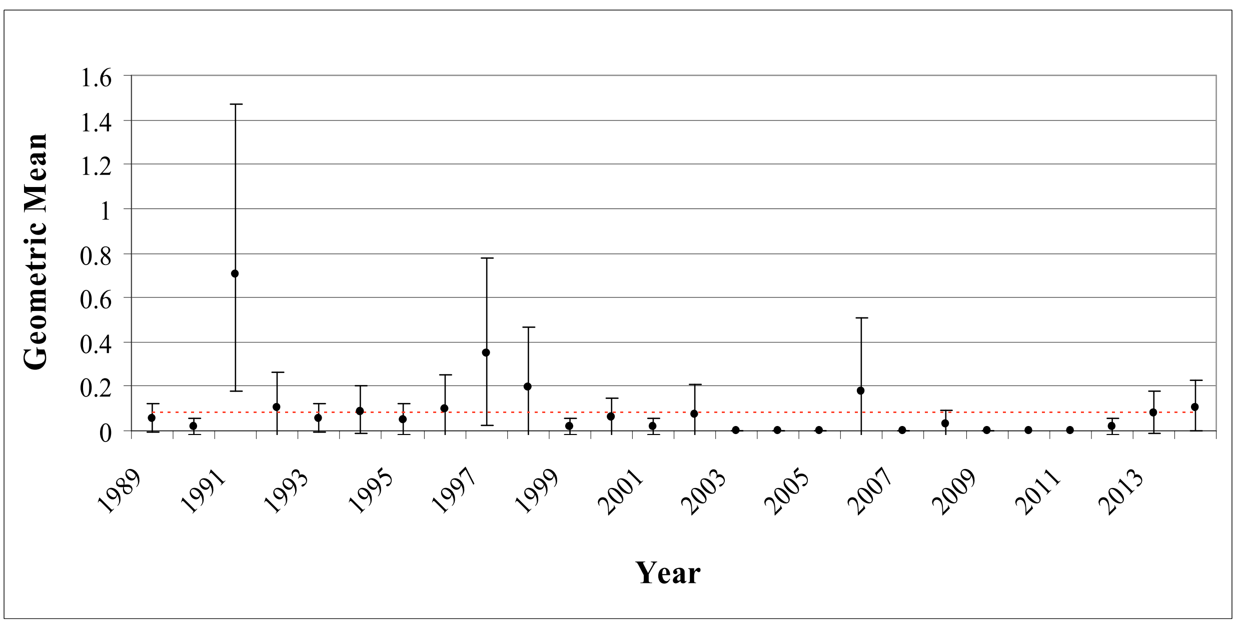

Figure 7. Atlantic croaker (*Micropogonias undulates*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

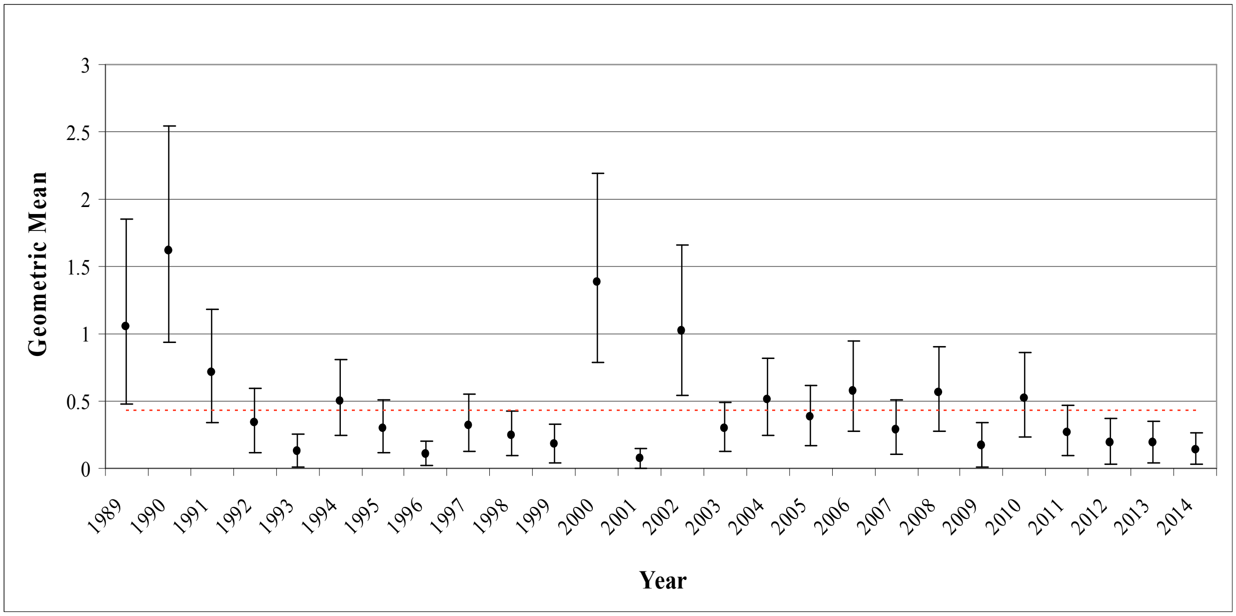

Figure 8. Atlantic menhaden (Brevoortia tyrannus) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

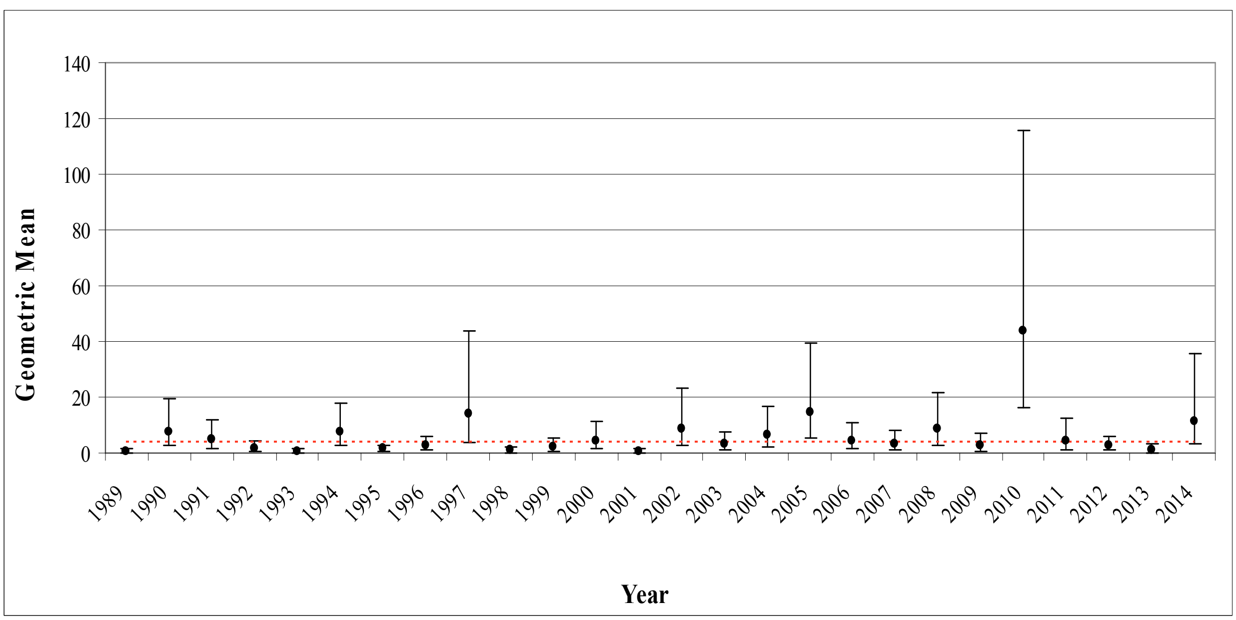

Figure 9. Atlantic menhaden (*Brevoortia tyrannus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

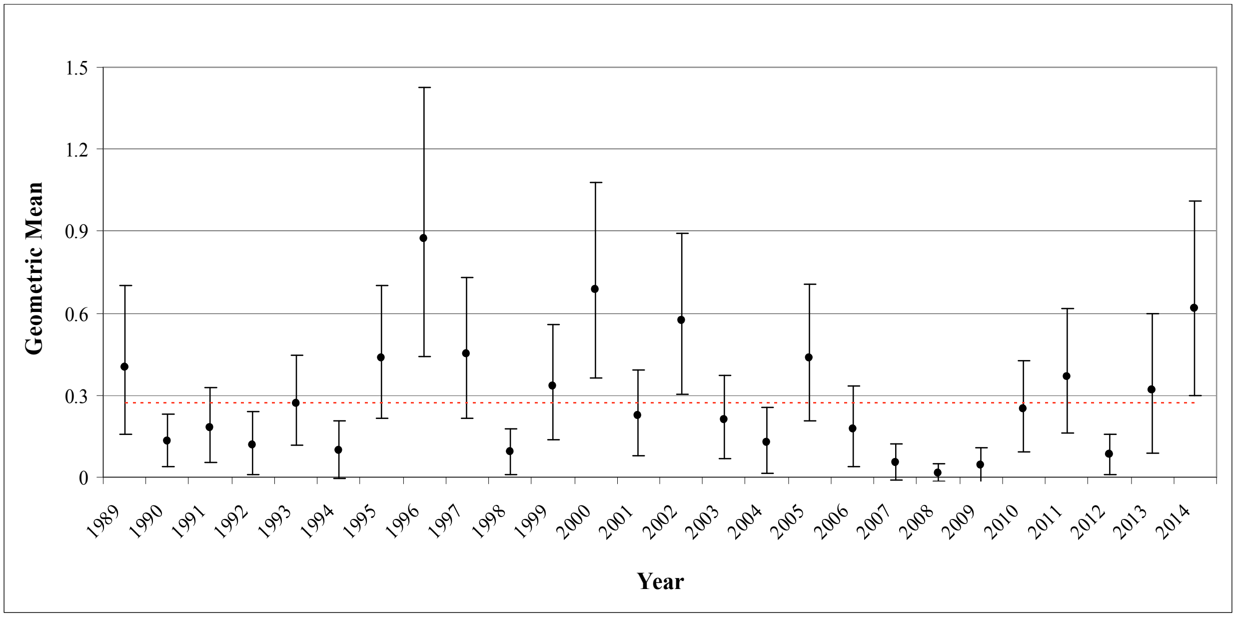

Figure 10. Atlantic silverside (*Menidia menidia*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

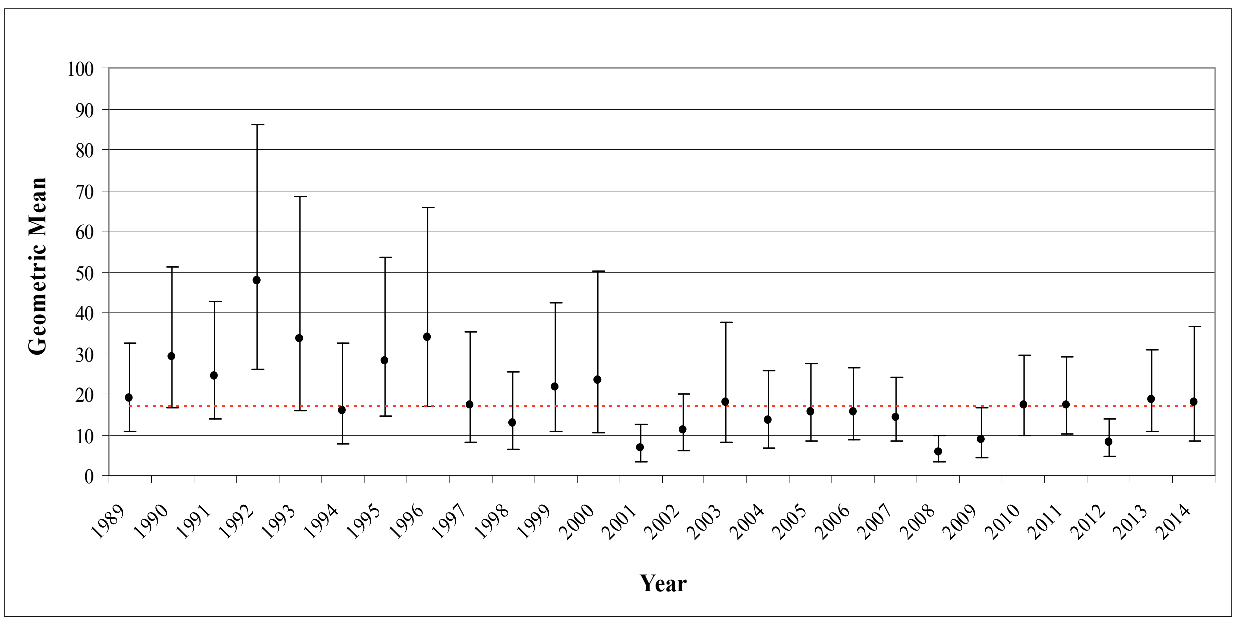

Figure 11. Atlantic silverside (*Menidia menidia*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

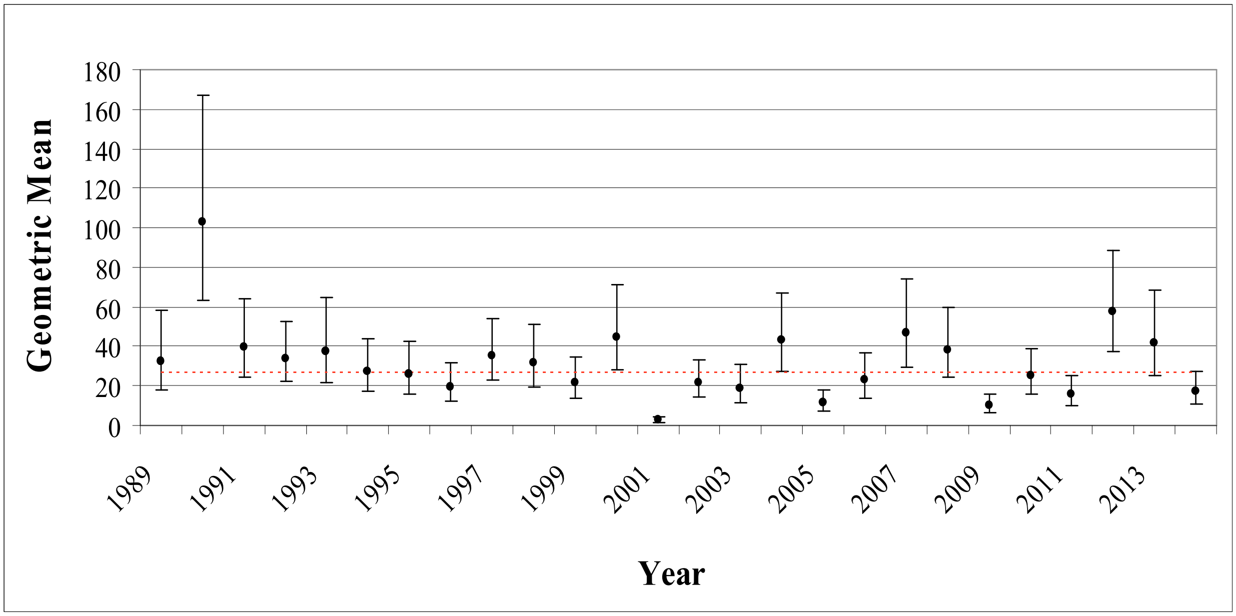

Figure 12. Bay anchovy (*Anchoa mitchilli*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

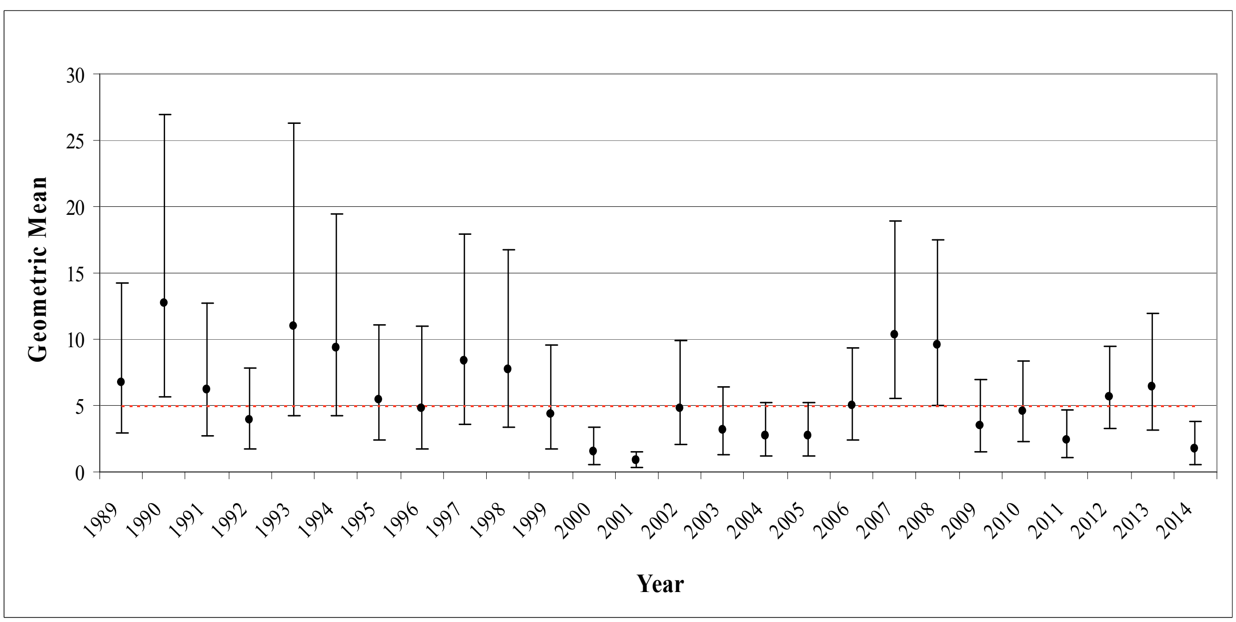

Figure 13. Bay anchovy (*Anchoa mitchilli*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

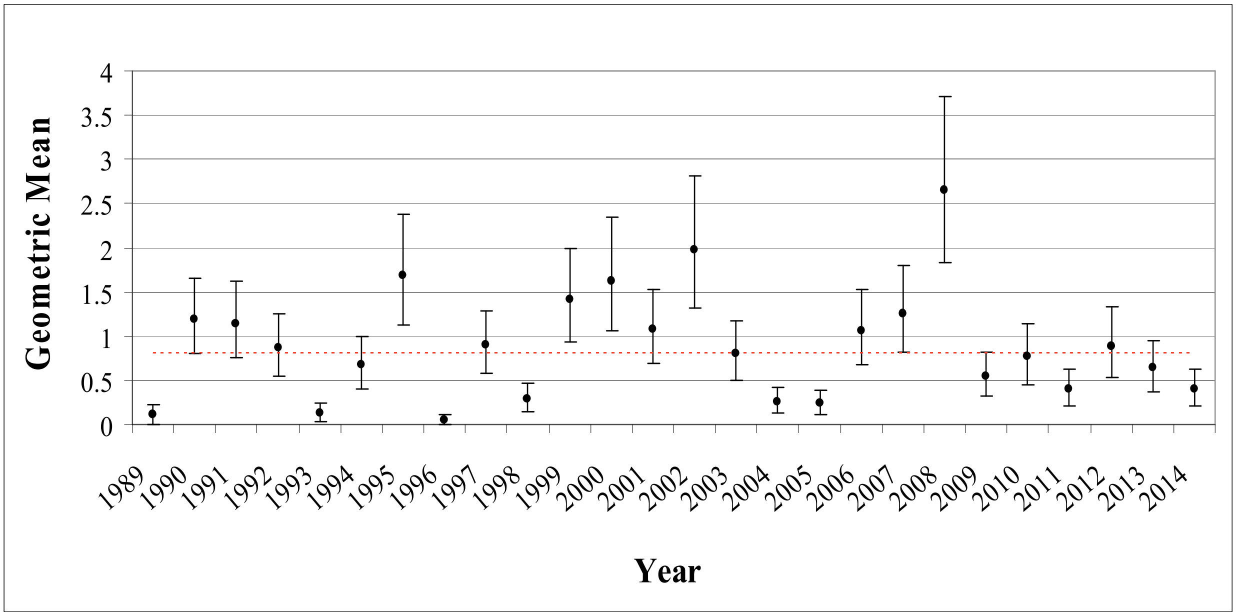

Figure 14. Black sea bass (*Centropristis* striata) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

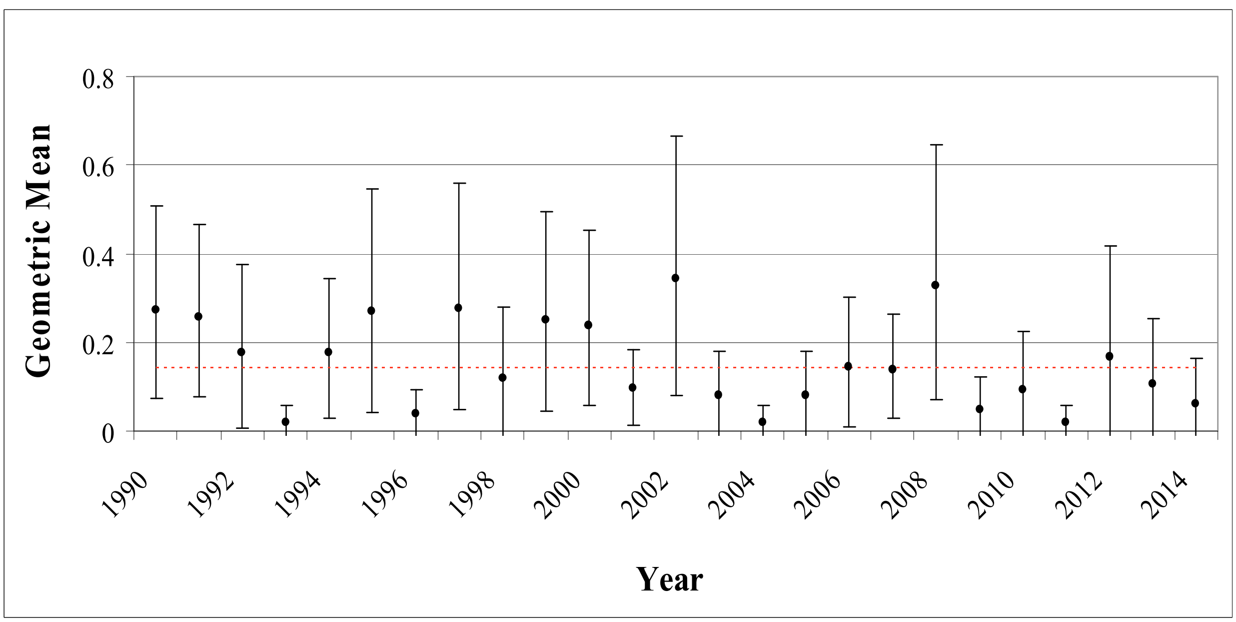

Figure 15. Black sea bass (*Centropristis* striata) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

