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

July 2015 - June 2016 Final Report




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The Coastal Bays Fisheries Investigation has been sampling fishes in the Coastal Bays for 43 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) 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.

Supplemental adult finfish data would not have been possible without the assistance of the staff working at Southern Connection of Ocean City, Martin Fish Co., and the captains and first mates working commercial vessels in Ocean City. Your patience and safe passage are appreciated.

Accomplishments

The following milestones were completed July 1, 2015 through June 30, 2016.

Completed Monthly July - October 2015

- Collected 20 trawl samples at 20 fixed locations on Maryland's Coastal Bays each month
  - Completed data entry/cleanup from prior months sampling
  - Updated current finfish indices for trend analysis
- Accompanied commercial trawlers to gather biological information on important recreational and commercial finfish species in June, July, August, and October

Completed September 2015

- Conducted beach seine sampling at 19 fixed locations on Maryland's Coastal Bays
- Conducted SAV Habitat Survey beach seines at 12 sites in Sinepuxent Bay
  - Completed data entry/cleanup from prior months sampling

Completed October – December 2015

- Completed data entry/cleanup from October sampling
- Completed QA/QC for all data collected during the 2015 field sampling season

Completed (January 1 through March 31, 2016)

- Conducted data analyses of the 2015 trawl, beach seine, and SAV Habitat Survey samples
- Wrote the F-50-R-24 Annual Report draft
- Prepared for the 2016 field sampling season (Trawl and Seine Survey)
- Determined sampling needs for SAV habitat analysis
- Cleaned tautog operculum's
- Aged 200 tautog operculum's

Completed Monthly (April 1 through June 30, 2016)

- Collected 20 trawl samples at 20 fixed locations on Maryland's Coastal Bays each month
  - Completed data entry/cleanup from prior months sampling

Completed May 2016

- Length, weight, sex, and operculums were collected from 75 tautog samples obtained from a charterboat. Otoliths were extracted from select fish.
- Edited the F-50-R-24 Annual Report

Completed June 2016

- Completed one trip onboard a commercial trawler to gather biological information on important recreational and commercial finfish species
- Length, weight, sex, and operculums were collected from 110 tautog samples obtained from a charterboat. Otoliths were extracted from select fish.
- Conducted beach seine sampling at 19 fixed locations on Maryland's Coastal Bays
- Edited the F-50-R-24 Annual Report

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;
- using a depth finder and collecting GPS coordinates at each sample;
- 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. 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 1972-1973, 1977-1988 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 by circling the seine for greater catchability of demersal fish. Sinepuxent Bay was selected as the study area in 2015 to reduce the covariant effects of location and allow for comparison of fish abundance results with other CBFI survey information from a balanced sampling design.

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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 – 2015.

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. Martin 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). 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 located 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 $15 billion dollar tourism industry catering to approximately 8 million visitors annually. 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*. Common species of macroalgae include *Agardhiella 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. A GPS was used for navigation, marking latitude and longitude coordinates in degrees and decimal minutes (ddmm.mmm) for each sample, 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. 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 to 2.8 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.

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.

Seine

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. Chemical data were only taken 30 cm below the surface for each beach 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 beach seine sites, depth was estimated by the biologists pulling the seine. Wind speed measurements were acquired using a 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 (Table 3). 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, sponges, 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 (1989-2015). That method was adopted by the Atlantic States Marine Fisheries Commission (ASMFC) Striped Bass Technical Committee as the preferred index of relative abundance to model stock status. The mean was calculated using catch per area covered for trawl and catch per haul for beach seine. The 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: α=0.05, n-1)], respectively. A geometric grand mean was calculated for the time series (1989-2015) and used as a point estimate for comparison to the annual (2015) estimate of relative abundance.

To investigate species specific habitat preference by finfish, an analysis of variance was performed on the catch data to determine if sites differed in mean abundance (CPUE) for each species by site for 1989-2015. A subsequent multiple pairwise comparison of means test (Duncan's Multiple Range Test) was performed to determine differences among sites in

1989-2015. Those results are reported for each species in this chapter. The site or groups of sites with the most abundant individuals per species were classified as primary sites. Secondary sites were second most abundant. Fish diversity was calculated by the Shannon Index.

To summarize macroalgae presence in the CBFI, statistical analyses were conducted on all species from 2006 to 2015. The measure of abundance (CPUE) for the trawl was mean liters per hectare; the beach seine was mean liters per haul. Annual CPUE was compared to the time series grand mean. Macroalgae diversity was calculated by the Shannon Index.

To evaluate water quality at trawl sites, the mean for each parameter (temperature, dissolved oxygen, salinity, turbidity) per bay (six systems) was derived from using the surface and bottom values. 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 41,777 fish caught trawling (8,568) and beach seining (33,139 fish) in 2015 (Table 4)**.** The total number of fish caught was similar to the last 10 years. Collected fishes represented 74 species which is a normal representation of species in a year.

An above average index was produced in 2015 for Atlantic silverside and silver perch in the trawl. It was the highest trawl catch for Atlantic silverside in the survey time series. Record beach seine indices were also produced in 2015 for gag grouper, sheepshead, and pinfish.

Below average indices were produced for black sea bass, summer flounder, and spot in the trawl and bay anchovy, spot, and summer flounder in the beach 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 21,000 specimens caught trawling (9,755 crustaceans) and beach seining (11,245 crustaceans) in 2015 (Table 5). Blue crabs substantially increased in abundance from the year before for the second year in a row. Fifteen crustacean species were identified, which is similar to the numbers of crustaceans found between 1989 and 2014. A record trawl index value was produced for brown shrimp in 2015.

The third most abundant taxa captured in the survey were molluscs. Specifically, they accounted for 567 specimens caught trawling (181 molluscs) and beach seining (386 molluscs; Table 6). Molluscs were represented by 18 different species which is similar to the numbers of molluscs found between 1989 and 2014.

Other types of animals captured trawling and beach seining included: terrapins, horseshoe crabs, ctenophores, tunicates, and sponges (Table 7). Eighteen 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 six of 140 trawls (4.3%) and in four of 38 beach seines (11%). A total of 27 American eel were collected in trawl (8 fish) and beach seine (19 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). American eel ranked 32nd out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.5 fish/hectare and 0.5 fish/haul, respectively.

The relative abundance indices for the 2015 trawl and beach seine were not significantly different from the grand means (Figures 4 and 5). Since 1989, the trawl and beach seine indices rarely (three years trawl, four years beach seine) varied from the grand means.

Discussion
The relative abundance indices for trawl and beach seine were not significantly different from the grand mean (1989-2015). 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 beach 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 are close to land in protected bays or creeks located off the main bays. Trawl site T006, where many eels are caught, is in Turville Creek where MDNR Fisheries Service's Eel Project conducts an annual elver survey further up the creek from our sampling site. 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. The scattered range of preferred beach seine sites for American eels is due to their preference for near shore shallow weedy areas.

Management
American eel are managed by the State of Maryland in cooperation with Atlantic States Marine Fisheries Commission (ASMFC). Maryland's 2015 recreational American eel regulations were comprised of a 25 fish creel and a 9 inch minimum size limit (Table 9). Commercial restrictions included a nine 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 18 of 140 trawls (13%) and in zero of 38 beach seines (0%). A total of 105 juvenile Atlantic croakers were collected in trawl (105) and beach seine (0) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Atlantic croakers ranked 19th out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 6.0 fish/hectare and 0 fish/haul, respectively.

The 2015 trawl and beach seine relative abundance indices were below the grand means (Figures 6 and 7). Since 1989, the trawl index occasionally (6 years) varied from the grand mean and the beach seine index often varied (13 years) from the grand mean.

Discussion
The relative abundance indices for trawl and beach seine were below the grand means. Juvenile Atlantic croakers were more frequently caught in deeper water (trawl). Atlantic croaker are rarely caught in beach seines, so the trawl index is a better indicator of abundance. Therefore, the trawl index represents a more accurate picture of changes in relative abundance when compared to the beach seine index.