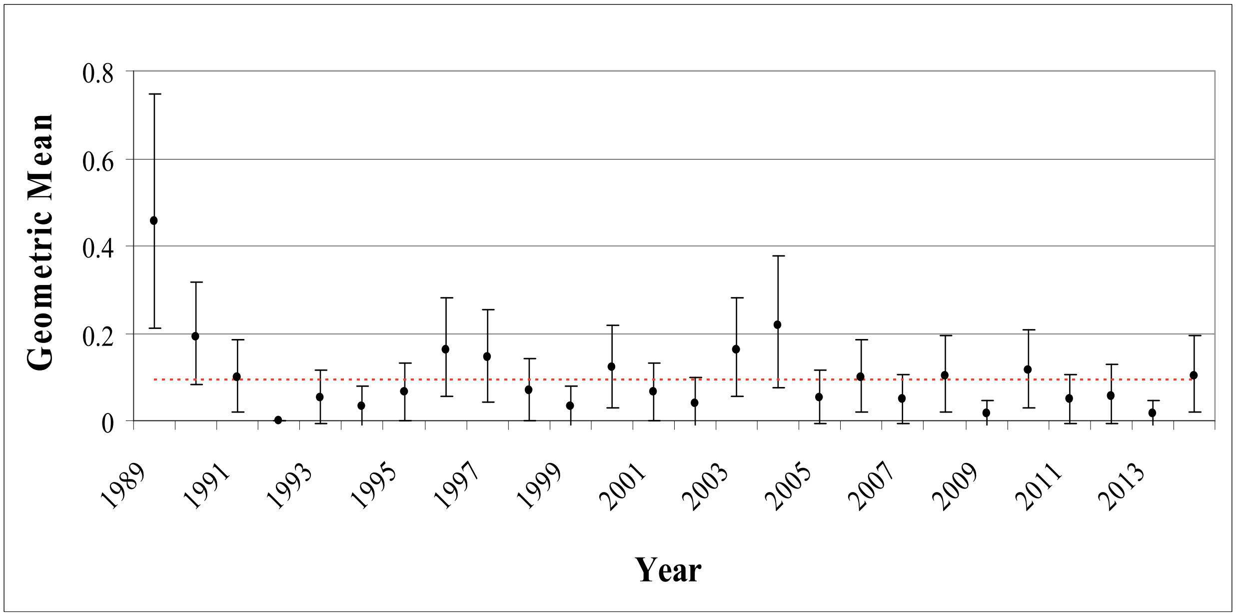

Figure 16. Bluefish (*Pomatomus saltatrix*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

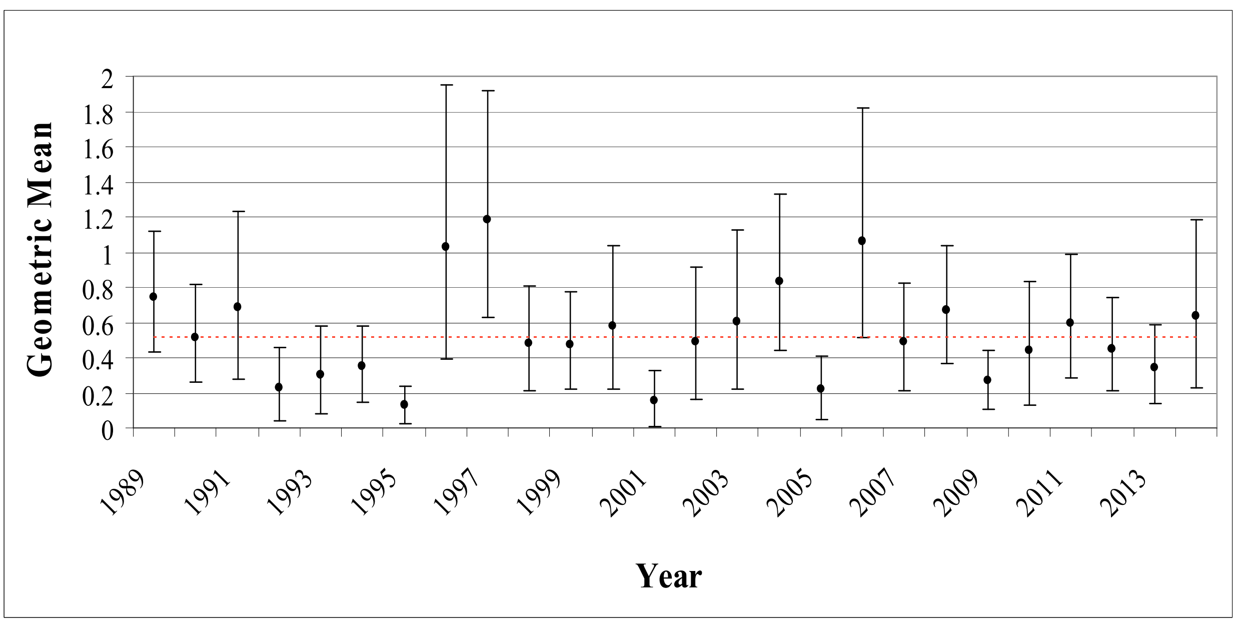

Figure 17. Bluefish (*Pomatomus saltatrix*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

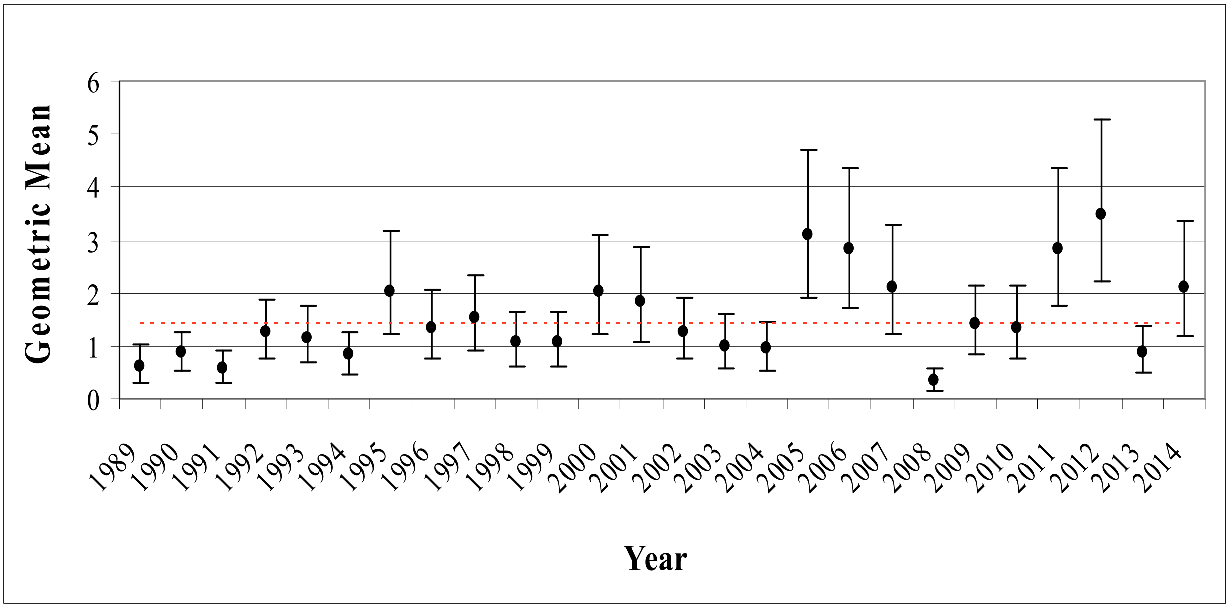

Figure 18. Silver perch (*Bairdiella chrysoura*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

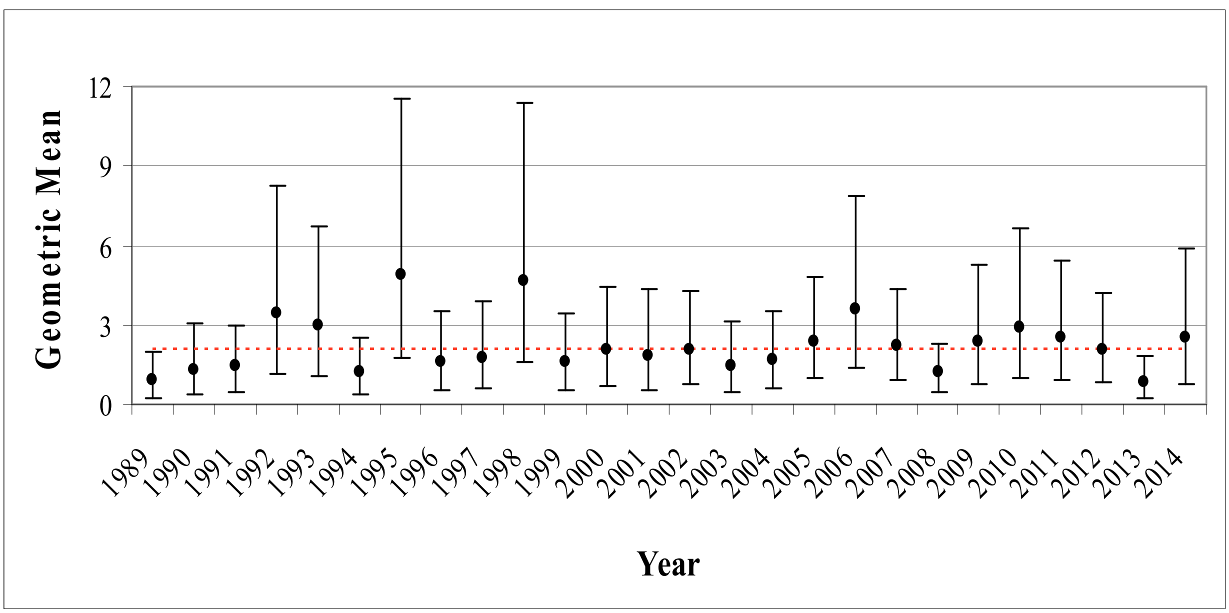

Figure 19. Silver perch (*Bairdiella chrysoura*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

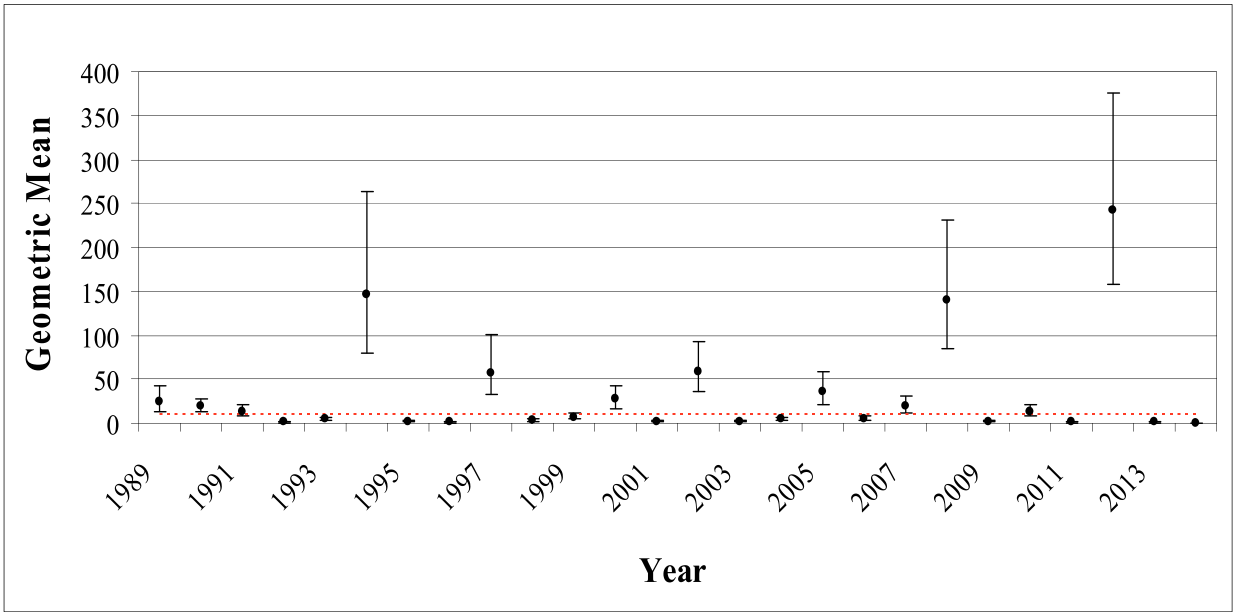

Figure 20. Spot (*Leiostomus xanthurus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

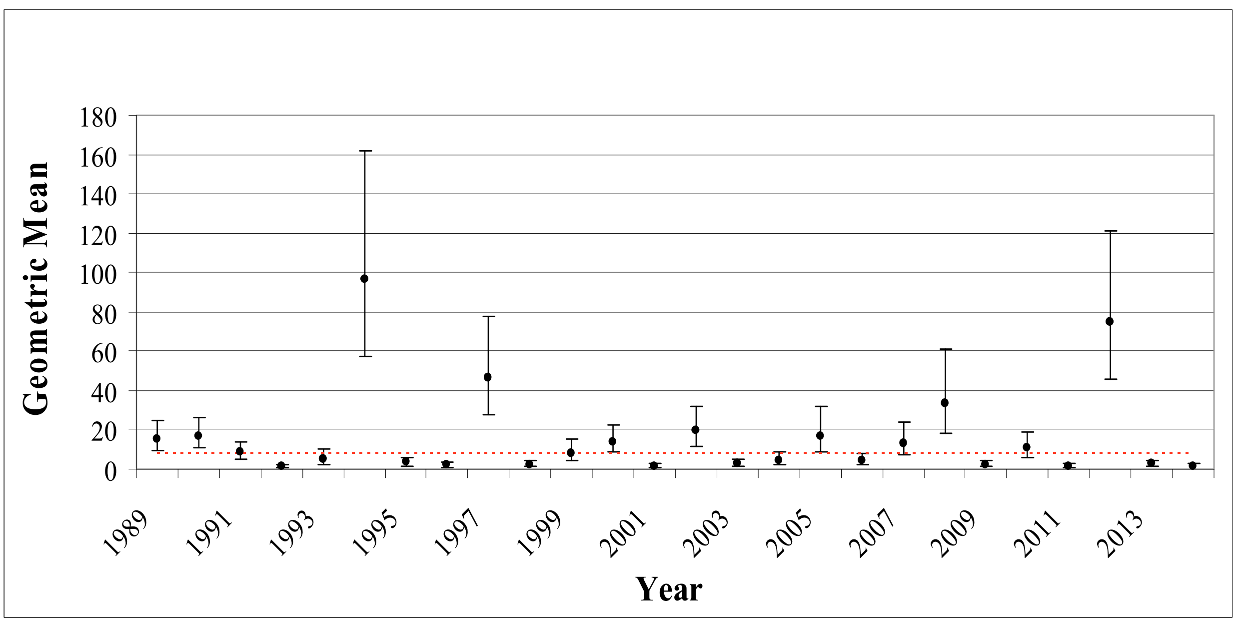

Figure 21. Spot (*Leiostomus xanthurus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

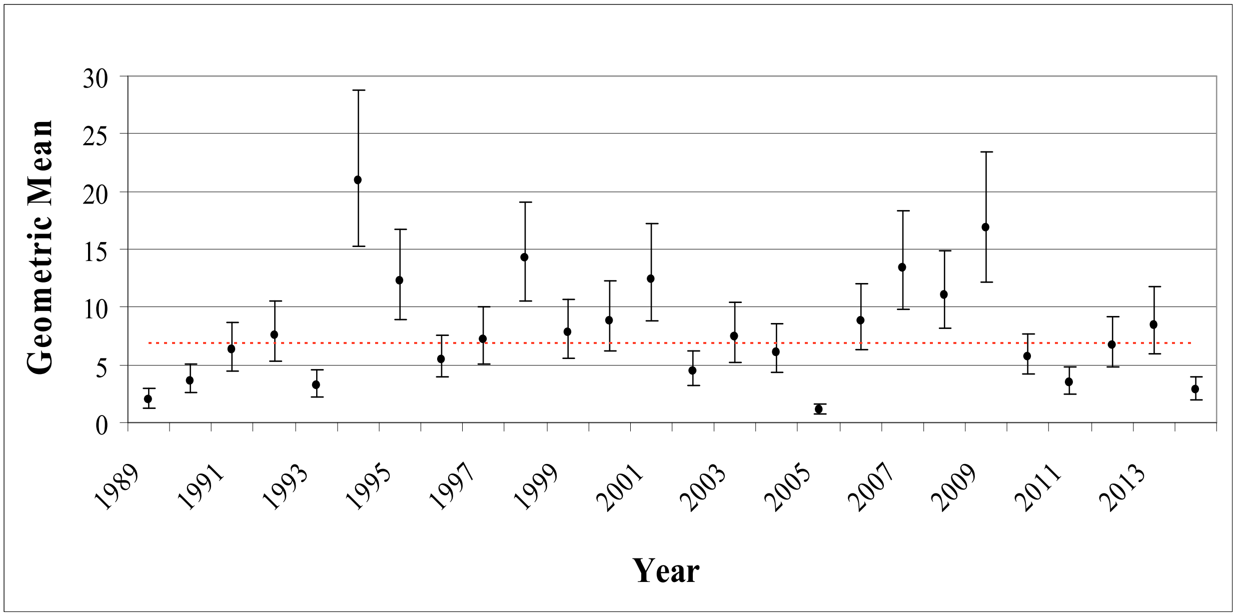

Figure 22. Summer flounder (*Paralichthys dentatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

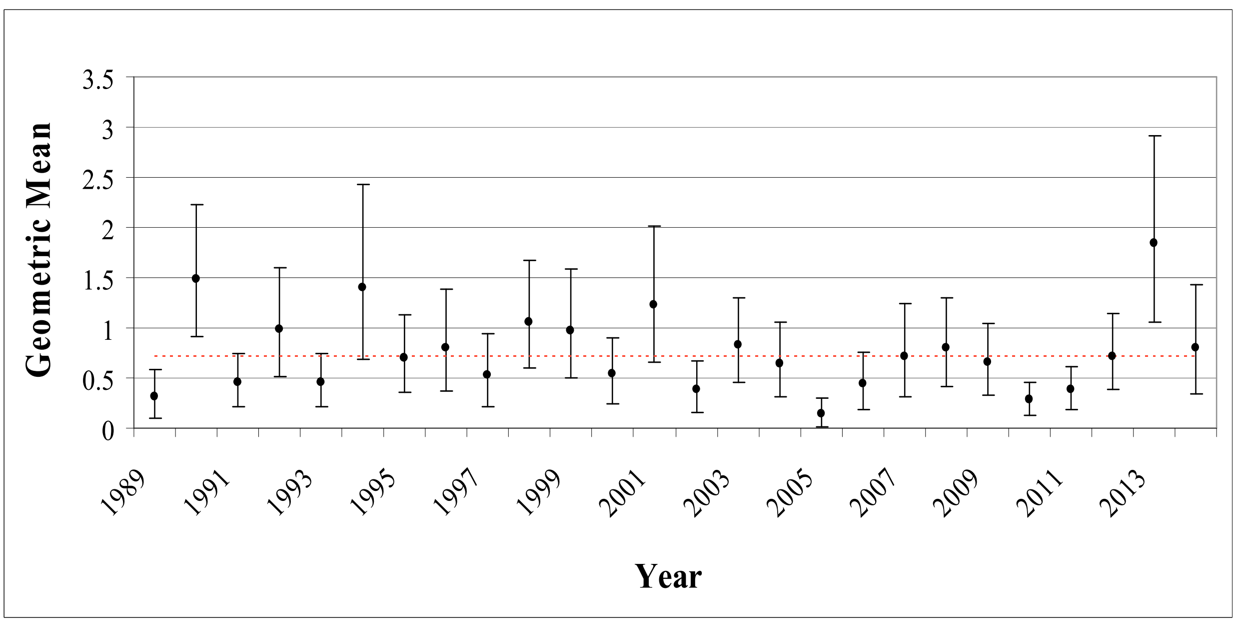

Figure 23. Summer flounder (*Paralichthys dentatus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