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).

Good trawl sites for collecting Atlantic croakers were located in the relatively protected areas of Assawoman Bay, the St. Martin 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 *et al.* 2008).

Management
Atlantic croakers are managed by the State of Maryland in cooperation with ASMFC. Maryland's 2015 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 from March 16 until December 31 (Table 10). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic menhaden (*Brevoortia tyrannus*)
Atlantic menhaden were captured in 9 of 140 trawls (6.4%) and in 18 of 38 beach seines (47%). A total of 17,166 Atlantic menhaden were collected in trawl (39 fish) and beach seine (17,127 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Atlantic menhaden ranked first out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.2 fish/hectare and 450.7 fish/haul, respectively.

The 2015 trawl relative abundance index was below grand mean and the beach seine index was not significantly different than the grand mean (Figures 8 and 9). Since 1989, the trawl index often (13 years) varied from the grand mean and beach seine index occasionally (8 years) varied from the grand mean.

Discussion
The relative abundance index for trawl was below the grand mean and the beach seine index was not significantly different than the grand mean. Atlantic menhaden were caught more often in near shore locations (beach seine). Therefore, the beach seine index represents a more accurate picture of changes in relative abundance when compared to the trawl index. Significant changes in relative abundance may reflect a combination of environmental

conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and/or overfishing.

Good trawl sites for collecting Atlantic menhaden are in protected areas at the head of Turville Creek (T006) and the St. Martin River (T005). Turville Creek is known to have high nutrient levels and may attract the prey sources of Atlantic menhaden (Maryland Department of the Environment, 2001). Those trawl sites are likely to have high chlorophyll concentrations and shallow water, a desirable characteristic for a filter feeder (Wazniak *et al.* 2004). The best beach seine site (S019) for Atlantic menhaden was located in a muddy protected creek. Good beach seine sites displayed a geographically wide dispersion indicating preference for shallow water shoreline edge habitat with low flow characteristics.

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 2015. A commercial harvest cap of 2,553 metric-tons was implemented in 2016 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 30 of 140 (21%) trawls and in 37 of 38 beach seines (97%). A total of 7,429 Atlantic silversides were collected in trawl (1,573 fish) and beach seine (5,856 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Atlantic silversides ranked 2nd out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 89.6 fish/hectare and 154.1 fish/haul, respectively.

The 2015 trawl relative abundance index was well above the grand mean and the beach seine index was not significantly different than the grand mean (Figures 10 and 11). Since 1989, the trawl index often (14 years) varied from the grand mean and beach seine index rarely (five years) varied from the grand mean.

Discussion

The relative abundance index for trawl was above the grand mean and the beach seine index was not significantly different than the grand mean. The trawl index was notable in that it was the highest catch value in the time series. Atlantic silversides are more frequently caught in the beach seines than the trawls and were caught in all the beach seines in 2015 except one. 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.

Good trawl and beach seine sites for collecting Atlantic silversides were located in the shallow, protected areas of Assawoman Bay, Isle of Wight Bay and its tributaries, Sinepuxent Bay, and Chincoteague Bay. Similar characteristics found at these sites are the proximity to land and inlets. They are also collected from all sites in Sinepuxent Bay which would indicate that they are not deterred by current. They do not seem to prefer large expanses of exposed open water. 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 63 of 140 trawls (45%) and in 20 of 38 beach seines (53%). A total of 4,819 bay anchovies were collected in trawl (3,267 fish) and beach seine (1,552 fish) samples collected in Maryland's Coastal Bays in 2015 (Table 4). Bay anchovies ranked 3rd out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 186.1 fish/hectare and 40.8 fish/haul, respectively.

The 2015 trawl relative abundance index was below the grand mean and the beach seine index was not significantly different than the grand mean (Figures 12 and 13). Since 1989, the trawl and beach seine indices occasionally (eight years trawl, six years beach seine) varied from the grand means.