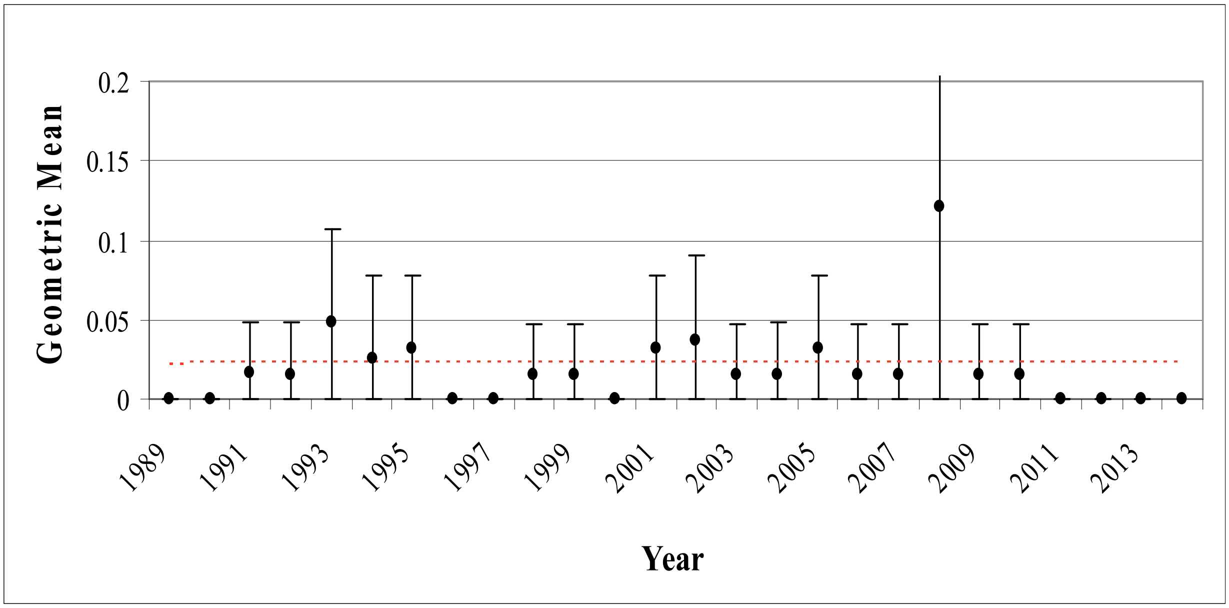

Figure 24. Tautog (*Tautoga onitis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

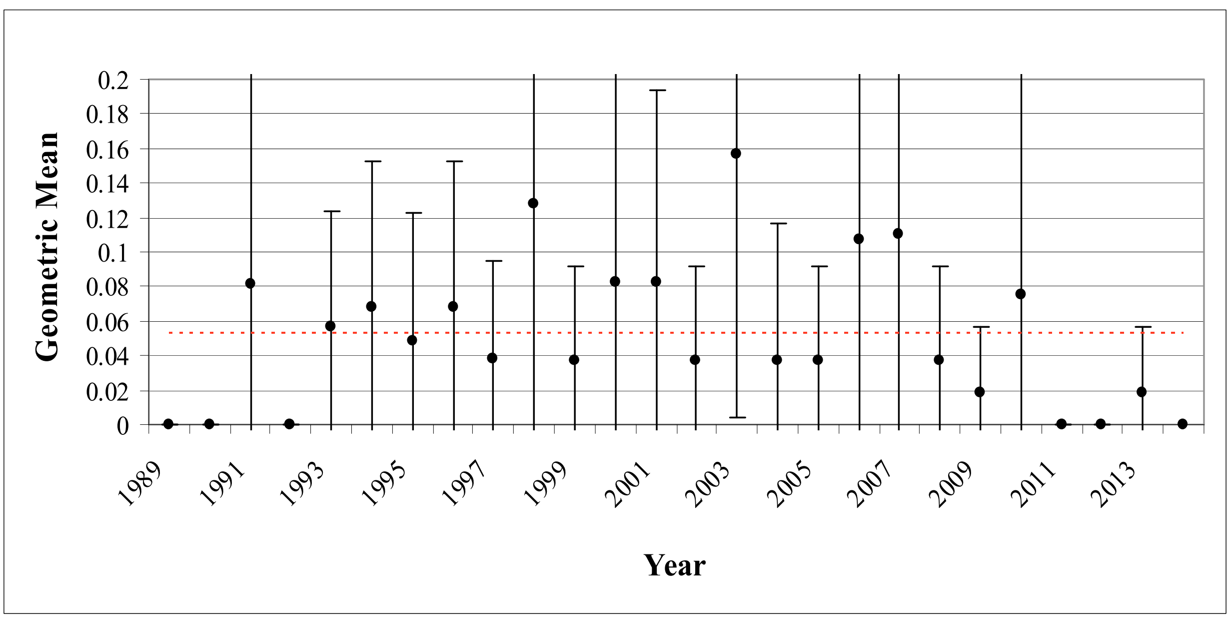

Figure 25. Tautog (*Tautoga onitis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

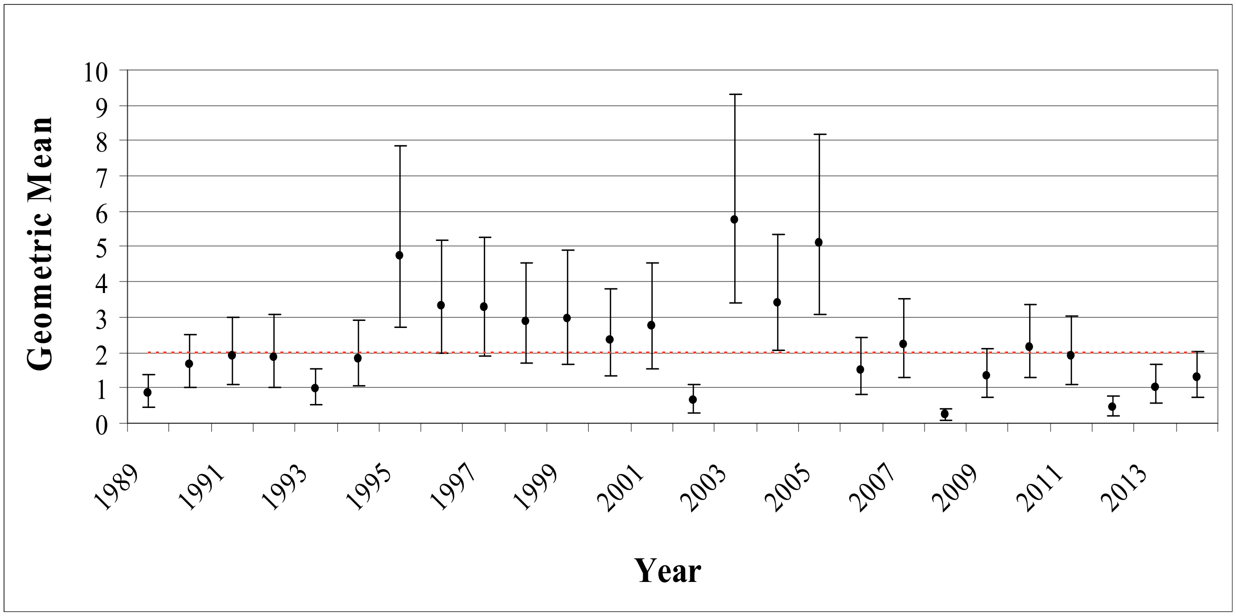

Figure 26. Weakfish (*Cynoscion regalis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

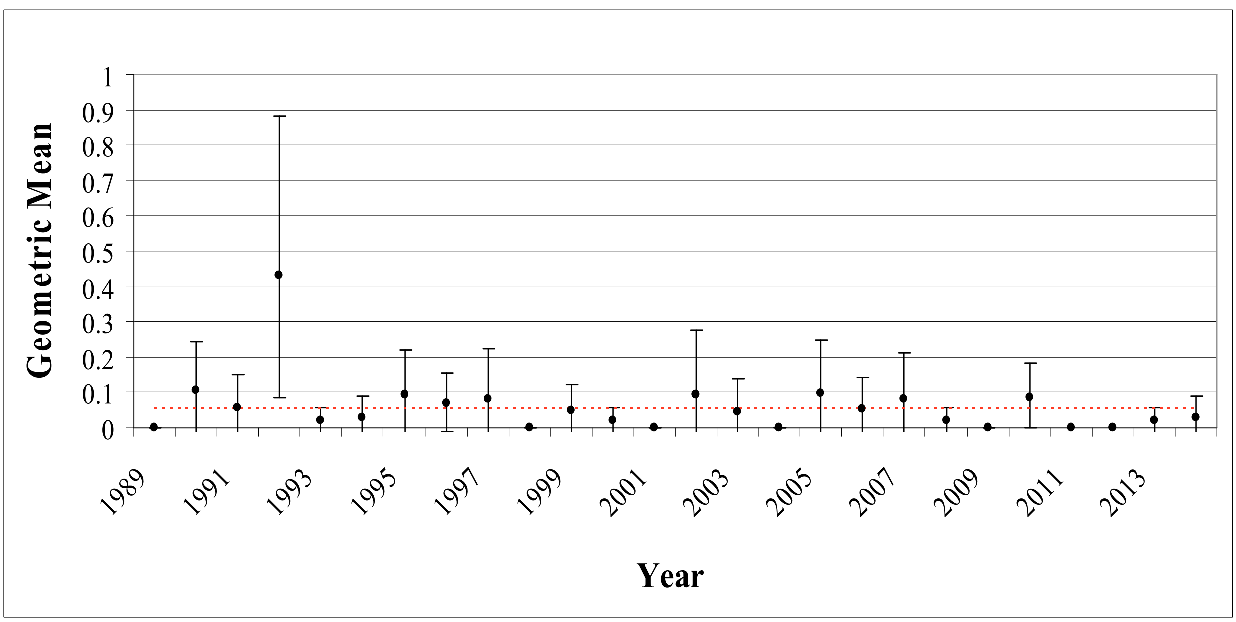

Figure 27. Weakfish (*Cynoscion regalis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

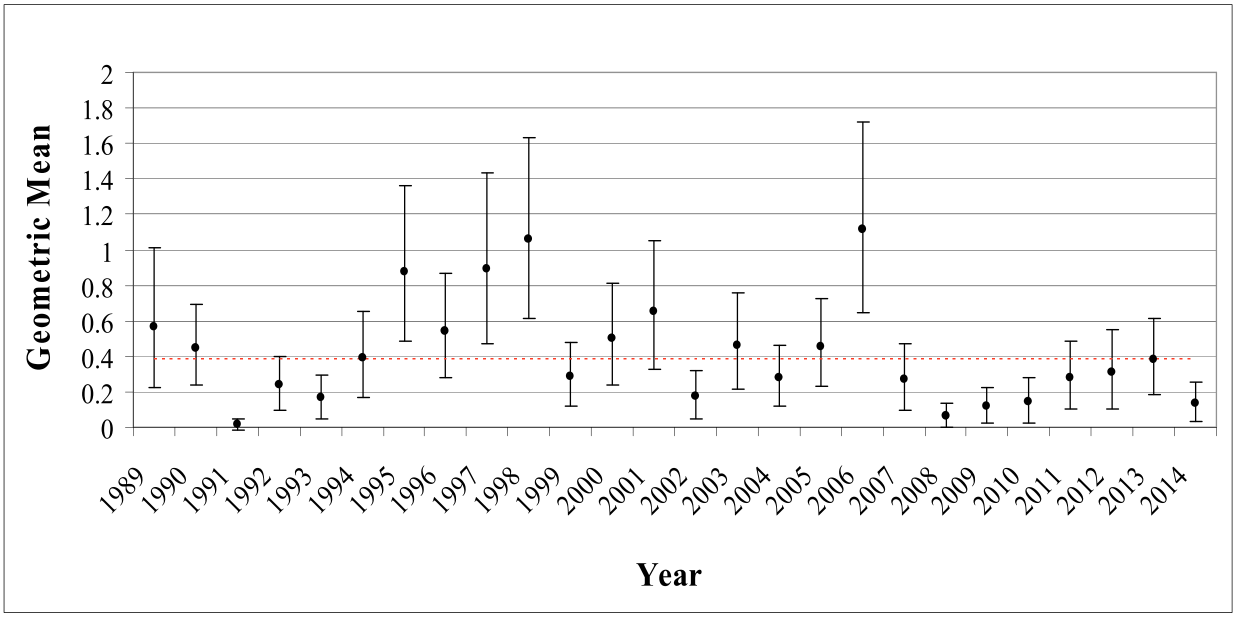

Figure 28. Winter flounder (*Pseudopleuronectes americanus)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

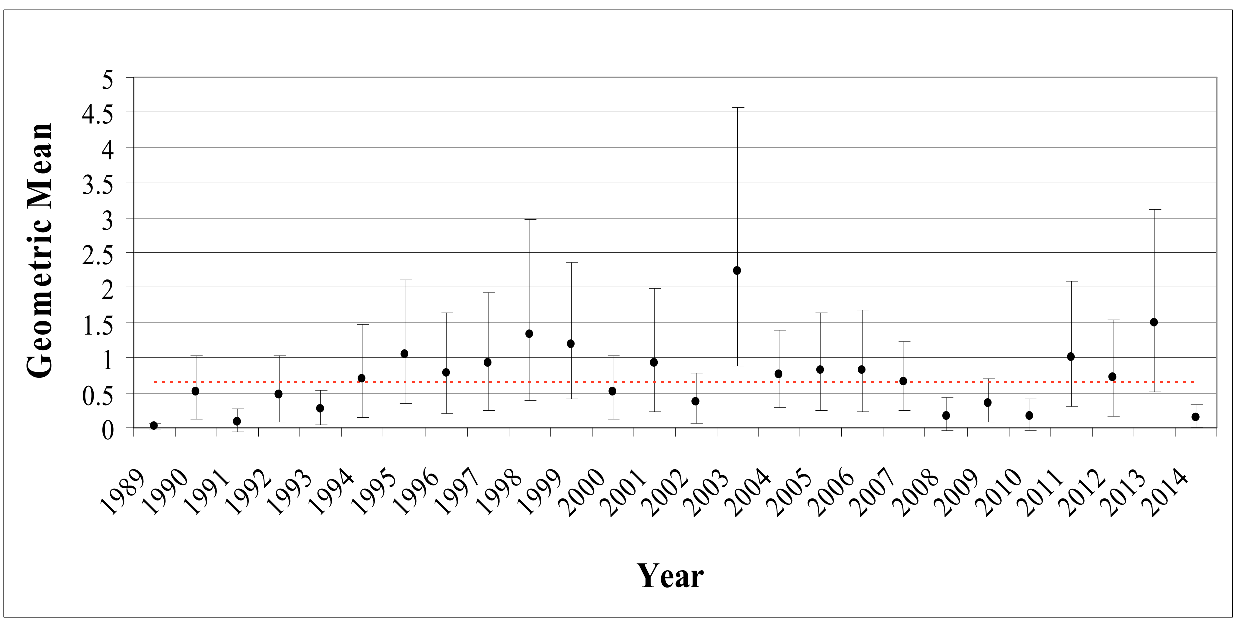

Figure 29. Winter Flounder (*Pseudopleuronectes americanus)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2013). Dotted line represents the 1989-2013 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

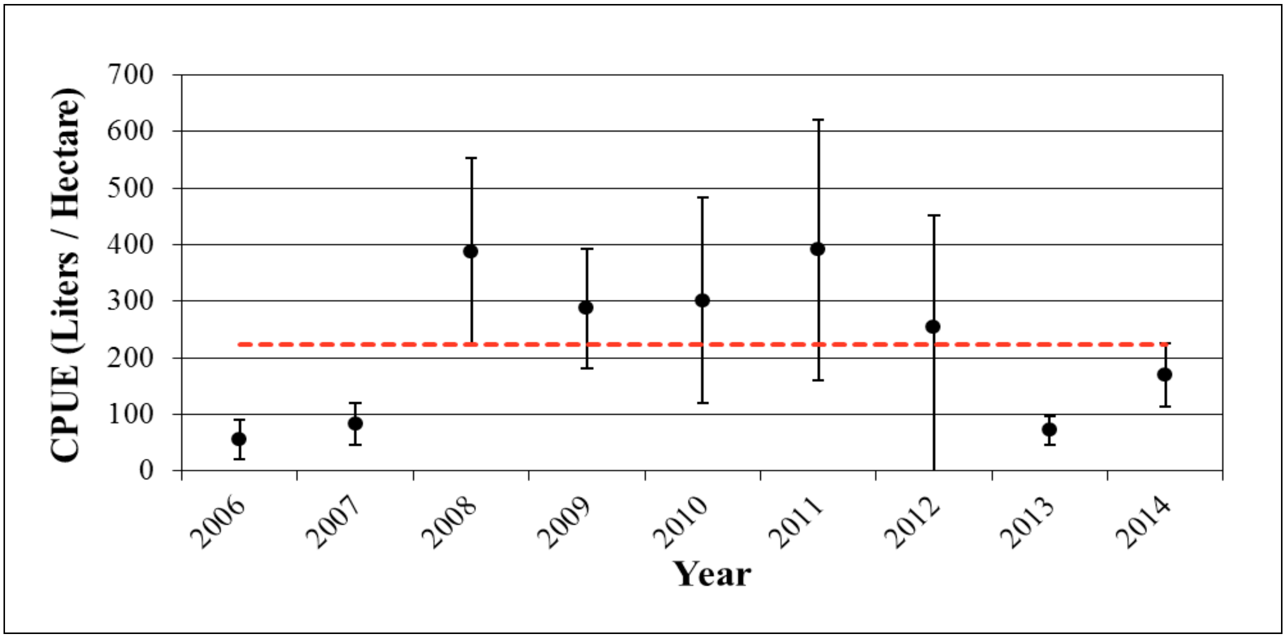

Figure 30. Coastal Bays trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=140/year).

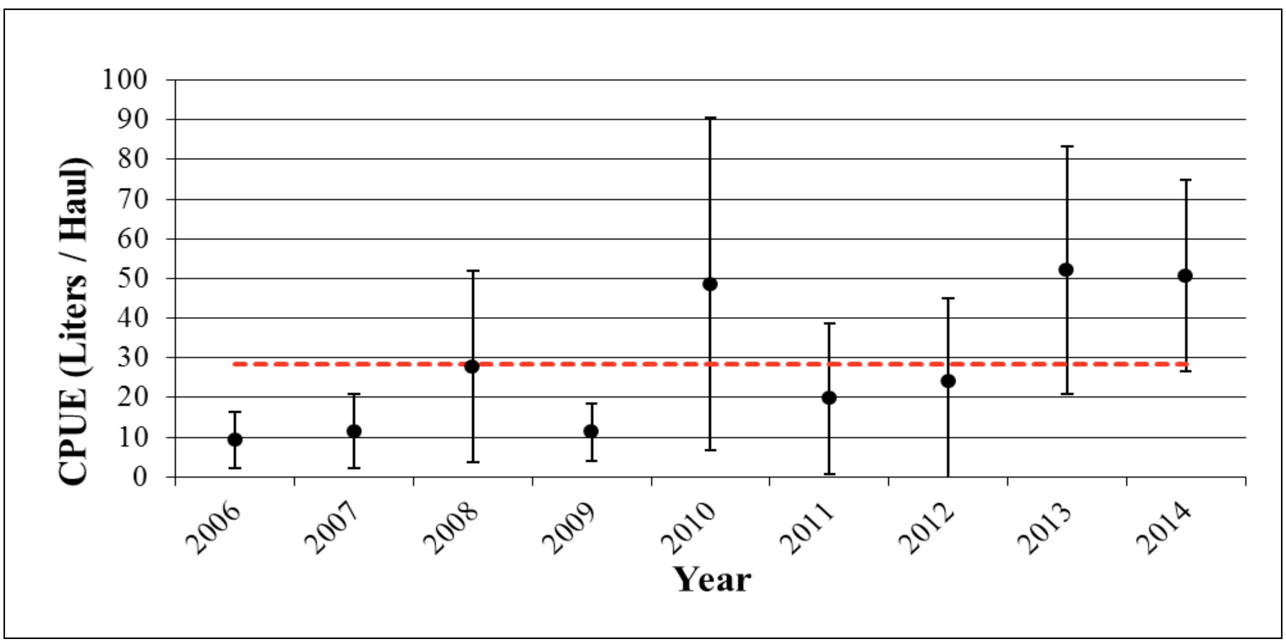

Figure 31. Coastal Bays beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=38/year).

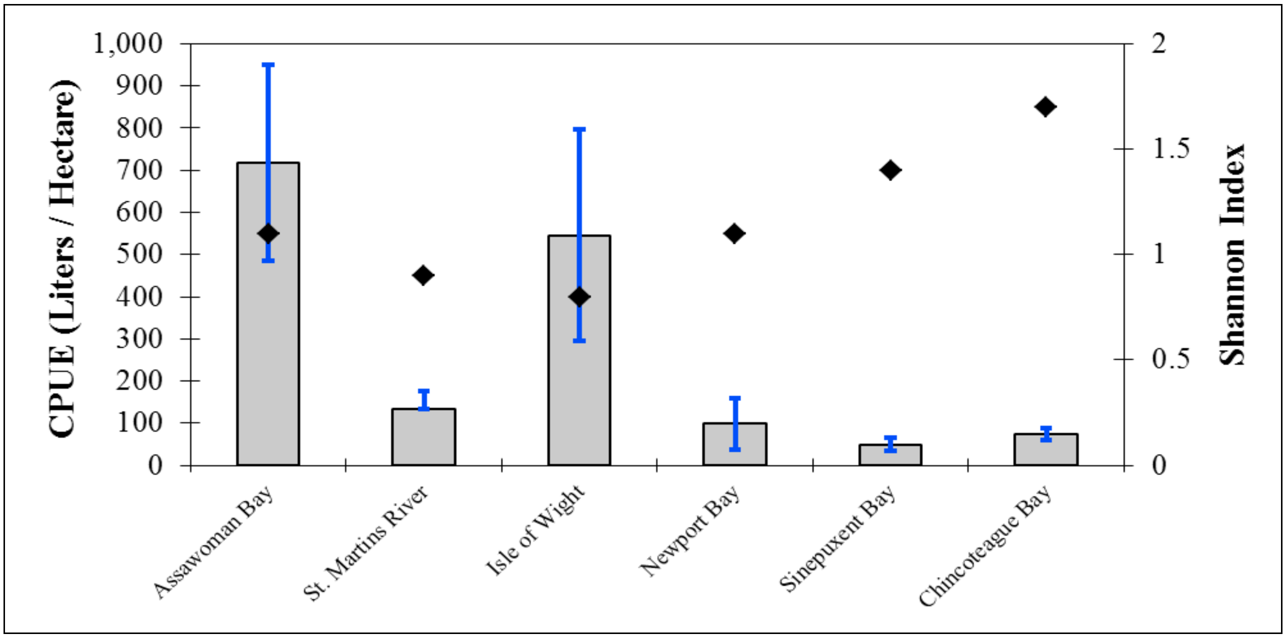

Figure 32. Coastal Bays trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Black diamond represents the 2006-2014 time series Shannon index of Diversity.