Discussion
The trawl relative abundance index was below the grand mean and the beach seine index was not significantly different than 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.

Good trawl and beach seine sites for collecting bay anchovies were located more in the northern bays for trawl and more in the southern bays for beach seine. 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 14 of 140 trawls (10%) and two of 38 beach seines (5%). A total of 65 juvenile black sea bass were collected in trawl (35 fish) and beach seine (30 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Black sea bass were ranked 28th out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.0 fish/hectare and 0.8 fish/haul, respectively.

The 2015 trawl relative abundance index was below the grand mean and the beach seine index was not significantly different than the grand mean (Figures 14 and 15). Since 1989, the trawl index often (14 years) varied from the grand mean and beach seine index occasionally (six years) varied from the grand mean.

Discussion

The 2015 trawl relative abundance index was below the grand mean and the beach seine index was not significantly different than the grand mean. Black sea bass are commonly caught in both gears; however, the trawl gear catches a few more than the beach seine 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.

Good trawl and beach seine sites for collecting black sea bass were locations with or near structure such as channels, drop offs, rip rap, or crab pots. 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 2015 included a 12.5 inch total length minimum size limit, 15 fish/day creel limit, and an open season from May 15 until September 21st, and October 22nd through December 31st (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 four of 140 trawls (3%) and in 15 of 38 beach seines (39%). A total of 137 juvenile bluefish were collected in trawl (four fish) and beach seine (133 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Bluefish ranked 16th out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.2 fish/hectare and 3.5 fish/haul, respectively.

The 2015 trawl and beach seine relative abundance indices were both not significantly different than the grand means (Figures 16 and 17). Since 1989, the trawl and beach seine indices occasionally (six years trawl, six years beach seine) varied from the grand means.

Discussion

The 2015 relative abundance indices were both not significantly different than the grand means. Bluefish were caught more frequently in near shore (beach seine) locations.

Therefore, the beach seine index represents a more accurate picture of changes in relative abundance when compared to the trawl index. 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.

Good trawl and beach seine sites for collecting bluefish were located in Assawoman Bay, St. Martin River, Isle of Wight Bay, and Sinepuxent Bay. All good sites were located north of the Ocean City Inlet with the exception of site S010 in Sinepuxent Bay. 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 2015 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: Pinfish (*Lagodon rhomboides*)
Pinfish were collected in 15 of 140 trawls (11%) and in 20 of 38 beach seines (53%). A total of 1245 juvenile pinfish were collected in trawl (39 fish) and beach seine (1206 fish) samples conducted on Maryland’s Coastal Bays in 2015 (Table 4). Pinfish ranked 6th out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.2 fish/hectare and 31.7 fish/haul, respectively.

The 2015 trawl and beach seine relative abundance indices were both significantly higher than the grand means (Figures 18 and 19). Since 1989, the trawl and beach seine indices frequently (18 years trawl, 16 years beach seine) varied from the grand means, indicating large variability in abundance over the time period.

Discussion
The 2015 relative abundance indices were both significantly higher than the grand means. Pinfish have been more abundant in the past five years with two of those years significantly above the grand mean for both trawl and beach seine. The 2015 beach seine data point was the highest in the time series. 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.

Management
Pinfish 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.

Species Results: Sheepshead (*Archosargus probatocephalus)*

Sheepshead were collected in 6 of 140 trawls (4%) and 15 of 38 seines (39%). A total of 148 juvenile sheepshead were collected in trawl (12) and beach seine (136) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Sheephead ranked 15th out of 74 species in overall finfish abundance. The trawl and beach seine CPUE's were 0.7 fish/hectare and 3.6 fish/haul, respectively. An increasing trend in sheephead abundance is evident in recent years so they have been added to analysis this year.

The 2015 trawl and beach seine relative abundance indices were both significantly higher than the grand means and are the highest values in the time series (Figures 20 and 21). Since 1989, the trawl and beach seine indices frequently (24 years trawl, 16 years beach seine) varied from the grand means, indicating large variability in abundance over the time period.