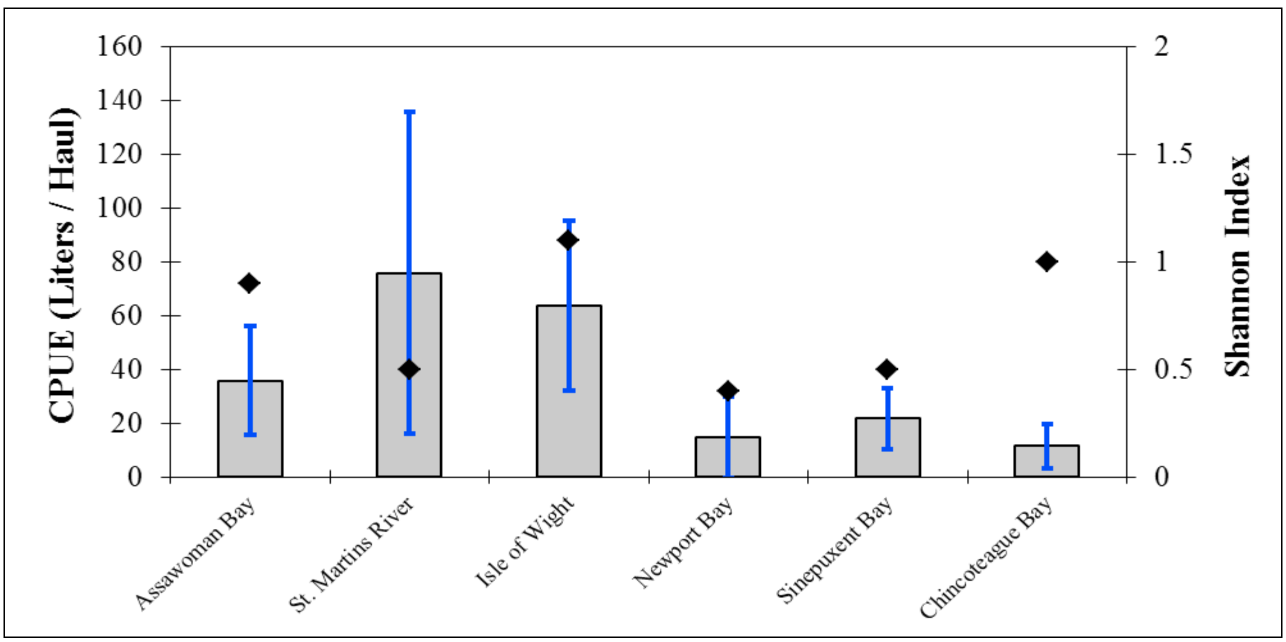

Figure 33. Beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2014). Black diamond represents the 2006-2014 time series Shannon index of Diversity.

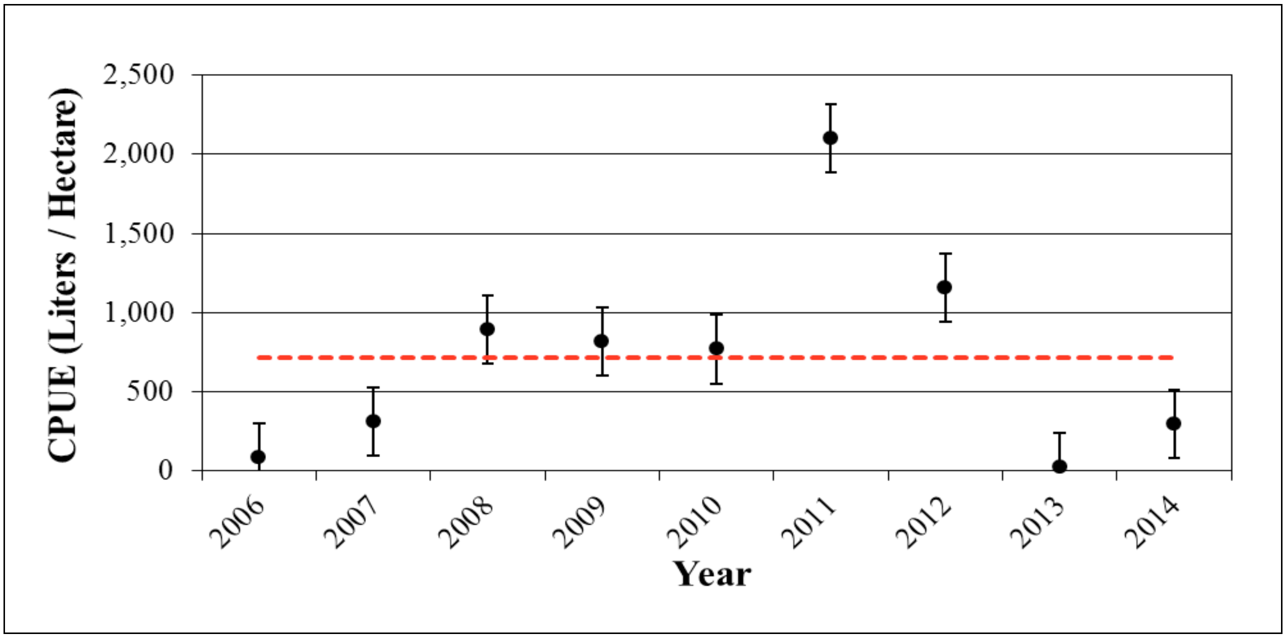

Figure 34. Assawoman Bay trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=21/year).

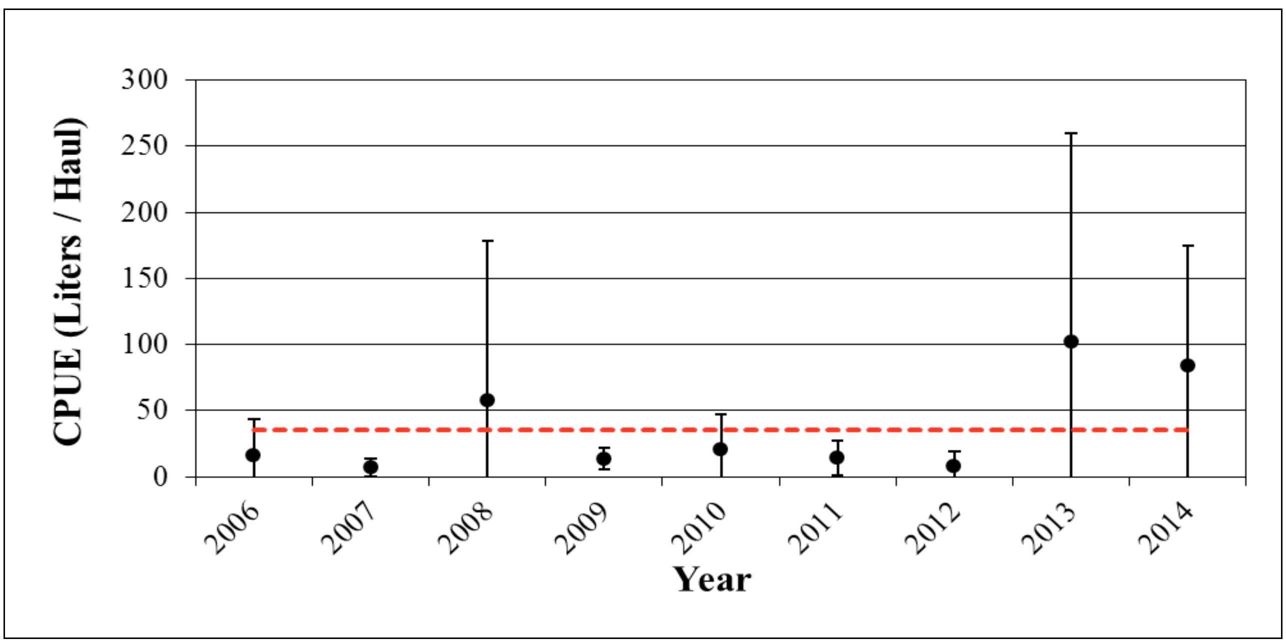

Figure 35. Assawoman Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=6/year).

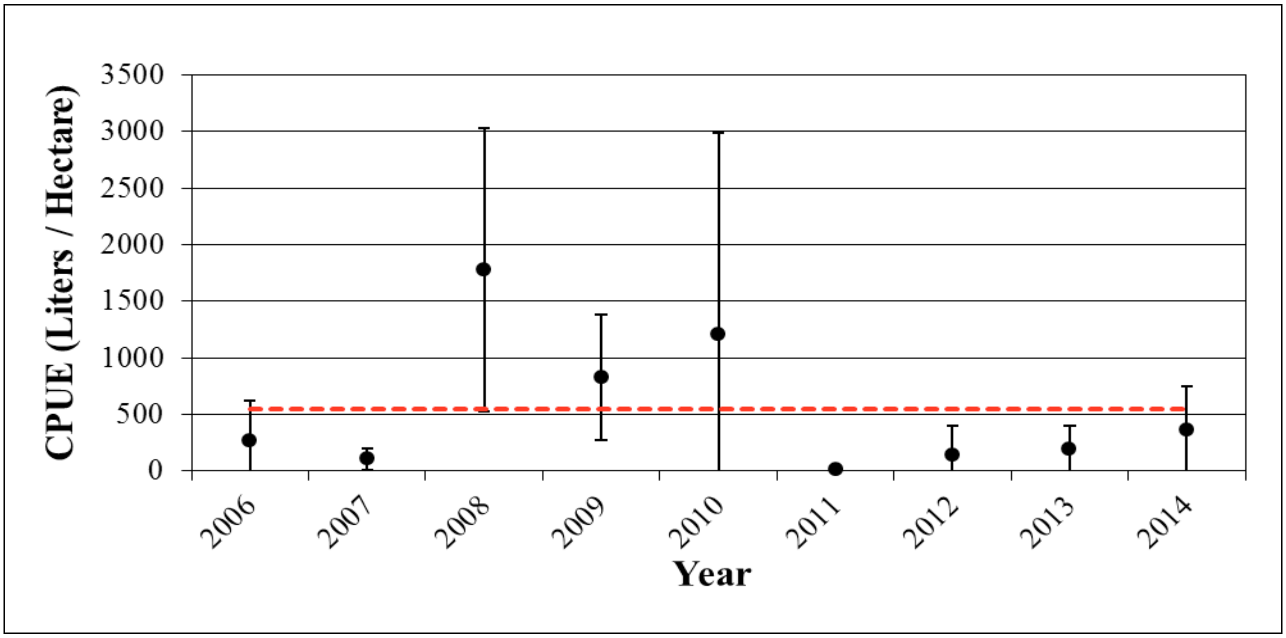

Figure 36. Isle of Wight Bay trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=14/year).

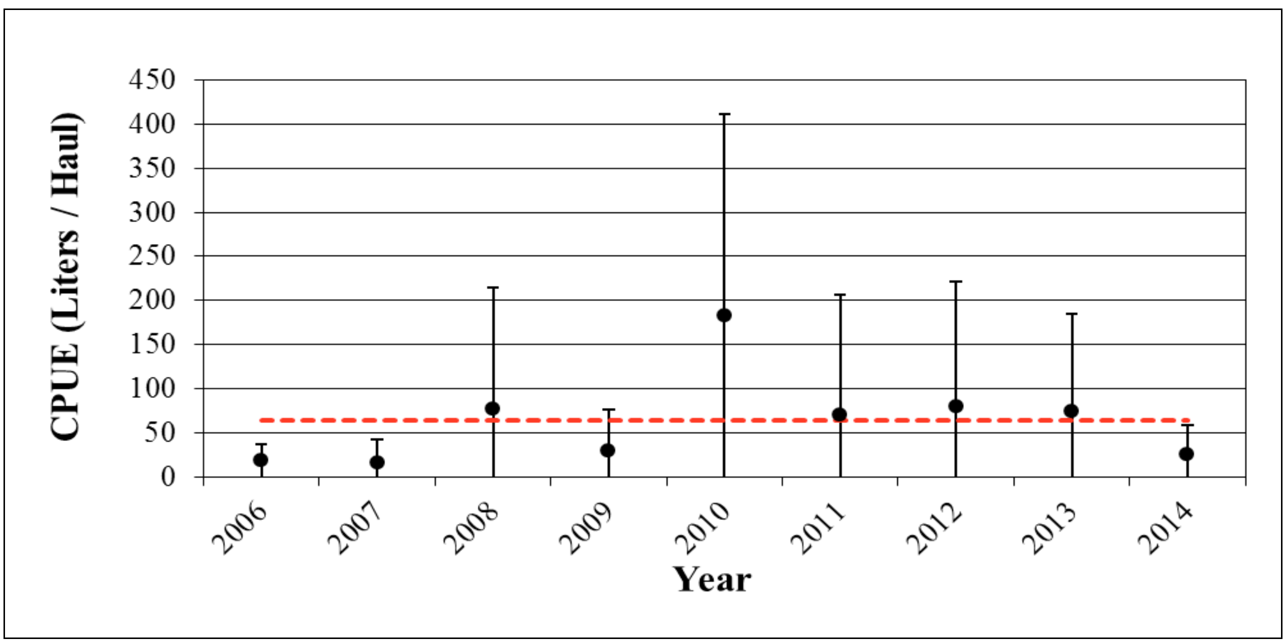

Figure 37. Isle of Wight Bay seine index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=4/year).

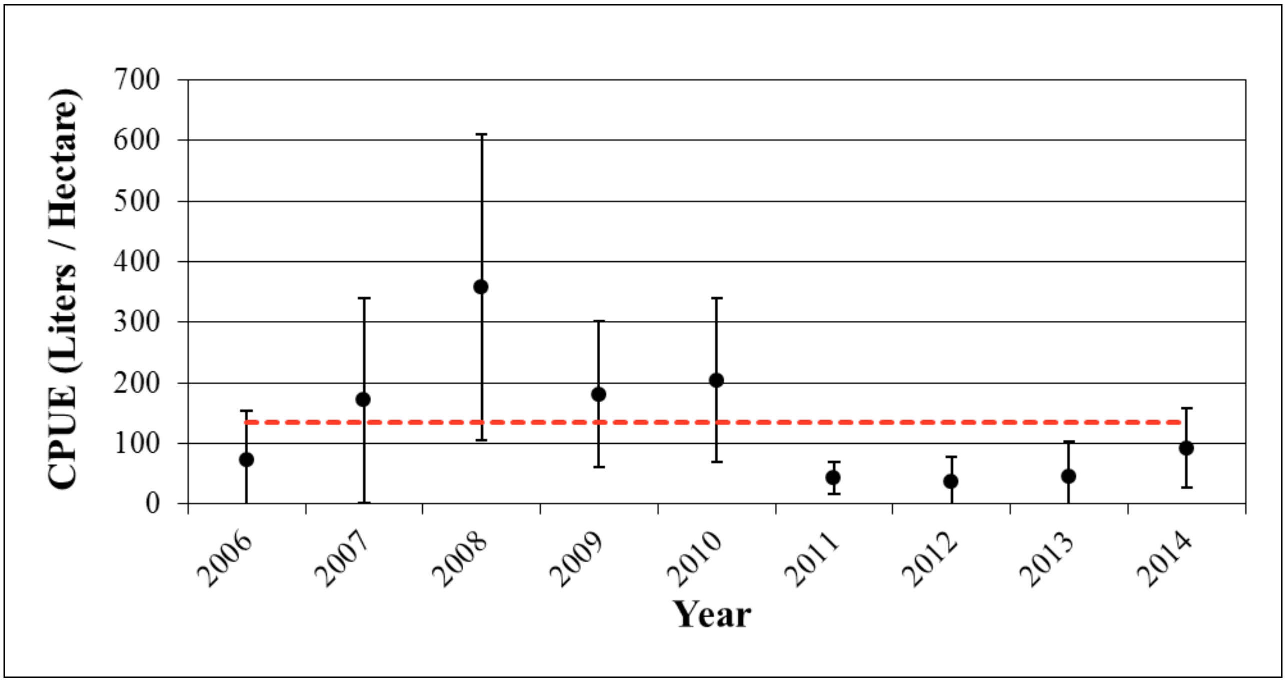

Figure 38. St. Martins River trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=14/year).

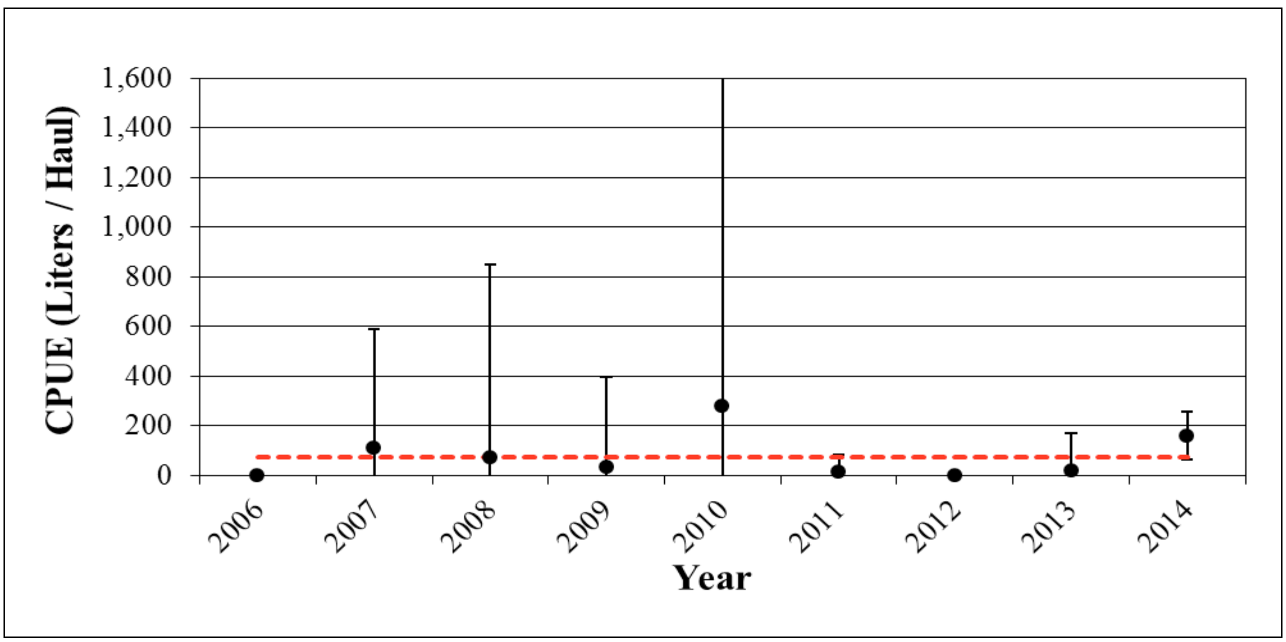

Figure 39. St. Martins River seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2014; 2010 [-2,479, 3,032]). Dotted line represents the 2006-2014 time series grand mean, (n=2/year).

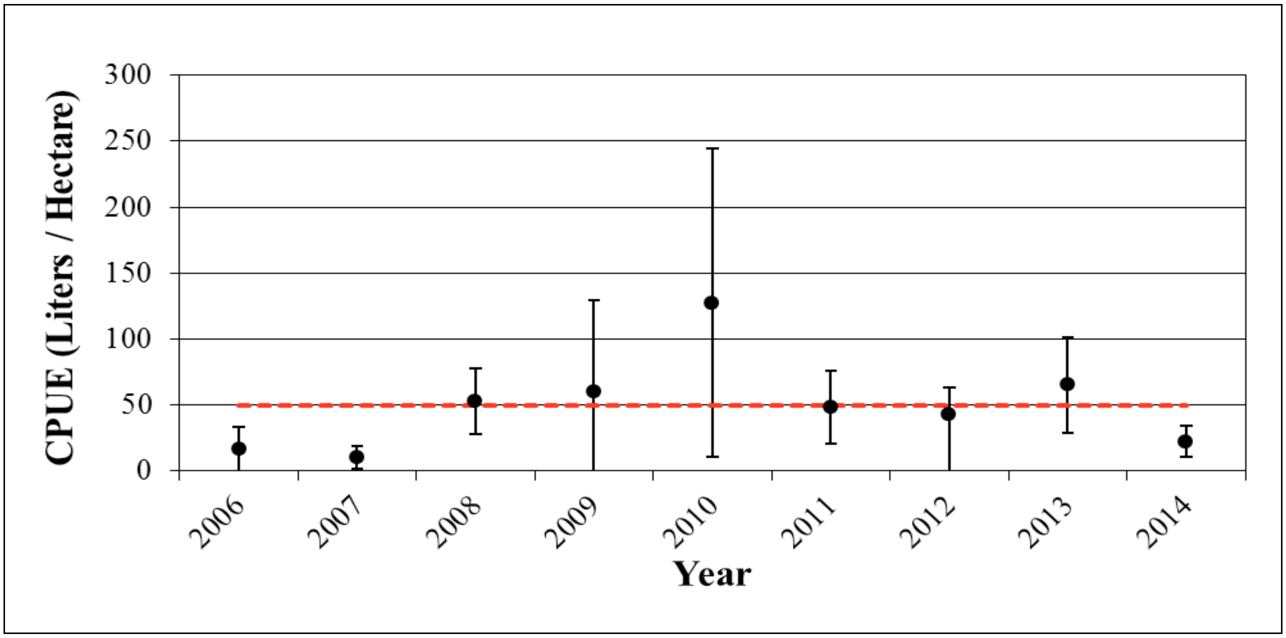

Figure 40. Sinepuxent Bay trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=21/year).