Discussion

The 2015 relative abundance indices were significantly higher than the grand means. Sheephead were caught more frequently in shallow water (beach seine). Therefore, the beach seine index represents a more accurate picture of changes in relative abundance when compared to the trawl index. Since 1997, sheepshead have begun to show up more frequently in our samples. Whether this is a range expansion or an anomaly time will tell. 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.

Management

Sheepshead are not managed in 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.

Species Results: Silver perch (*Bairdiella chrysoura*)

Silver perch were collected in 44 of 140 trawls (31%) and 15 of 38 beach seines (39%). A total of 3,283 silver perch were collected in trawl (1,798 fish) and beach seine (1,485 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Silver perch ranked 4th out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 102.4 fish/hectare and 39.1 fish/haul, respectively.

The 2015 trawl relative abundance index was above average and the beach seine index was not significantly different than the grand mean (Figures 22 and 23). Since 1989, the trawl index often (11 years) varied from the grand mean and beach seine index rarely (two years) varied from the grand mean.

Discussion

The 2015 trawl relative abundance index was above average and the beach seine index was not significantly different than the grand mean. There have recently been several years with above average abundance in the trawls. 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 samples collected throughout 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 beach seines (39.5%). A total of 2088 spot were collected in trawl (615 fish) and beach seine (1,473 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Spot ranked 5th out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 35.0 fish/hectare and 38.8 fish/haul, respectively.

The 2015 trawl relative abundance index was below the grand mean and the beach seine index was not significantly different than the grand mean (Figures 24 and 25). Since 1989, the trawl and beach seine indices frequently (21 years trawl, 19 years beach seine) varied from the grand means, indicating variability in abundance over the time period.

Discussion

The 2015 trawl relative abundance index was below the grand mean and the beach seine index was not significantly different than the grand mean. 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. 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 samples collected throughout 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 45 of 140 trawls (32%) and 11 of 38 beach seines (29%). A total of 118 summer flounder collected in trawl (96 fish) and beach seine (22 fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Summer flounder ranked 18th out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 5.5 fish/hectare and 0.6 fish/haul, respectively.

The 2015 trawl relative abundance index and beach seine indices were both significantly below the grand mean (Figures 26 and 27). Since 1989, the trawl index often (15 years) varied from the grand mean and the beach seine index occasionally (eight years) varied from the grand mean.

Discussion
The 2015 relative abundance indices were both significantly below than the grand mean. Summer flounder are caught more frequently in open water (trawl). Therefore, the trawl index represents a more accurate picture of changes in relative abundance when compared to the beach seine index; although, not to the extent of 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.

Good trawl and beach seine sample sites were located in all bays. This indicates that most of the habitat of the Maryland Coastal Bays is favorable nursery habitat for this species.

Management
Summer flounder are managed by the State of Maryland in cooperation with ASMFC and the MAFMC. Maryland's 2015 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 three of 140 trawls (2%) and in four of 38 beach seines (11%). A total of seven tautogs were collected in trawl (three fish) and beach seine (four fish) samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Tautog ranked 52nd out of 74 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.2 fish/hectare and 0.1 fish/haul, respectively.

The 2015 trawl and beach seine relative abundance indices were both not significantly different than the grand means (Figures 28 and 29). Since 1989, the trawl and beach seine indices occasionally (nine years trawl, six years beach seine) varied from the grand mean.

Discussion
The relative abundance indices for trawl and beach seine were both not significantly different than the grand means. Sporadic catches indicate that this survey may not be an effective means for determining tautog juvenile abundance. Juvenile tautogs prefer SAV, and adult tautogs prefer structured habitat. Our survey in past years indicated a site preference for beach seine sites in the northern bays.

Management
Tautogs are managed by the State of Maryland in cooperation with ASMFC. Maryland's 2015 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).

The 2015 stock assessment indicated that the mid-Atlantic stock was not overfished. 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 charter and party boat fleet.

Species Results: Weakfish (*Cynoscion regalis*)
Weakfish were collected in 23 of 140 trawls (16%) and zero of 38 beach seines (0%). A total of 249 juvenile weakfish were collected in trawl samples conducted on Maryland's Coastal Bays in 2015 (Table 4). Weakfish ranked 13th out of 74 species in overall finfish abundance. The trawl CPUE was 14.2 fish/hectare.

The 2015 trawl and beach seine relative abundance indices were significantly below the grand means (Figures 30 and 31). Since 1989, the trawl and beach seine indices occasionally (10 years trawl, nine years beach seine) varied from the grand mean.

Discussion
The 2015 relative abundance indices were below the grand means. Weakfish were caught more frequently in open water (trawl). Therefore, the trawl index represents a more accurate picture of changes in relative abundance when compared to the beach seine index. 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.

Good trawl sample sites for 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 River.

Management
Weakfish are managed by the State of Maryland in cooperation with ASMFC. Maryland's 2015 recreational weakfish regulations were comprised of a one fish creel and a 13 inch

minimum size limit (Table 9). Commercial regulations in 2015 restricted fisherman to a 12 inch minimum size (Table 10). The commercial fishery is managed as a bycatch fishery with a 100 pound 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: Brown Shrimp (*Farfantepenaeus aztecus)*)
Brown shrimp were collected in 45 of 140 trawls (32%) and six of 38 beach seines (16%). A total of 808 brown shrimp were collected in trawl (722) and beach seine (86) samples conducted on Maryland's Coastal Bays in 2015 (Table 5). Brown shrimp ranked 4th out of 15 crustacean species in overall abundance. The trawl and beach seine CPUEs were 41.1 shrimp/hectare and 2.3 shrimp/haul, respectively. It was an unusually high year of abundance for brown shrimp so they were added to analysis this year.

The 2015 trawl relative abundance index was significantly higher than the grand mean and the beach seine index was not significantly different than the grand mean (Figures 32 and 33). Since 1989, the trawl index often (15 years) varied from the grand mean and the beach seine index occasionally (nine years) varied from the grand mean.

Discussion
The 2015 trawl relative abundance index was significantly higher than the grand mean and was the highest number in the time series. Brown shrimp were caught more frequently in trawls. Therefore, the trawl index currently represents a more 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.

Brown shrimp were most abundant in Turville Creek and the St. Martin River. They were found in the greatest numbers in the months of July through September. Brown shrimp are a great forage opportunity for fishes.

Management
Brown shrimp 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.

Diversity and abundance by Embayment
The Shannon Index and total numbers of species by embayment were analyzed in an effort to quantify fish habitat value. The Shannon Index gives a value for fish abundance evenness. Number of species and evenness were relatively similar for all bays for both beach seine and trawl samples (Figures 34 and 35; Tables 11 and 12).

For trawl the number of species was greatest for Chincoteague Bay and the Shannon diversity was greatest for Sinepuxent Bay. The highest value for number of species was 91 in Chincoteague Bay and the lowest was 66 in Newport Bay. While Sinepuxent had the greatest diversity it also had the lowest catch per unit effort in trawl.

For beach seine, St. Martin River and Sinepuxent Bay had the lowest diversity, and Newport Bay and Chincoteague Bay had the greatest diversity. Isle of Wight had the highest number of species by beach seine and Newport Bay had the lowest. Catch per unit effort was greatest in the St. Martin River and lowest in Chincoteague Bay.

Between bays and gears, not any one area stands out as having consistently better abundance, numbers of species, or diversity. All areas represent relatively good finfish habitat for one species or another.

Macroalgae

This time series spans 10 years from 2006 to 2015. To date, 20 genera and over 45,000 L of macroalgae have been collected in Maryland's Coastal Bays by the trawl and beach seine. Since this time series began, *Rhodophyta* (Red macroalgae) have been the dominant macroalgae in both trawl and beach seine collections. *Chlorophyta* (Green macroalgae), *Phaeophyta* (Brown macroalgae) and *Xanthophyta* (Yellow-Green macroalgae) were represented in the survey collections. *Chlorophyta* was the second most abundant macroalgae in the time series.