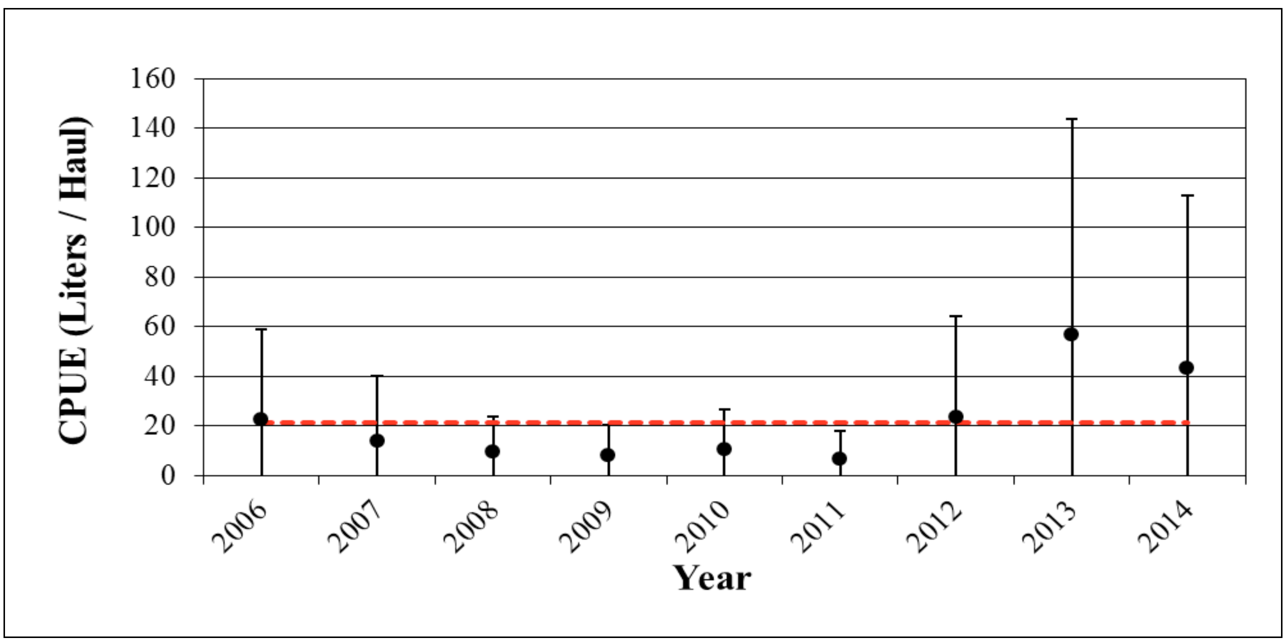

Figure 41. Sinepuxent Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=6/year).

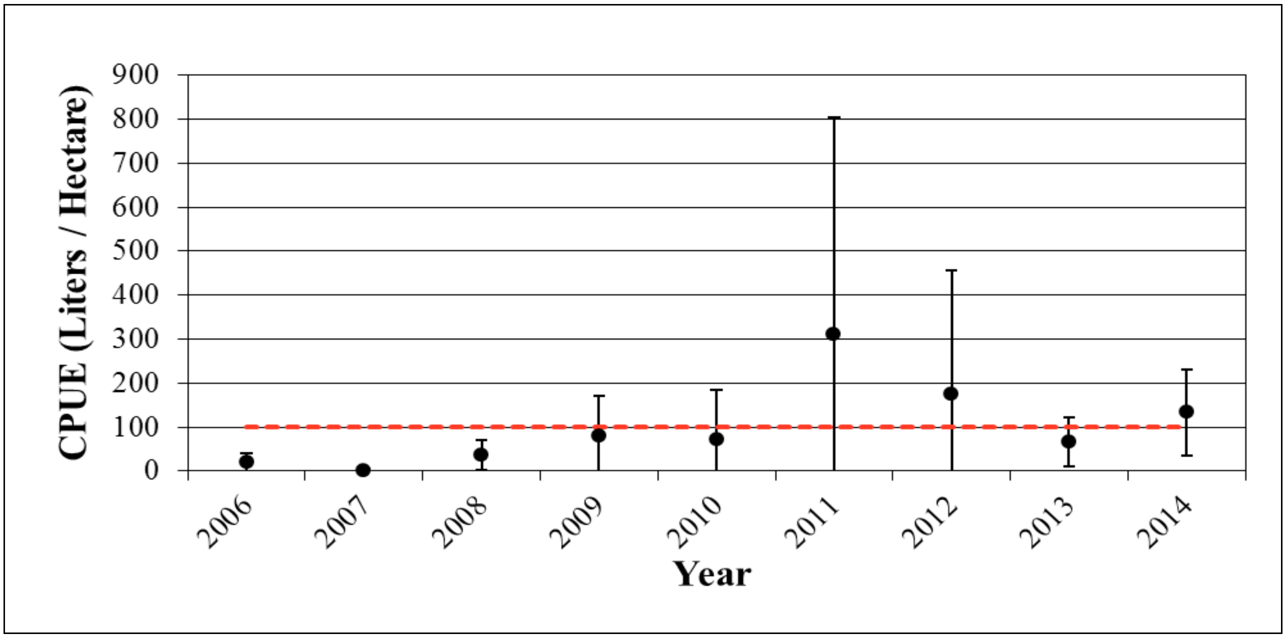

Figure 42. Newport Bay trawl index of relative macroalgae abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=14/year).

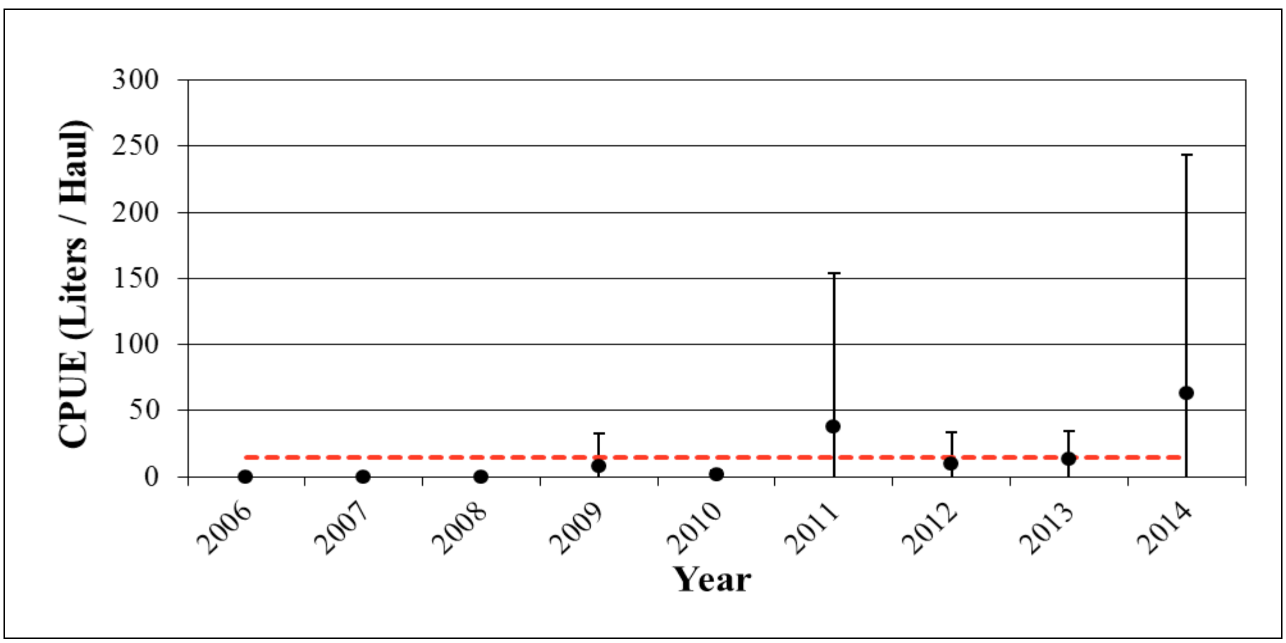

Figure 43. Newport Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=4/year).

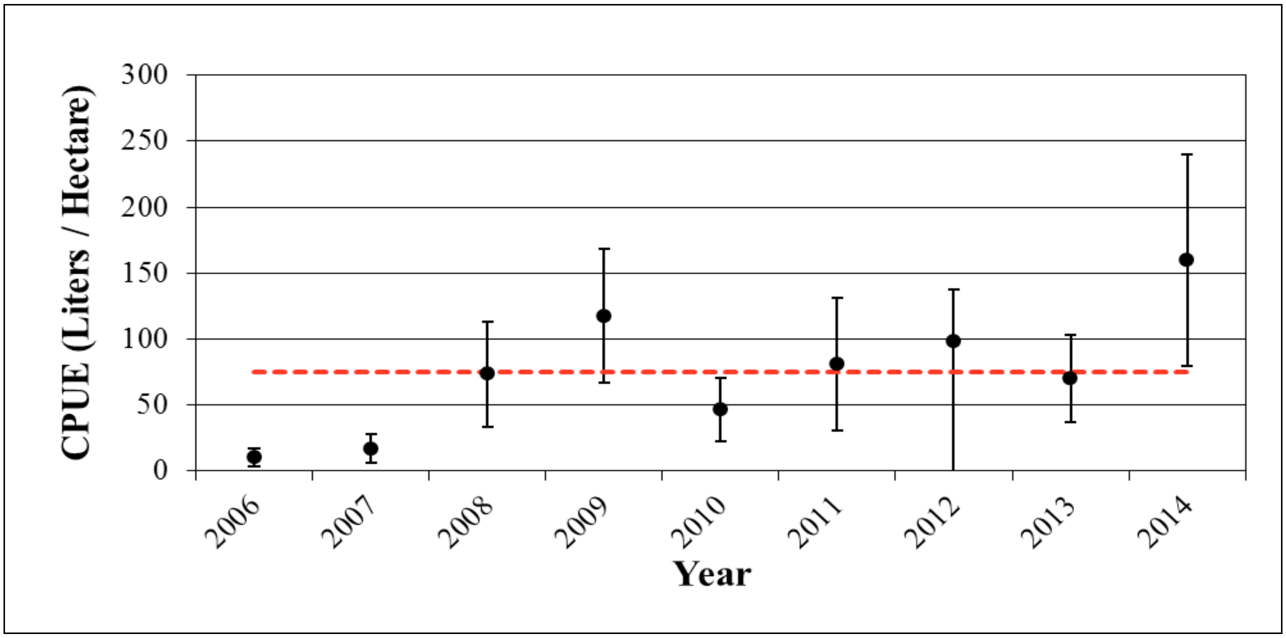

Figure 44. Chincoteague trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=56/year).

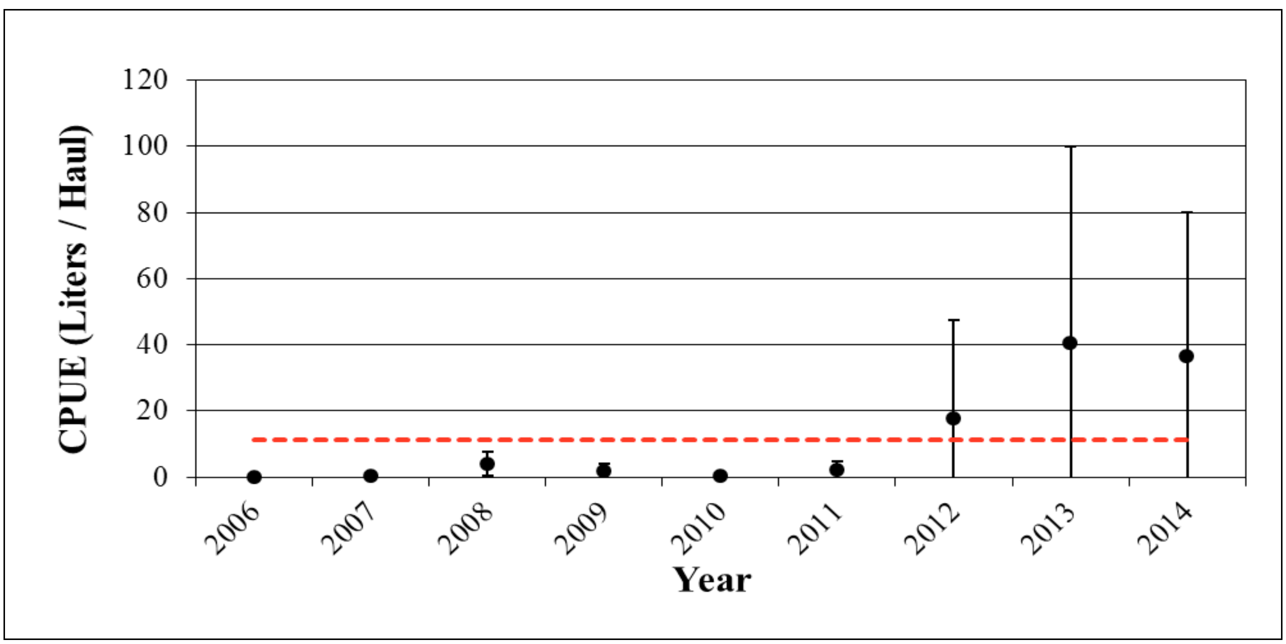

Figure 45. Chincoteague Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2014). Dotted line represents the 2006-2014 time series grand mean, (n=12/year).

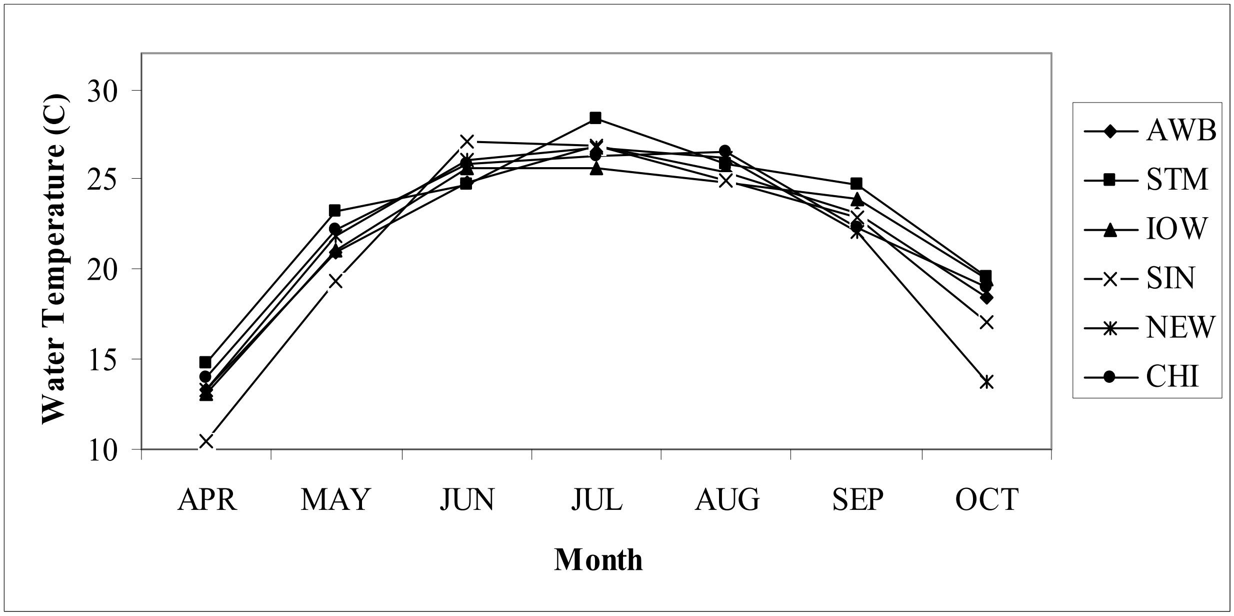

Figure 46. 2014 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

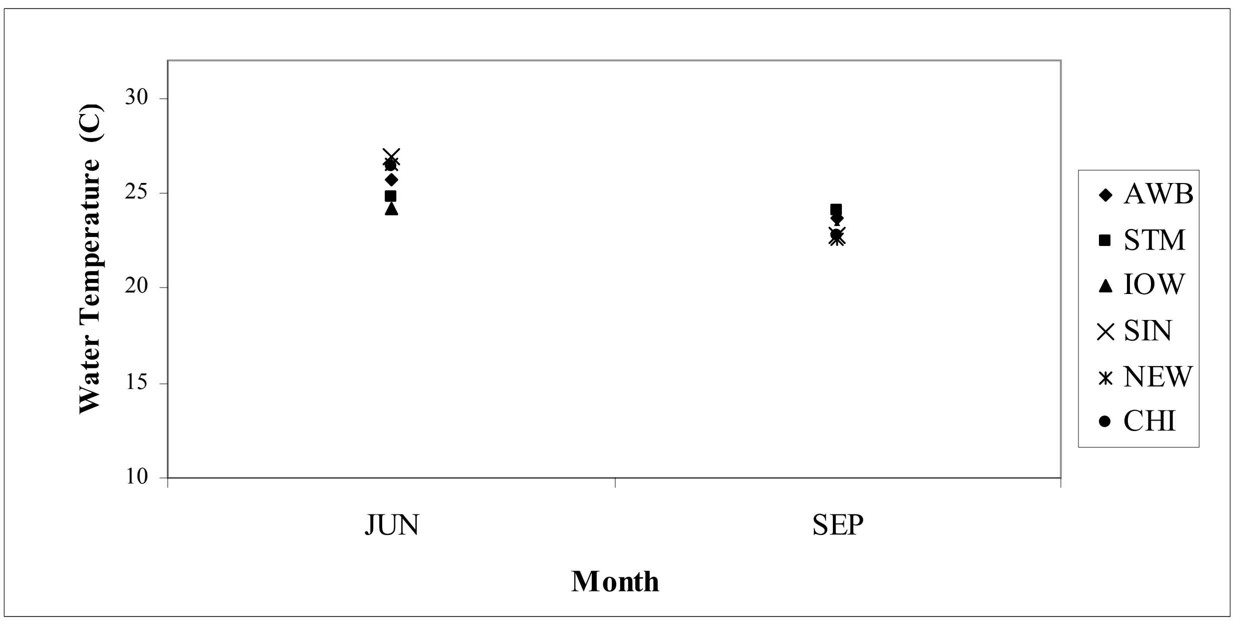

Figure 47. 2014 Coastal Bays Fisheries Investigations Beach Seine Survey mean water temperature (C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

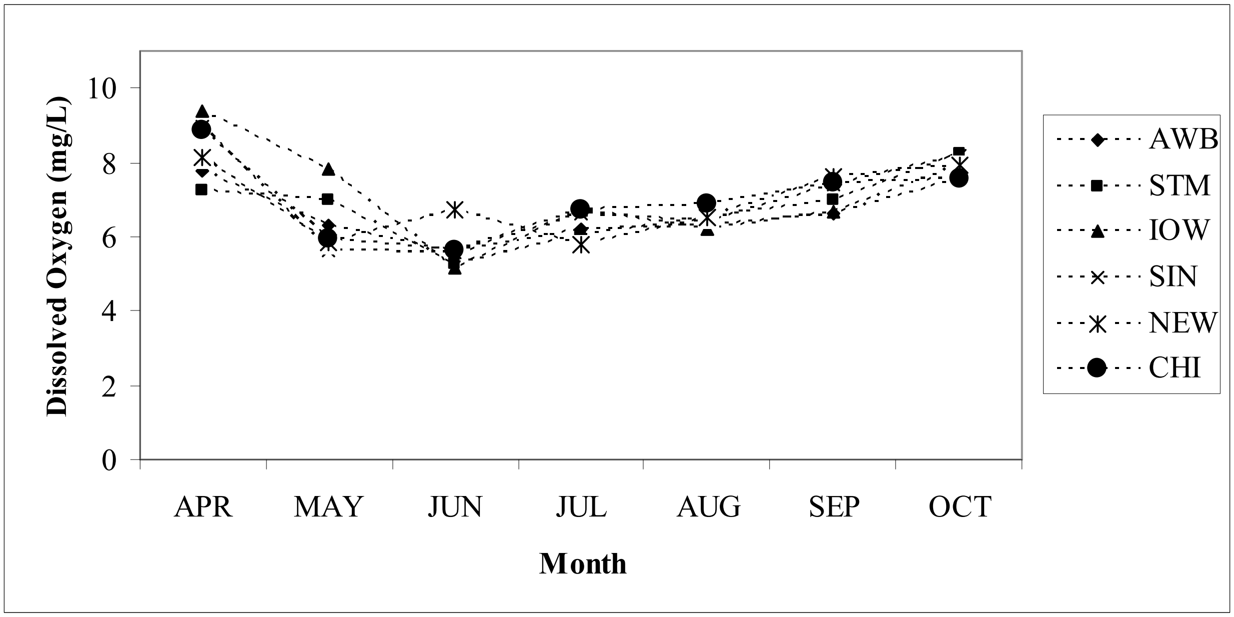

Figure 48. 2014 Coastal Bays Fisheries Investigations Trawl Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