Fourteen genera were collected by trawl within the Coastal Bays in 2015, which was below the average (15 genera) in the time series. Results showed that *Agardhiella* were the most encountered macroalgae (80.4%) in 2015. Other genera that contributed more than 5% to the sample population in 2015 were *Ulva* (5.9%) and *Chaetomorpha* (5.7%; Table 8). The 2015 Shannon Index of diversity (evenness) among genera collected in the Coastal Bays by trawl was (H = 0.82), which was below the time series average (H = 1.33). The 2015 trawl CPUE (261.0 L/ha) was not different from the grand mean (192.0 L/ha; Figure 36).

Ten genera were sampled within the Coastal Bays by beach seine in 2015. The beach seine results showed that *Agardhiella* were the most encountered macroalgae (75.6%) in 2015. Other genera that contributed more than 5% to the sample population in 2015 were *Vaucheria* (9.8%) *Polysiphonia* (5.1%) and *Cladophora* (5%; Table 8). The Shannon Index of diversity (evenness) among genera in the Coastal Bays (H = 0.92) was below the beach seine time series average (H = 1.22). The 2015 beach seine CPUE (69.3 L/haul) was not different than the grand mean (32.3 L/haul; Figure 37).

Over the trawl time series, mean CPUE was higher in the embayment's north of Ocean City Inlet. However, these areas had lower average Shannon Index values than areas south of the inlet (Figure 38). The beach seine time series showed a similar trend in CPUE, while the Shannon Index was variable among those areas' littoral zone (Figure 39).

Assawoman Bay: This embayment has been dominated by *Rhodophyta* since sampling began in 2006. Eight different genera were collected by trawl in 2015, which was just below the average (8.2 genera) for this embayment in the time series. The Shannon Index of diversity among genera within this embayment in 2015 was (H = 0.36), which was well below the time series average (H = 0.98). *Agardhiella* (91.4%) was the most abundant species. *Ulva* (7%) was the only other genera that contributed more than 5% to the sample population. The 2015 CPUE (1,199.1 L/ha) was not different from the grand mean (Figure 40).

The beach seine results showed the same trend as the trawl results in 2015. Five genera were collected which was below the time series average (6.9 genera) and low diversity among genera (H = 0.71) was also below the time series average (H = 0.85). *Agardhiella* (69%) was the most abundant. *Vaucheria* (28.8%) was only other genera that contributed more than 5% of the sample population. The beach seine CPUE (128.4 L/haul) was not different from the grand mean (43.5 L/haul; Figure 41).

Isle of Wight Bay: This embayment has been dominated by *Rhodophyta* since sampling began in 2006. Eight different genera were collected by trawl in 2015, which was above the average (6.9 genera) for this embayment in the time series. However, the Shannon Index of diversity among genera within this embayment in 2015 (H = 0.33) was below average (H = 0.76). The strong hold of *Agardhiella* (93.5%) was evident and the only genera that contributed more than 5% of the sample population. The trawl CPUE (221.6 L/ha) was not different from the grand mean (450.3 L/ha; Figure 42).

Six different genera were collected by beach seine in 2015, which was below the average (6.9 genera) for this embayment in the time series. The Shannon Index of diversity among genera within this embayment in 2015 (H = 0.63) was below the time series average (H = 1.09). *Agardhiella* (83.1%) was the most abundant; *Ulva* (10.3%) was the only other genera that contributed more than 5% of the sample population. The 2015 beach seine CPUE (56.1 L/haul) was not different than the grand mean (59.5 L/haul; Figure 43).

St. Martin River: This river has been dominated by *Rhodophyta* since sampling began in 2006, except in 2013, when *Chlorophyta* were dominant in the deeper water sampled by the trawl. Four different genera of macroalgae were collected by trawl in 2015, which was below the time series average (5.6 genera). The Shannon Index of diversity among genera in 2015 (H = 0.25) was below average (H = 0.80). *Agardhiella* (93.8%) was the most abundant; *Ulva* (5.4%) was the only other genera that contributed more than 5% of the sample population. Trawl CPUE (154.4 L/ha) in 2015 was not different from the grand mean (136 L/ha; Figure 44).