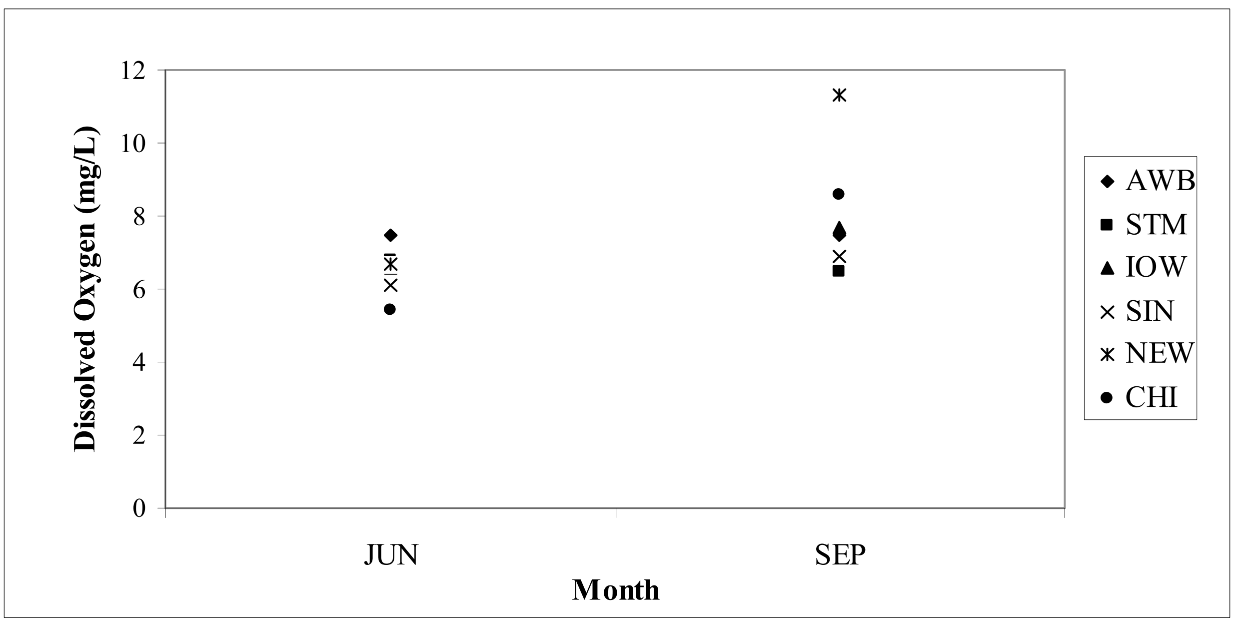

Figure 49. 2014 Coastal Bays Fisheries Investigations Beach Seine Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

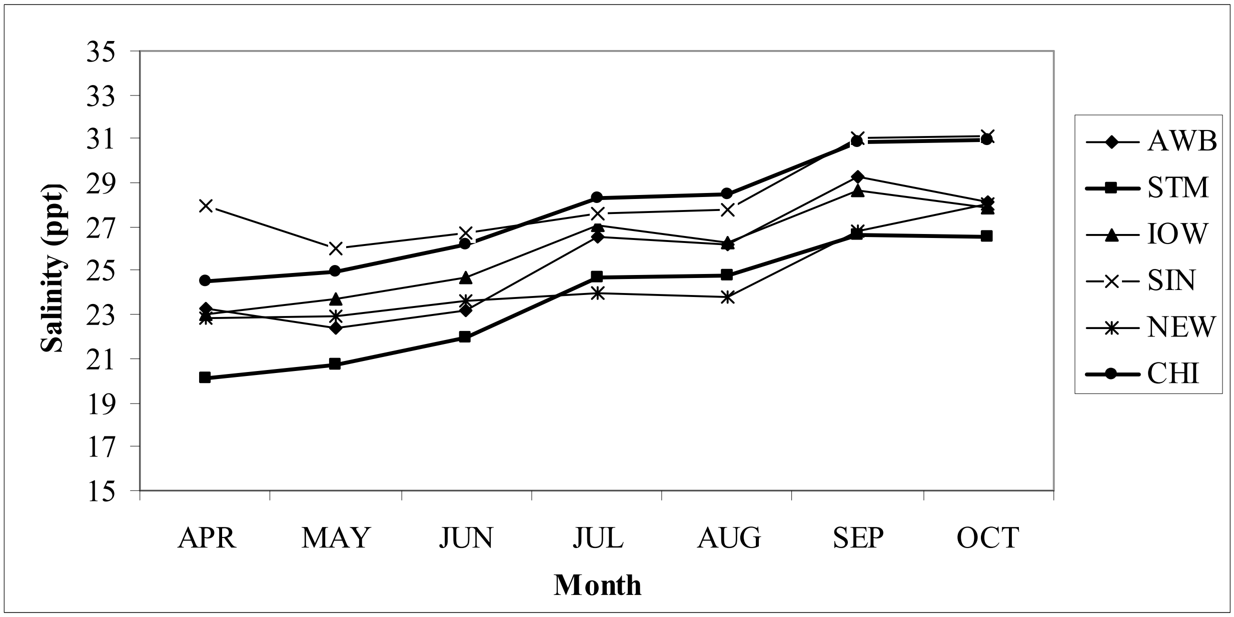

Figure 50. 2014 Coastal Bays Fisheries Investigations Trawl Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

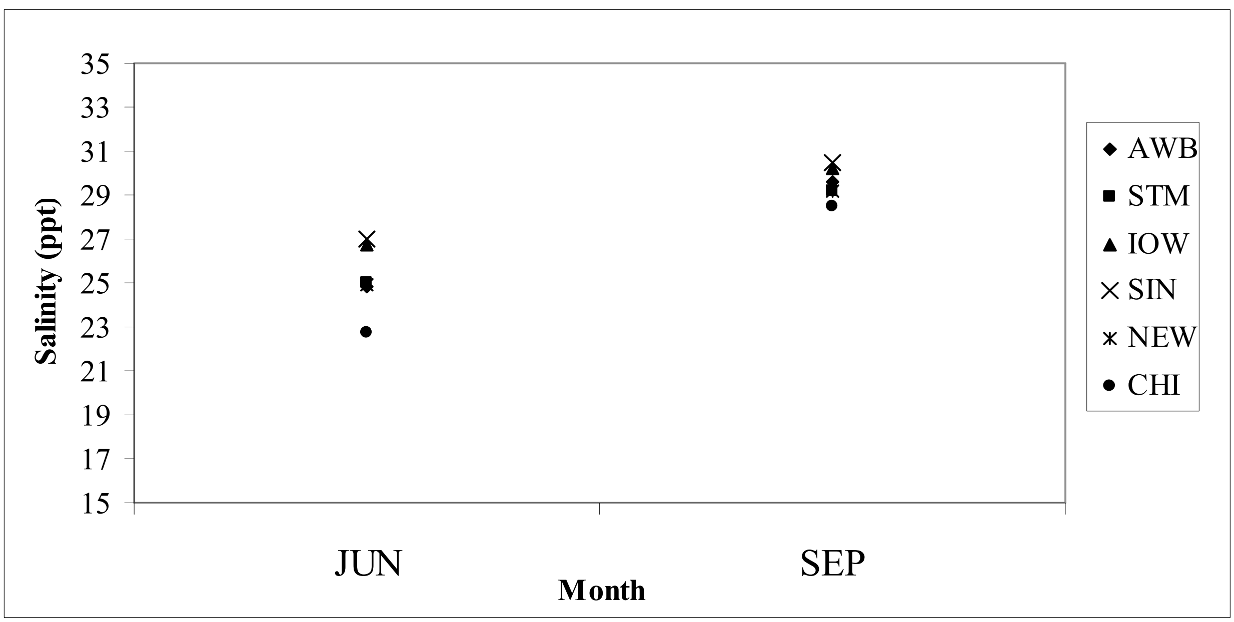

Figure 51. 2014 Coastal Bays Fisheries Investigations Beach Seine Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

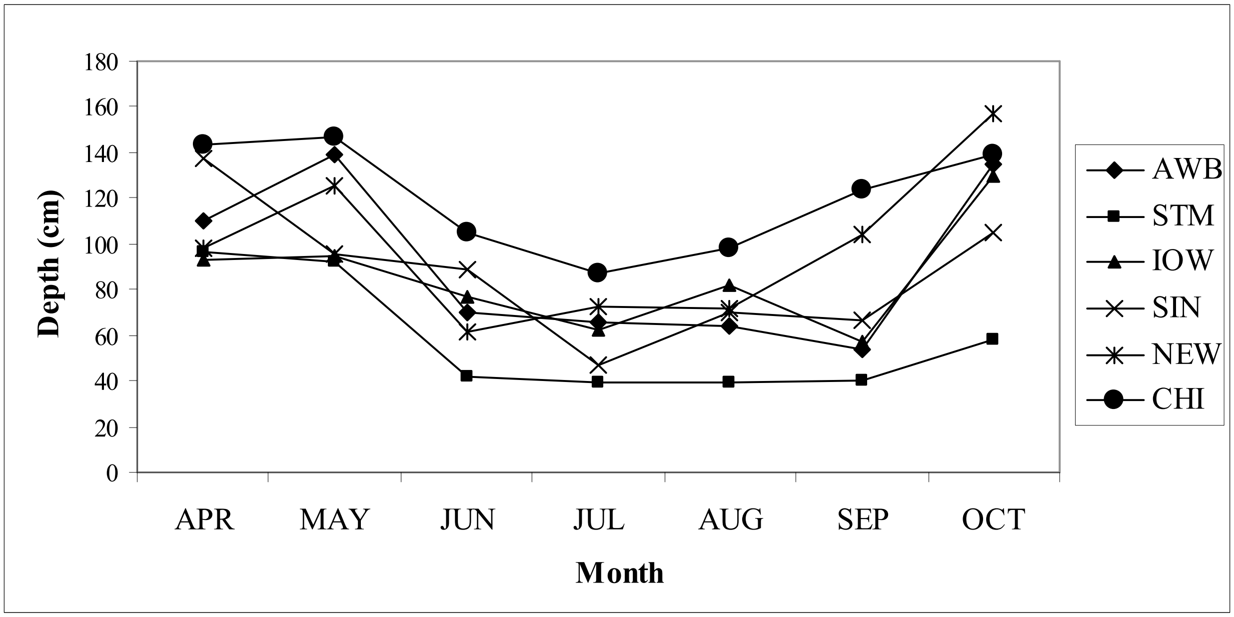

Figure 52. 2014 Coastal Bays Fisheries Investigations Trawl Survey mean turbidity (cm) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

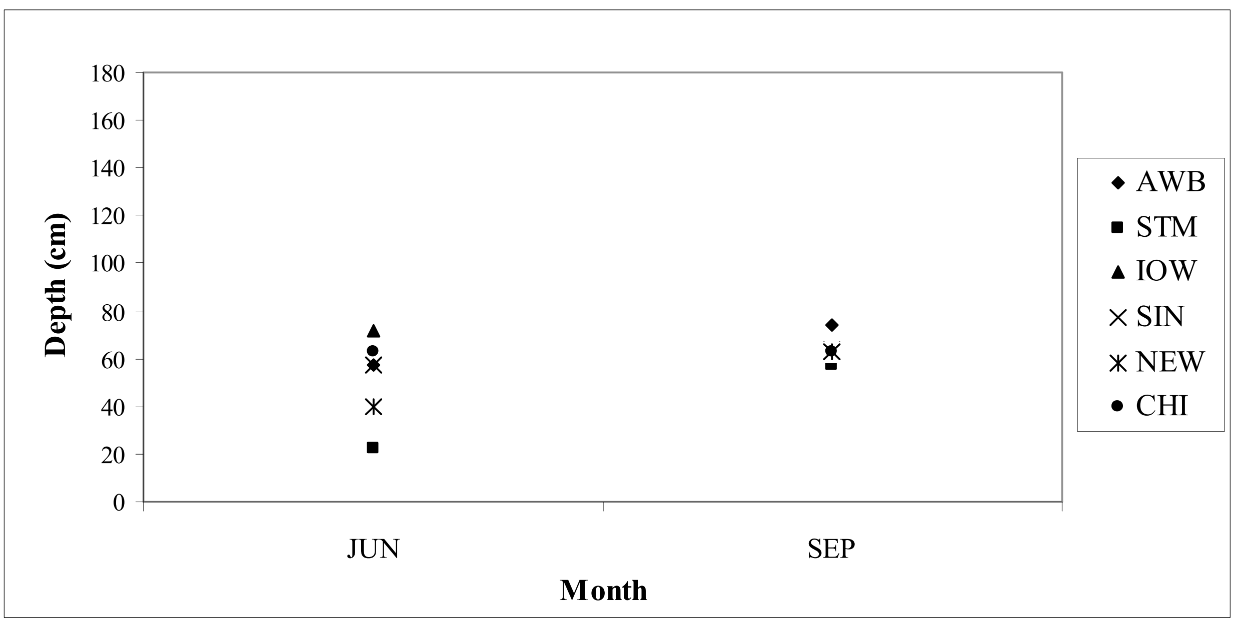

Figure 53. 2014 Coastal Bays Fisheries Investigations Beach Seine Survey mean turbidity (cm) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

Chapter 2

Coastal Bays Fisheries Investigations: Submerged Aquatic Vegetation Habitat Survey

Introduction

The Maryland Department of Natural Resources (MDNR) has been conducting the Coastal Bays Fisheries Investigations (CBFI) Trawl and Beach Seine Surveys since 1972, with a standardized protocol since 1989. These surveys are designed to characterize and quantify juvenile finfish abundance, but they also encounter bycatch that includes crustaceans, molluscs, sponges, and macroalgae. The surveys rarely sample in submerged aquatic vegetation (SAV). Currently, there is limited information specific to Maryland's Coastal Bays' SAV beds as critical or essential habitat for living resources.

Although there are many species of SAV in the Mid-Atlantic, there are only two species found in Maryland's Coastal Bays: eel Grass (*Zostera marina*) and widgeongrass (*Ruppia maritima*; Coastal Bays Sensitive Areas Technical Task Force 2004). While SAV beds are found throughout the Coastal Bays, they are not distributed evenly. The majority of the eel grass beds are located along the Assateague Island shoreline; widgeongrass is also present but at a lower abundance. Both SAV species provide a wide variety of functions essential to the ecological health of the bays; foremost among them is as prime nursery habitat. The young of many commercially, recreationally, and ecologically important 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 decapods, and SAV's susceptibility to anthropogenic perturbations, the characterization of fisheries resources within these areas is important (Connolly and Hindell 2006). As a result, MDNR expanded the CBFI to include sampling the SAV beds in 2012. 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 of this study to better guide management decisions.

Field Methods

Sampling Period
Sampling was conducted in June, July and August.

Study Area
Three zones were delineated: the Northern Bays (north of the Route 50 Bridge, comprised of Assawoman Bay and the Isle of Wight Bay), Sinepuxent Bay, and Chincoteague Bay (everything south of South Point). Four randomly selected sites were sampled in each zone in June and August 2013 (Figure 1, Table 1).

The sites were chosen using the Excel Random Number Generator (RANDBETWEEN function) and a 305 m x 305 m grid (created with GIS in 2012) overlaying areas where SAV beds had been present for at least five years based on data from the Virginia Institute of Marine Sciences (VIMS) SAV survey. All potential sites were verified in ArcMap to make sure there was at least 600 m^2 of SAV for sampling were appropriate depth (less than 1.5 m) and accessible. Sites that did not meet the minimum SAV bed size were eliminated. In the field, if a primary site lacked SAV, was too deep, or was inaccessible, an alternate site was used instead of the primary site.

Each zone was sampled entirely in one day, and there were no instances where severe weather or emergencies made it necessary to stop sampling before completing an entire zone.

An experimental round was conducted in July in order to test a different seining technique. Four areas in Sinepuxent Bay were selected as the study zones for side-by-side comparisons. All study areas had ample SAV abundance (above 50% SAV in the area).

Data Collection

A 25 foot C-hawk with a 225 horsepower Evinrude E-tec engine was used in the Northern Bays, and a borrowed 19 foot Carolina Skiff with a 90 horsepower Evinrude E-tec engine was used for transportation to the sample sites and gear deployment in the other areas of this survey. Latitude and longitude coordinates (waypoints) in degrees and decimal minutes (ddmm.mmm) were used to navigate to sample locations. The GPS was also used to obtain coordinates at the start and stop points of the seine haul.

A 15.24 m X 1.8 m X 6.4 mm mesh (50 ft X 6 ft X 0.25 in. mesh) zippered bag seine was used. Staff estimated percent of net open and a range finder was used to quantify the distance of the seine haul. The haul distance was 35 meters for all hauls. In June, as in the previous years of this survey, the seine was pulled across the SAV beds, swung up through the water column, and lifted out of the water using both the float and lead lines. Then the sample was shaken down into the bag and carried back to the boat for processing.

In July, a different technique was conducted, “circling” the seine at the end of the haul. Staff ensured that the lead line remained on the bottom until the catch was enclosed in the zipper bag. The “lift” and “circle” techniques were conducted side-by-side in July and August.

Water Quality and Physical Characteristic Data were collected using the same method and parameters described in Chapter 1. Only surface chemical data were collected due to the shallow depth (<1.5 m). Data were recorded on a standardized project data sheet printed on Rite in the Rain All Weather paper (Appendix 4).

Sample Processing

Samples were processed using the same methods described in Chapter 1. Fishes and invertebrates were identified, counted, and measured for Total Length (TL) using a wooden millimeter (mm) measuring board with a 90 degree right angle. A meter stick was used for species over 500 mm. At each site, a sub-sample of the first 20 fish (when applicable) of each species were measured and the remainder counted.

Blue crabs were measured for carapace width, sexed, and maturity status was determined. Sex and maturity categories included: male, immature female, mature female (sook), and sook with eggs. A subsample of the first 50 blue crabs at each site was measured and the rest were counted.

Jellyfishes, ctenophores, bryozoans, sponges, and macroalgae were measured volumetrically (liters, L) using calibrated containers with small holes in the bottom to drain the excess water. Small quantities (generally ≤ 10 specimens) of invertebrates were occasionally counted. Larger quantities of invertebrates were estimated. Bryozoans and macroalgae were combined for one volume measurement and a biologist estimated the percentage of each species in the sample.

Data Analysis

Comparison of "Circle" and "Lift" Seining Techniques
The circle and lift seining techniques were compared in order to investigate fish catchability by technique. A t-test was conducted on fish abundance (number of fish/haul).

Measures of Fish Abundance and Diversity
CPUE was calculated as the number of fish per seine haul. The Shannon-Weaver index converted to Effective Number of Species (ENS) was used to quantify diversity of species collected in each seine haul (Jost 2009).

Covariates
Fish abundance and diversity were compared across SAV coverage categories and zone, and against macroalgae abundance and diversity. Rank sum values of SAV coverage by zone were calculated by assigning the following rank values: D = 1, C = 2, B = 3, A = 4.

Results

Comparison of "Circle" and "Lift" Seining Techniques
The July seining comparison showed that the catchability of fish and fish community diversity were both higher utilizing the circle technique (11.75/fish per haul, ESN =5.6) than the lift technique (3.25/fish per haul, ESN = 3.3). These results supported a change in field technique, so August sampling included both techniques.

The same catchability results were repeated in August, with a 196.1/fish per haul collected using the circle technique compared to 65.1/fish per haul using the lift technique. Therefore, the results discussed below were calculated from data collected using the circle technique in August 2014.

Sample Size and Distribution
These results are based on 12 samples, evenly distributed among the Northern Bays, Sinepuxent Bay, and Chincoteague Bay, however, these twelve samples were not evenly distributed among SAV categories. Category D (0-25% coverage) and C (25-50% coverage)

had 4 and 5 samples, but Category B (50-75% coverage) had only 1 sample and Category A (75-100% coverage) had only 2 samples.

The SAV categories were not evenly distributed among zones. The Northern Bays equated to low SAV coverage (samples were categories C, C, D, and D, ranked sum SAV score = 6). Sinepuxent Bay and Chincoteague Bay showed greater diversity of coverage, with similar higher ranked sum SAV scores (Sinepuxent samples were A, B, C, D = 6, ranked sum SAV score = 10; Chincoteague samples were A, C, C, D; ranked sum SAV score = 9).

Fish sampling was dominated by silver perch (131.7 fish/haul, 70% of total catch) and Atlantic silverside (37.1 fish/haul, 19.7% of total catch; Table 2). These two species accounted for 90% of total catch and strongly affected both fish abundance and diversity values. Macroalgae was dominated by Agardh's Red Weed, which accounted for 56% of the total macroalgae sampled (Table 3).

Fish Diversity

Fish diversity showed an increasing trend with greater SAV coverage (Table 4). The Category D catch was dominated by silver perch (83% of the catch), resulting in an ENS of 1.8. Both Category C and B had ENS values of approximately 3, with approximately 80% of the catch comprised of silver perch and Atlantic silversides. Category A had much greater diversity (ENS = 9), with silver perch and Atlantic silversides comprising 50% of the catch.

Fish diversity by zone reflected SAV coverage results (Table 5). The Northern Bays catch was dominated by silver perch (93% of the catch), resulting in an ENS of = 1.5. Both Sinepuxent Bay Chincoteague Bay (higher SAV coverage scores) had ENS values of approximately 4, with 80% of the catch comprised of silver perch and Atlantic silversides.

Similarly, fish diversity increased with macroalgae diversity, as both showed increasing diversity with greater SAV coverage, generally increasing from north to south. Macroalgae ENS in the Category D was 1.8, whereas Category C and A values were both 3.8. (Category B had only one sample with an ENS of 1.8.) By zone, the Northern Bays ENS was 1.3 (dominated by Agardh's Red Weed at 96%), followed by the Sinepuxent Bay macroalgae ENS of 3.1 (with 63% tubed weeds and 21% Agardh's red weed) and the Chincoteague Bay macroalgae ENS of 4.5 (with 40% banded weeds, 23% hairy basket weed and 20% green hair algae).

Fish Abundance

Fish abundance results were dominated by presence/absence of silver perch and Atlantic silversides, which showed no preference for SAV (Table 4). Category D (0-25% coverage) showed 293 fish/haul over 4 samples (97% silver perch and Atlantic silversides), Category C (25-50% coverage) showed 164 fish/haul over 5 samples (85% silver perch and Atlantic silversides), Category B (50-75% coverage) showed 107 fish/haul in 1 sample (88% silver perch and Atlantic silversides), and Category A (75-100% coverage) showed 76 fish/haul over 2 samples (48% silver perch and Atlantic silversides).

Fish abundance by zone generally reflected SAV coverage results, with fish abundance following a north-south trend (Table 5). Northern Bays samples showed 363.5 fish/haul (98% silver perch and Atlantic silversides), followed by Sinepuxent Bay with 135.5 fish per/haul and Chincoteague Bay with 64 fish/haul (both 80% silver perch and Atlantic silversides).

Water Quality
The water quality tested at all SAV Habitat Survey sites was consistent with fish habitat requirements. The average DO in June was 7.2 mg/L, and was 7.3 mg/L in August. The water temperature average was 23.2°C in June and was 25.9ºC in August. The salinity average in June was 26 ppt and it was 27.6 ppt in August. The bottom was visible (depths up to 1.5m) at 75% of sites in June and 50% of the sites in August.

Discussion

The low sample sizes did not support statistical testing, so results are limited to observed means and diversity values. Although the small sample size limits interpretation of the results, the data indicate that diversity of both fish and macroalgae communities increased with greater local SAV coverage.

These results also indicate that there are other strong co-variates besides SAV coverage, as indicated by different fish and macroalgae communities in the different bays. The strong variability by zone (bay) indicated that results from sampling a single zone cannot be interpreted to represent all Coastal Bays.

The comparison between seine techniques also showed that results are highly dependent on very specific field techniques, and results cannot be compared across multiple studies or even across the years of this study.

Much larger sample sizes are needed per strata to support statistical comparisons. An attempt could be made to balance sampling of SAV categories across zones, but balanced SAV coverage is not indicative of actual zone conditions. The large difference seen in abundance across months showed high within-season variability, and indicate that an increased sampling period would not improve results due to increased variability of the data.

It is important to note that these results were seen at a scale too small and mercurial to be captured by remote sensing techniques or maps produced on multi-year schedules, and depended on ground-truthing to determine final sampling locations. Therefore, improvements to the results seen from this study are likely to come from a similar, targeted field study.

Recommendations

Future work should attempt to increase sample size and reduce the effects of zone, specifically the Northern Bays, while increasing the ability to compare results among the long-term surveys discussed in Chapter 1. This work should be accomplished by balanced sampling across SAV coverage (A, B, C and D) in Sinepuxent Bay in September for three years. Expected results should reveal the fish assemblage diversity and CPUE by SAV coverage. Moreover, those results may be compared to the long-term CBFI surveys that also target fish assemblages in September within the Coastal Bays, but not directed in SAV beds. Such comparisons may be able to detect that specific life stages of fish prefer SAV to other habitat like sandy beaches, muddy beaches or the open water.

References

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Connolly, R. M. and J. S. Hindell. 2006. Review of nekton patterns and ecological processes in seagrass landscapes. Estuarine, Coastal and Shelf Science. 68:433-444.

Jost, Louis, "The new synthesis of diversity indices and similarity measures." April, 2009. Web. 1 Feb 2014. http://www.loujost.com/Statistics%20and%20Physics /Diversity%20and%20Similarity/EffectiveNumberOfSpecies.htm

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Table 1. MDNR Coastal Bays Fisheries Investigation 2014 SAV Habitat Survey site descriptions.

Site Number	Bay	Site Description	Latitude	Longitude
V011	Assawoman Bay	West of first canal at 90th street	38 24.502	75 04.542
V049	Assawoman Bay	North of Rt. 90 Bridge; about 15 light posts from Ocean City	38 23.319	75 04.850
V050	Assawoman Bay	West of Ocean City water tower; North of Rt. 90 Bridge	38 23.259	75 04.631
V052	Isle of Wight Bay	South of Rt. 90 Bridge; 14 light posts West of Ocean City	38 23.189	75 04.855
V053	Isle of Wight Bay	South of Rt. 90 Bridge; West of Fager's Island	38 23.092	75 04.677
V054	Isle of Wight Bay	South of Rt. 90 Bridge; where Bridge meets Ocean City	38 23.118	75 04.483
V058	Isle of Wight Bay	South of Rt. 90 Bridge, West of Fager's Island	38 23.040	75 04.649
V128	Sinepuxent Bay	South of Duck Blind, East of Green Marker	38 17.118	75 07.749
V140	Sinepuxent Bay	West of Red #14 Daymarker	38 16.537	75 08.218
V146	Sinepuxent Bay	South of Gray's Cove	38 16.412	75 08.317
V174	Sinepuxent Bay	Northeast of Verrazano (611) Bridge, opposite Sandy Cove	38 15.452	75 07.964
V212	Sinepuxent Bay	South of Verrazano Bridge; West of Sandy Point Island; on channel edge	38 14.322	75 09.292
V280	Sinepuxent Bay	East of T011; close to shore	38 12.890	75 12.073
V297	Sinepuxent Bay	North of Great Egging Island; South of Bayside Road	38 12.462	75 10.556
V343	Chincoteague Bay	West of Lumber Marsh Island, North of Outward Tump	38 11.445	75 11.999
V434	Chincoteague Bay	Southwest of Crow Tump	38 10.100	75 12.517
V481	Chincoteague Bay	South of Crow Tump	38 09.317	75 11.544
V484	Chincoteague Bay	Southwest of Crow Tump	38 09.086	75 12.153

Table 2. List of fishes collected in Maryland's Coastal Bays SAV Habitat Survey from August 2014. Species are listed in order of total abundance. Total SAV Habitat Sites = 12.

Common Name	Scientific Name	Total Number Collected	Percent of Total Catch	CPUE SAV Habitat Survey #/Haul
Silver Perch	*Bairdiella chrysoura*	1,580	70.1	131.7
Atlantic Silverside	*Menidia menidia*	445	19.7	37.1
Northern Pipefish	*Syngnathus fuscus*	38	1.7	3.2
Pigfish	*Orthopristis chrysoptera*	33	1.5	2.8
Striped Anchovy	*Anchoa hepsetus*	24	1.1	2.0
Bay Anchovy	*Anchoa mitchilli*	20	0.9	1.7
Striped Blenny	*Chasmodes bosquianus*	20	0.9	1.7
Dusky Pipefish	*Syngnathus floridae*	12	0.5	1.0
Rainwater Killifish	*Lucania parva*	12	0.5	1.0
Northern Puffer	*Sphoeroides maculatus*	10	0.4	0.8
Oyster Toadfish	*Opsanus tau*	9	0.4	0.8
Atlantic Menhaden	*Brevoortia tyrannus*	8	0.4	0.7
Tautog	*Tautoga onitis*	8	0.4	0.7
Atlantic Needlefish	*Strongylura marina*	6	0.3	0.5
Striped Burrfish	*Chilomycterus schoepfii*	5	0.2	0.4
Mummichog	*Fundulus heteroclitus*	4	0.2	0.3
Black Sea Bass	*Centropristis striata*	3	0.1	0.3
Striped Mullet	*Mugil cephalus*	3	0.1	0.3
Gag	*Mycteroperca microlepis*	2	0.1	0.2
Naked Goby	*Gobiosoma bosc*	2	0.1	0.2
Summer Flounder	*Paralichthys dentatus*	2	0.1	0.2
Winter Flounder	*Pseudopleuronectes americanus*	2	0.1	0.2
Blue Runner	*Caranx crysos*	1	0.04	0.1
Bluespotted Cornetfish	*Fistularia tabacaria*	1	0.04	0.1
Pinfish	*Lagodon rhomboides*	1	0.04	0.1
Sheepshead	*Archosargus probatocephalus*	1	0.04	0.1
Southern Stingray	*Dasyatis americana*	1	0.04	0.1
Spot	*Leiostomus xanthurus*	1	0.04	0.1
Striped Killifish	*Fundulus majalis*	1	0.04	0.1
	Total Finfish	**2,255**		

Table 3. List of macroalgae collected in Maryland's Coastal Bays SAV Habitat Survey from August 2014. Species are listed in order of total abundance. Total SAV Habitat Sites = 12.

Common Name	**Scientific Name**	**Total Volume Collected (L)**	**Percent of Total Catch**	**CPUE SAV Habitat Survey L/Haul**
Agardh's Red Weed	*Agardhiella tenera*	47.6	56.1	4.0
Banded Weeds	*Ceramium sp.*	12.7	15.0	1.1
Hairy Basket Weed	*Spyridia sp.*	7.4	8.7	0.6
Green Hair Algae	*Chaetomorpha sp.*	6.7	8.1	0.6
Tubed Weeds	*Polysiphonia sp.*	5.5	6.5	0.5
Graceful Red Weed	*Gracilaria sp.*	2.8	3.3	0.2
Hollow Green Weed	*Enteromorpha sp.*	0.9	1.1	0.1
Sea Lettuce	*Ulva sp.*	0.8	0.9	0.1
Green Tufted Seaweed	*Cladophora sp*	0.2	0.3	0.0
	Total Macroalgae	84.6		

Table 4. Fish and macroalgae abundance and community diversity by SAV coverage category.

SAV Coverage Category	N	Zones	Fish Abundance (fish/haul)	Fish Diversity (ENS)	Macroalgae Abundance (L/haul)	Macroalgae Diversity (ENS)
D (0-25%)	4	NNSC	293	1.8	8	1.8
C (25-50%)	5	NNSCC	164	3.1	6.7	3.8
B (50-75%)	1	S	107	3.0	3	1.8
A (75-100%)	2	SC	76	8.9	8	3.7

Table 5. Fish and macroalgae abundance and community diversity by zone.

Zone	N	SAV Coverage Categories	Fish Abundance (fish/haul)	Fish Diversity (ENS)	Macroalgae Abundance (L/haul)	Macroalgae Diversity (ENS)
N	4	CCDD	363	1.5	11.7	1.3
S	4	ABCD	136	3.7	1.6	3.1
C	4	ACCD	64	4.2	7.9	4.5

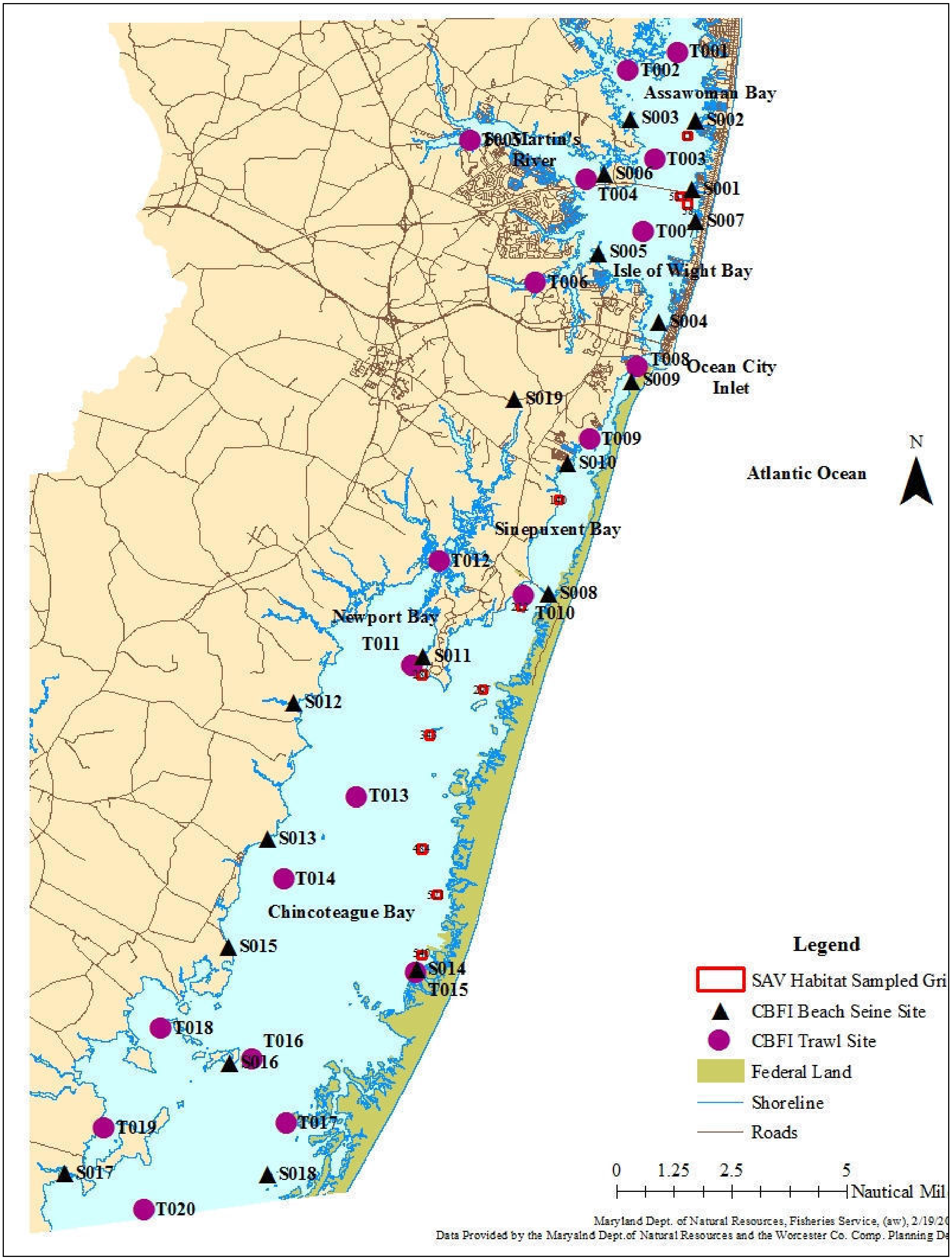

Figure 1. Coastal Bay Fisheries Investigation SAV Habitat Survey 2014 sample sites.

Chapter 3

Offshore Trawl Survey

Introduction:
In an effort to obtain information on adult fishes in the near-shore Atlantic waters, catches onboard cooperating commercial trawlers operating out of Ocean City, Maryland were sampled. Length and abundance data were taken and used to supplement the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey. Offshore sampling provides access to species and length groups not frequently available within Maryland's Coastal Bays. In addition, these data were used to meet Atlantic States Marine Fisheries Commission (ASMFC) data requirements and were included in compliance reports for summer flounder (*Paralichthys dentatus*), weakfish (*Cynoscion regalis*), and horseshoe crabs (*Limulus polyphemus*).

Methods:

Time
In 2014, Commercial sampling trips were conducted on June 22, July 7, August 18, September 2, October 8, November 3 and December 5. When targeting horseshoe crabs, trawls usually occurred at night in order to increase the legal size catch. The last trawl (December) targeted striped bass and occurred in the morning.

Gear and Location
Sampling was conducted on commercial trawlers targeting horseshoe crabs. The net used for the trawls from June to November was a standard summer flounder bottom trawl net with a 13.97 cm net body mesh, with the exception of August, where the net body mesh was 15.24 cm. A 13.97 cm codend was used for all these trawls. Head rope lengths ranged from 18.29 m up to 22.25 m for the June to November trawls. Foot rope lengths varied from 24.48 m to 29.26 m during that same period.

For the last offshore sampling trip of the year, the vessel employed a flynet. The net body and codend mesh were 40.6 cm and 5.1 cm, respectively. Head rope length was 15.24 m and the foot rope length was 21.34 m. The start and stop depths (m) of each trawl sample were recorded. Sites were determined by the fishing vessel captains on a trip by trip basis depending on the target species.

Trawling
When the trawl was set (the net was 100% deployed) the sampler recorded the time, depth (ft), water temperature(C; available from onboard electronics), wind direction and overall weather conditions. Wind speed (kts) was determined using an anemometer. At haul back, time and depth was recorded. When multiple trawls were conducted, the start data for the subsequent set was the same as the end data of the previous set. Data were recorded on a standardized data sheet (Appendix 5).

Sample Processing
A representative sub-sample of the catch was collected from each haul, and placed into a 1000 Liter (L) tub. All fishes were measured for total length (TL) in millimeters (mm). Wing span was measured on skates and rays; horseshoe crabs were measured for prosomal width. Based on morphological differences between and male and female horseshoe crabs, sex was determined for individuals in the samples. Crabs were measured for carapace width. Whelks were measured for length from the tip of the spire to the anterior tip of the body whorl. Staff biologists consulted the *Peterson Field Guide-Atlantic Seashore* (1978) and *Peterson Field Guide-Atlantic Coast Fishes* (1986) for assistance with species identification.

Total catch was estimated using two methods depending on the target species. The primary method was utilized when targeting horseshoe crabs. Commercial fishermen counted and sexed each horseshoe crab on every haul because there was a male-only daily landing limit requirement. Watermen's counts were used to estimate the sub-sample to total haul ratio. When the individuals of a target species could not be counted and compared to the total harvest from that haul, the sub-sample to catch ratio was estimated.

Data analysis
Staff biologists entered the data into a Microsoft Excel spreadsheet. Data on length, abundance, and length-frequency were analyzed using Excel or SAS for species of interest. Total catch was extrapolated from the subsample. For instance, if one third of the catch was sampled then the total catch was three times the amount sampled. If one half of the catch was sampled then the total catch was double the amount sampled. In the spreadsheet, the extrapolation factor was represented by the variable "X factor". Catch sampled times the X factor gives an estimate of the total catch.

Results:
Trawl time varied, with time ranging between 33 and 93 minutes. Water temperature ranged from a high of 24.9 C in September to a low of 9.7 C in December (Table 1). Depth over the course of the surveys ranged from 8.5 m to 18.3 m (Table 1).

The target species for six trips was horseshoe crab. Striped bass was the target species for the December trip (7th trip). Numbers of species collected ranged from 12 to 17 per trip (Table 2). Predominant species encountered from all the trawls were horseshoe crabs (*Limulus polyphemus*), summer flounder (*Paralichthys dentatus),* clearnose skate *(Raja eglanteria),* southern kingfish (*Menticirrhus americanus*), Atlantic croakers (*Micropogonias undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), nine-spined spider crab *(Libinia emarginata),* and knobby whelk (*Busycon carica*; Table 4).

From June to December, prosomal widths were collected for 448 horseshoe crabs (Figure 1). Prosomal width ranged from 91 mm to 332 mm. There were 169 females with a mean prosomal width of 193.5 mm and mode of 180.0 mm. The rest were males (279) with a mean prosomal width of 187.0 mm and mode of 200.0 mm.

From all trips combined, a total of 126 summer flounder were measured. Lengths ranged in size from 157 mm to 625 mm (Figure 2). The mean was 394.5 mm and the mode was 410 mm.

Discussion:
Horseshoe crabs continued to be a productive resource for both biomedical and bait harvest. This survey indicated that the population appears to be robust (they are easily captured) and continues to supply rare information that characterizes the horseshoe crab fishery. The horseshoe crab length-frequency histogram showed a robust juvenile and adult population. Females dominated from 90 to 110 mm and also from 240 to 340 mm. Males comprised the bulk of the catch between 120 and 230 mm (Figure 1). The histogram depicts a maturing population of females and males with both mature and immature individuals well represented.

A greater quantity of smaller and, therefore, younger summer flounder was observed during these outings compared to 2013. The size distribution shown in the histogram may be influenced by the small sample size and net mesh size. The majority of fish captured had reached the length where they were capable of spawning. Summer flounder are generally able to spawn upon reaching lengths of 14 inches (355.6 mm) for females and 12 inches (304.8 mm) for males (Manooch, 1984). Most were at or above the 355.6 mm minimum size limit allowed commercially by net, pot, trap, trotline, or seine (Figure 2). For 2013, very few summer flounder measurements were gathered below minimum size. Seeing almost no smaller fish could have been a cause for concern, however, the 2014 season data lead to a more optimistic view of this population.

Lengths were taken for 27 knobby whelk as compared to 44 measurements recorded during the 2013 trawls. It would be difficult to make observations concerning this animal based on these data for 2014.

References:

Gosner, Kenneth L. 1978. Peterson Field Guide-Atlantic Seashore. Boston. Houton Mifflin Company.

Manooch, Charles S. 1984. Fisherman's Guide: Fishes of the Southeastern United States. North Carolina State Museum of Natural History. Raleigh, NC. 362 pp.

Robins, Richard C. and G. Carleton Ray. 1986. Peterson Field Guide: Atlantic Coast Fishes. Boston. Houton Mifflin Company. 354 pp.

List of Tables

List of Figures

Table 1. Temperature range (C), depth range and number of tows for each survey trip.

Trip Date	Temperature (C)	Depth Range (m)	Number of Tows
June 22	22.0	9.1-10.7	2
July 16	19.7	8.5-11.0	2
August 18	23.4	15.2-16.4	2
September 13	24.9	14.4-14.9	2
October 8	20.2	16.2-17.7	1
November 3	14.4	14.9-17.4	2
December 17	9.7	11.3-18.3	1

Table 2. Trip date, number of species, number of animals counted and number of measurements per trip. Six trips targeted horseshoe crabs. The last trip targeted striped bass.

Trip Date	Number of Species	Number of Animals Counted	Number Measured
June 22	11	124	107
July 16	16	147	124
August 18	11	138	130
September 13	13	134	125
October 8	15	94	92
November 3	12	145	144
December 17	18	133	131

Table 3. Changes in gear for trawl trips.

Trip Date	Net Codend Mesh (cm)	Net Body Mesh (cm)	Head Rope Width (m)	Foot Rope Width (m)
June 22	13.97	13.97	21.34	29.26
July 16	13.97	13.97	21.34	28.96
August 18	13.97	15.24	21.34	27.43
September 13	13.97	13.97	21.34	27.43
October 8	13.97	13.97	18.29	24.48
November 3	13.97	13.97	22.25	29.26
December 17	5.08	40.64	15.24	21.34

Table 4. List of species collected in sub-sampled commercial offshore trawls from June through December 2014 by the Maryland Department of Natural Resources, n= 915. Species were grouped (Finfish, Crustaceans, Mollusks, and Other) and listed by order of extrapolated total number, n= 23,099 (numbers under total number column were extrapolated: number of individuals multiplied by X factor). The actual number of animal counts was presented under Total Number Counted.

Common Name	Scientific Name	Extrapolated Total Number Captured	Total Number Counted
Finfish Species			
Southern Kingfish	*Menticirrhus americanus*	1,259	46
Clearnose Skate	*Raja eglanteria*	893	30
Atlantic Croaker	*Micropogonias undulatus*	596	16
Summer Flounder	*Paralichthys dentatus*	243	126
Atlantic Menhaden	*Brevoortia tyrannus*	114	57
Smooth Butterfly Ray	*Gymnura micrura*	99	7
Weakfish	*Cynoscion regalis*	92	8
Smallmouth Flounder	*Etropus microstomus*	80	2
Smooth Dogfish	*Mustelus canis*	80	2
Windowpane Flounder	*Scophthalmus aquosus*	48	10
Spotted Hake	*Urophycis regia*	44	3
Rough Tail Stingray	*Dasyatis centroura*	35	1
Silver Perch	*Bairdiella chrysoura*	30	1
Striped Burrfish	*Chilomycterus schoepfii*	30	1
Striped Bass	*Morone saxatilis*	22	11
Northern Searobin	*Prionotus carolinus*	21	2
Blueback Herring	*Alosa aestivalis*	20	10
Winter Skate	*Leucoraja ocellata*	12	6
Spiny Dogfish	*Squalus acanthias*	6	3
Bullnose Ray	*Myliobatis freminvillii*	4	4
Hickory Shad	*Alosa mediocris*	4	2
Atlantic Angel Shark	*Squatina dumeril*	5	5
Butterfish	*Peprilus triacanthus*	3	2
Black Drum	*Pogonias cromis*	2	2
Sand Tiger	*Carcharias taurus*	2	2
Southern Stingray	*Dasyatis americana*	2	2
Red Drum	*Sciaenops ocellatus*	2	2
Spiny Butterfly Ray	*Gymnura micrura*	1	1
	Total Finfish	**3,749**	**364**

Table 4. (con't.). List of species collected in sub-sampled commercial offshore trawls from June through December 2014 by the Maryland Department of Natural Resources, n= 915. Species were grouped (Finfish, Crustaceans, Mollusks, and Other) and listed by order of extrapolated total number, n= 23,099 (numbers under total number column were extrapolated: number of individuals multiplied by X factor). The actual number of animal counts was presented under Total Number Counted.

Common Name	**Scientific Name**	**Extrapolated Total Number Captured**	**Total Number Counted**
Crustacean Species			
Portly Spider Crab	*Libinia emarginata*	1,405	36
Blue Crab	*Callinectes sapidus*	158	10
Flatclaw Hermit Crab	*Pagurus pollicaris*	81	2
Lady Crab	*Ovalipes ocellatus*	60	2
Long-Armed Hermit Crab	*Pagurus longicarpus*	20	1
Iridescent Swimming Crab	*Portunus gibbesii*	2	1
Pink Shrimp	*Farfantepenaeus duorarum*	1	1
	Total Crustaceans	**1,727**	**53**
Mollusc Species			
Knobby Whelk	*Busycon carica*	957	27
Channeled Whelk	*Busycotypus canaliculatus*	120	3
Long-Finned Squid	*Loligo pealeii*	36	18
Threelined Mudsnail	*Nassarius trivittatus*	35	1
	Total Molluscs	**1,148**	**49**
Other Species			
Horseshoe Crab	*Limulus polyphemus*	16,473	448
Lion's Mane Jellyfish	*Cyanea capillata*	2	1
	Total Other	**16,473**	**448**

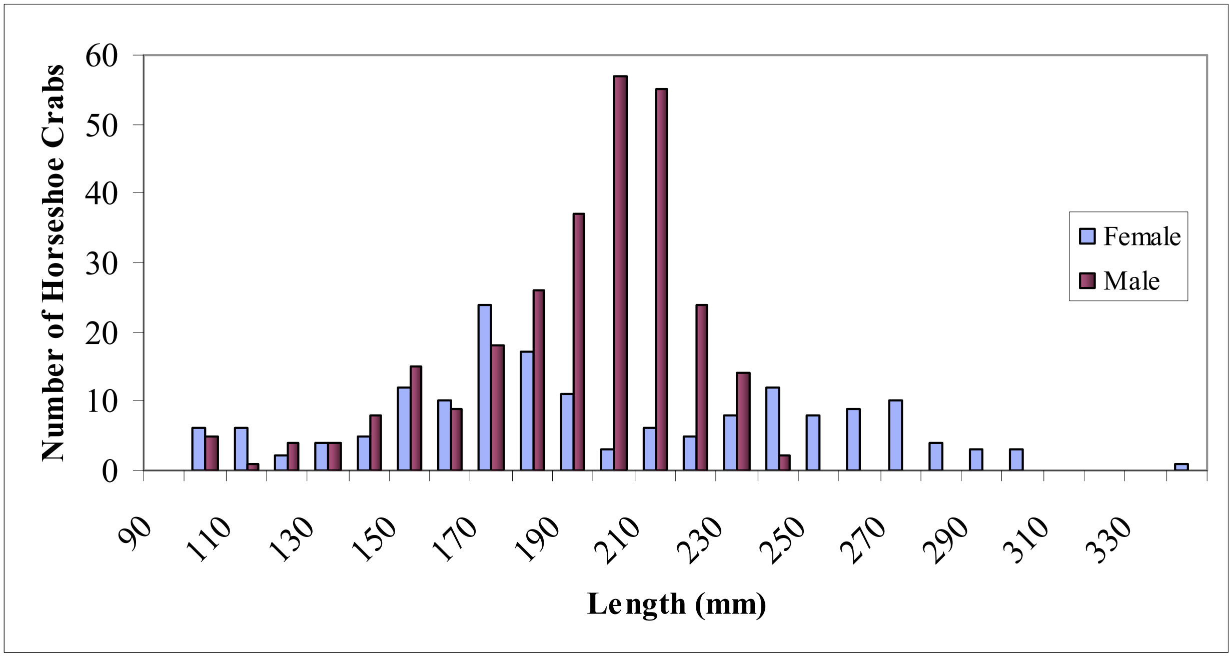

Figure 1. Horseshoe crabs (*Limulus polyphemus*) length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources between June to December, n= 448. Data were derived from four trawl trips taken at different water depths.

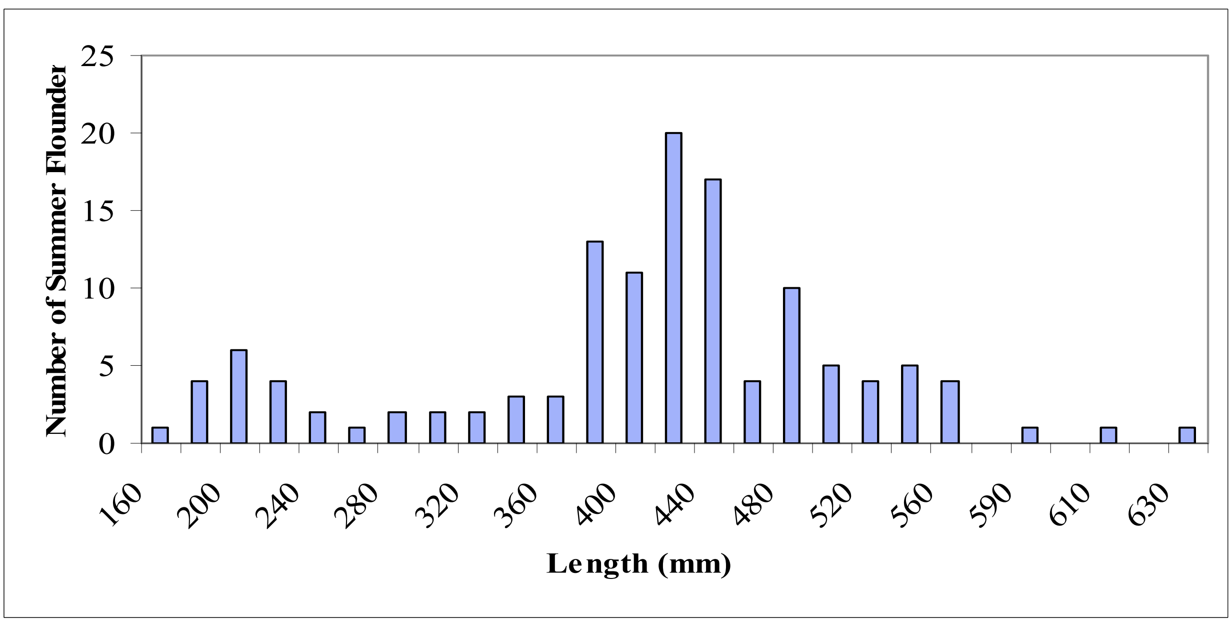

Figure 2. Summer flounder (*Paralichthys dentatus)* length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources between June and December 2014, n= 126. Data were derived from seven trawl trips taken at different water depths.

MD DNR Coastal Bays Trawl Data Sheet

Appendix 1.

Draw line separating ♂ and ♀ crabs. Start females in the right column and work towards the middle.
Place ● next to sook and a 2nd ● to indicate with eggs (ex: 60 mm sook with eggs is abbrev. 60●● and sook with no eggs 60●

♂ Blue Crab														♀ Blue crab

Cts

Total Blue Crabs

Sp.	Sp.	Sp.	Sp.	Sp.	Sp.	Sp.	Sp.
Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Tot.	Tot.	Tot.	Tot.	Tot.	Tot.	Tot.	Tot.

Sp.	Sp.	Sp.	Sp.	Sp.	Sp.	Sp.	Sp.
Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Tot.	Tot.	Tot.	Tot.	Tot.	Tot.	Tot.	Tot.

Species Name	Counts	Total

Species Name	Counts	Total

MD DNR Coastal Bays Trawl Data Sheet

Date	Start Time (12 hr)	Collector	Set#	
______/_____/2013				
Site# **T0**	Station Description			
Waypoint Start	**Waypoint Stop**	**Temp (C)** Surface / Bottom	**Sal (ppt)** Surface / Bottom	**DO (mg/L)** Surface / Bottom
Latstrt 38° .	**Latstop** 38° .	**Secchi (cm)**	**Weather**	**Tide**
Longstrt 75° .	**Longstop** 75° .	**Depth (ft)** Start / Stop	**Wind Direction & Speed (Knots)** @	

List species collected for vouchers & quantities

21 L Bucket Cnt	**Comments**	**Survey Checklist:**
		Datasheets/Protocol Pencils/Sharpener YSI, GPS Depth Finder/Sounding Pole AA Batteries YSI (6) GPS (2) Camera (2) 4 measuring boards Stop watch Buckets Cell Phone ID books/Keys Plastic bags/sharpie/labels Cooler Digital Camera Secchi Disk

Tide Codes
HF ≡ High flood
HS ≡ High slack
HE ≡ High Ebb
LF ≡ Low flood
LS ≡ Low slack
LE ≡ Low ebb

Weather Codes
0 ≡ clear, no clouds
1 ≡ partly cloudy
2 ≡ overcast
3 ≡ Waterspout
4 ≡ fog, haze
5 ≡ drizzle
6 ≡ rain
7 ≡ mixed snow and/or rain
8 ≡ showers
9 ≡ thunderstorms

Bottom Type Codes
S ≡ Sand M ≡ mud
O ≡ shell R ≡ rubble
G ≡ gravel C ≡ clay
A = SAV NT ≡ not taken

Miscellaneous
Collector ≡ person taking data
Tot ≡ total
Cts ≡ Counts
Spp ≡ Species
WTR ≡ Water
Specvol ≡ Actual vol. measured in Liters (L)
Estimatevol ≡ Visual volume estimate in L
Estimatecnt ≡ Visual estimate of the number of individuals
% ≡ Percentage of catch
TotSpecVol ≡ Total volume of all species combined and within the bracket
Est. % Net Open ≡ Width of seine opening

People Checklist:
Lunch/H_20
Hat/Sunglasses/sun screen
Oil Skins

Boat Checklist:
Sharp knife/tools
Anchors/line
Gas/oil for generator/boat
Life Jackets, flares, sound device, throw ring, paddle
Sun block/first aid kit/horn
Gas card/credit card

				Draw bracket for grouped spp.	

MD DNR Coastal Bays Beach Seine Data Sheet

Appendix 2.

Date (MM/DD/YYYY) ______/_______/2013	**Start Time (12 hr)**	**Collector**	**Set#**
Site# **S0**	**Station Description**		
Seine Length: **100 foot** **50 foot**		**Temp (°C)**	**Sal (ppt)**
Waypoint Start	**Waypoint Stop**	**DO (mg/L)**	**Secchi (cm)**
Latstrt **38° .**	**Latstop** **38° .**	**Weather**	**Tide**
Longstrt **75° .**	**Longstop** **75° .**	**Depth (ft)**	**Est. % Net Open**
%SAV – Choose One 0–No SAV in sample area 1-up to 25% 2-26-50% 3-51%-75%, 4-76%-100% 5-SAV present 6-Undeterminable – give reason		**Bottom Type** 1. 2. Use N/A for line 2 if only 1 type	**Wind Direction & Speed (Knots)** @

Tide Codes
HF ≡ High flood
HS ≡ High slack
HE ≡ High Ebb
LF ≡ Low flood
LS ≡ Low slack
LE ≡ Low ebb

Weather Codes
0 ≡ clear, no clouds
1 ≡ partly cloudy
2 ≡ overcast
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S ≡ Sand M ≡ mud
O ≡ shell R ≡ rubble
G ≡ gravel C ≡ clay
A = SAV NT ≡ not taken

Miscellaneous
Collector ≡ person taking data
Tot ≡ total
Cts ≡ Counts
Spp ≡ Species
WTR ≡ Water
Specvol ≡ Actual vol. measured in Liters (L)
Estimatevol ≡ Visual volume estimate in L
Estimatecnt ≡ Visual estimate of the number of individuals
% ≡ Percentage of catch
TotSpecVol ≡ Total volume of all species combined and within the bracket
Est. % Net Open ≡ Width of seine opening

People Checklist:
Lunch/H_20
Hat/Sunglasses/sun screen
Oil Skins

Boat Checklist:
Sharp knife/tools
Anchors/line
Gas/oil for generator/boat
Life Jackets, flares, sound device, throw ring, paddle
Sun block/first aid kit/horn
Gas card/credit card

List species collected for vouchers & quantities

21 L Bucket Cnt

Comments

Subsample

Species:
Number of Fish/L:
L Count:

Survey Checklist:
Datasheets/Protocol
Pencils/Sharpener
YSI, GPS
Depth Finder/Sounding Pole
AA Batteries
YSI (6)
GPS (2)
Camera (2)
4 measuring boards
Stop watch
Buckets
Cell Phone
ID books/Keys
Plastic bags/sharpie/labels
Voucher buckets
Cooler
Digital Camera
Secchi Disk

EstimateVol (L)	**EstimateCnt**	**SpecVol (L)**	**%**	**TotSpecVol (L)**	**Species Name**
				Draw bracket for grouped spp.	

MD DNR Coastal Bays Beach Seine Data Sheet

Draw line separating ♂ and ♀ crabs. Start females in the right column and work towards the middle.
Place ● next to sook and a 2nd ● to indicate with eggs (ex: 60 mm sook with eggs is abbrev. 60●● and sook with no eggs 60●

♂ Blue Crab														♀ Blue crab
Cts													**Total Blue Crabs**	

Sp.		Sp.		Sp.		Sp.		Sp.		Sp.		Sp.		Sp.	
Cts.		Cts.		Cts.		Cts.		Cts.		Cts.		Cts.		Cts.	
Tot.		Tot.		Tot.		Tot.		Tot.		Tot.		Tot.		Tot.	

Sp.		Sp.		Sp.		Sp.		Sp.		Sp.		Sp.		Sp.	
Cts.		Cts.		Cts.		Cts.		Cts.		Cts.		Cts.		Cts.	
Tot.		Tot.		Tot.		Tot.		Tot.		Tot.		Tot.		Tot.	

Species Name	Counts	Total

Species Name	Counts	Total

Table 1. 2014 Species List for the CBFI voucher collection, n=231.

Family	Scientific Name	Common Name	Number of Specimens
Achiridae	Trinectes maculatus	Hogchoker	3
Anguillidae	Anguilla rostrata	American eel	2
Atherinopsidae	Membras martinica	Rough silverside	8
Atherinopsidae	Menidia beryllina	Inland silverside	4
Atherinopsidae	Menidia menidia	Atlantic silverside	2
Belonidae	Strongylura marina	Atlantic needlefish	3
Blenniidae	Hypsoblennius hentz	Feather blenny	1
Carangidae	Caranx crysos	Blue runner	6
Carangidae	Caranx hippos	Crevalle jack	2
Carangidae	Selene setapinnis	Atlantic moonfish	1
Carangidae	Trachinotus falcatus	Permit	4
Catostomidae	Erimyzon oblongus	Creek chubsucker	3
Centrarchidae	Lepomis gibbosus	Pumpkinseed	2
Centrarchidae	Pomoxis nigromaculatus	Black crappie	1
Clupeidae	Alosa pseudoharengus	Alewife	2
Clupeidae	Brevoortia tyrannus	Atlantic menhaden	3
Clupeidae	Clupea harengus harengus	Atlantic herring	5
Clupeidae	Dorosoma cepedianum	Gizzard shad	2
Cynoglossidae	Symphurus plagiusa	Blackcheek tonguefish	1
Cyprinidae	Cyprinus carpio	Common carp	2
Cyprinidae	Notemigonus crysoleucas	Golden shiner	4
Cyprinodontidae	Cyprinodon variegatus	Sheepshead minnow	1
Dasyatidae	Dasyatis americana	Southern stingray	2
Diodontidae	Chilomycterus schoepfii	Striped burrfish	3
Elopidae	Elops saurus	Ladyfish	1
Engraulidae	Anchoa hepsetus	Striped anchovy	7
Engraulidae	Anchoa mitchilli	Bay anchovy	3
Fistulariidae	Fistularia tabacaria	Bluespotted cornetfish	2
Fundulidae	Fundulus diaphanus	Banded killifish	5
Fundulidae	Fundulus majalis	Striped killifish	4
Fundulidae	Lucania parva	Rainwater killifish	2
Gasterosteidae	Apeltes quadracus	Fourspine stickleback	1
Gasterosteidae	Gasterosteus aculeatus	Threespine stickleback	6
Gerreidae	Eucinostomus argenteus	Spotfin mojarra	2
Gobiidae	Ctenogobius pseudofasciatus	Slashcheek goby	1
Gobiidae	Gobiosoma bosc	Naked goby	3
Gobiidae	Microgobius thalassinus	Green goby	6
Gymnuridae	Gymnura micrura	Smooth butterfly ray	1
Haemulidae	Orthopristis chrysoptera	Pigfish	4
Hemiramphidae	Hyporhamphus unifasciatus	Halfbeak	5
Ictaluridae	Ameiurus nebulosus	Brown bullhead	3
Labridae	Tautoga onitis	Tautog	1
Labridae	Tautogolabrus adspersus	Cunner	1
Lutjanidae	Lutjanus griseus	Gray snapper	3
Monacanthidae	Stephanolepis hispidus	Planehead filefish	2
Moronidae	Morone americana	White perch	1

Family	Scientific Name	Common Name	Number of Specimens
Mugilidae	Mugil cephalus	Striped mullet	1
Mugilidae	Mugil curema	White mullet	2
Ophidiidae	Ophidion marginatum	Striped cusk-eel	2
Paralichthyidae	Etropus microstomus	Smallmouth flounder	8
Paralichthyidae	Paralichthys dentatus	Summer flounder	2
Phycidae	Urophycis regia	Spotted hake	3
Pleuronectidae	Pseudopleuronectes americanus	Winter flounder	1
Poeciliidae	Gambusia affinis	Mosquitofish	1
Pomatomidae	Pomatomus saltatrix	Bluefish	3
Priacanthidae	Pristigenys alta	Short bigeye	2
Rachycentridae	Rachycentron canadum	Cobia	2
Sciaenidae	Bairdiella chrysoura	Silver perch	3
Sciaenidae	Cynoscion nebulosus	Spotted seatrout	1
Sciaenidae	Cynoscion regalis	Weakfish	3
Sciaenidae	Leiostomus xanthurus	Spot	4
Sciaenidae	Menticirrhus americanus	Southern kingfish	6
Sciaenidae	Menticirrhus saxatilis	Northern kingfish	2
Sciaenidae	Micropogonias undulatus	Atlantic croaker	3
Sciaenidae	Pogonias cromis	Black drum	1
Scombridae	Scomberomorus maculatus	Spanish mackerel	2
Scophthalmidae	Scophthalmus aquosus	Windowpane	1
Serranidae	Centropristis striata	Black sea bass	5
Serranidae	Mycteroperca microlepis	Gag	3
Sparidae	Archosargus probatocephalus	Sheepshead	3
Sparidae	Lagodon rhomboides	Pinfish	2
Sparidae	Stenotomus chrysops	Scup	3
Sphyraenidae	Sphyraena borealis	Northern sennet	1
Stromateidae	Peprilus triacanthus	Butterfish	5
Syngnathidae	Hippocampus erectus	Lined seahorse	1
Syngnathidae	Syngnathus floridae	Dusky pipefish	2
Syngnathidae	Syngnathus fuscus	Northern pipefish	5
Synodontidae	Synodus foetens	Inshore lizardfish	3
Tetraodontidae	Sphoeroides maculatus	Northern puffer	4
Trichiuridae	Trichiurus lepturus	Atlantic cutlassfish	1
Triglidae	Prionotus carolinus	Northern searobin	4
Triglidae	Prionotus evolans	Striped searobin	5
		Total	**231**