Four different genera were collected by beach seine in 2015, which was above the average (3.7 genera) for this embayment in the time series. The Shannon Index of diversity among genera within this embayment in 2015 (H = 0.35) was below the time series average (H = 0.48). *Agardhiella* (92.2%) was the most abundant and the only other genera that contributed more than 5% of the sample population. The 2015 beach seine CPUE (102.2 L/haul) was not different from the grand mean (73.1 L/haul; Figure 45).

Sinepuxent Bay: This embayment has been dominated by *Rhodophyta* in eight of the 10 years since sampling began in 2006. *Chlorophyta* (Green macroalgae) were dominant in 2008 and 2009. Nine different genera of macroalgae were collected by trawl in 2015, which was below the average (10.1 genera) for this embayment in the time series. The Shannon

Index of diversity among genera within this embayment in 2015 (H = 1.12) was below the average (H = 1.39). *Agardhiella* (46.2%), *Ulva* (40.9%) and *Polysiphonia* (7.4%) were the only genera that contributed more than 5% of the sample population. The CPUE (18.6 L/ha) in 2015 was lower than grand mean (44.9 L/ha; Figure 46).

Six different genera were collected by beach seine in 2015, which was below the average (6.6 genera) for this embayment in the time series. *Agardhiella* (61.4%) was most abundant. *Cladophora* (33.3%) was the only other genera that contributed more than 5% of the sample population. The 2015 beach seine CPUE (62.9 L/haul) was not different from the grand mean (25.2 L/haul; Figure 47).

Newport Bay: This embayment has been dominated by *Rhodophyta* in seven of the 10 years since sampling began in 2006. *Chlorophyta* were dominant in 2008-2010. Seven different genera were collected by trawl in 2015, which was below the average (7.3 genera) for this embayment in the time series. The Shannon Index of diversity among genera within this embayment in 2015 was equal to the time series average (H = 1.1). *Agardhiella* (48.6%); *Polysiphonia* (29.1%) and *Gracilaria* (21.1%) were the only genera that contributed more than 5% of the sample population. The CPUE (119.4 L/ha) was not different from the grand mean (100.7 L/ha; Figure 48).

Seven different genera were collected by beach seine in 2015, which was above the average (3.4 genera) for this embayment in the time series. The Shannon Index of diversity among genera (H = 0.65) was above the time series average (H = 0.42). Agardh's red weed (82.1%) was most abundant. *Polysiphonia* (12.5%) was the only other genera that contributed more than 5% of the sample population. The 2015 beach seine CPUE (196.6 L/haul) was not different from the grand mean (31.8 L/haul; Figure 49).

Chincoteague Bay: This embayment has undergone shifts in dominance from *Rhodophyta* in 2006-2007, *Phaeophyta* in 2008, *Chlorophyta* in 2009-2010, *Rhodophyta* in 2011-2014, and back to *Chlorophyta* in 2015. Eleven different genera were collected by trawl in 2015, which was below the times series average (11.7 genera). The Shannon Index of diversity among genera in 2015 (H = 1.53) was below the average (H = 1.68) within this embayment for the time series. *Chaetomorpha* (49.7%), *Spyridia* (18.7%), *Agardhiella* (11.3%) and *Gracilaria* (5.6%) were the only genera that contributed more than 5% of the sample population. The CPUE (72.4 L/ha) was not different than the grand mean (68.2 L/ha; Figure 50).

Eight different genera were collected by beach seine in 2015, which was above the average (6.9 genera) for this embayment in the time series. The Shannon Index of diversity among genera (H = 1.50), was above the time series average (H = 1.01). *Agardhiella* (49.4%) was most abundant. *Polysiphonia* (19.8%), Ulva (9.8%), *Vaucheria* (8.0%) and *Gracilaria* (6.9%) were the only other genera that contributed more than 5% of the sample population. The 2015 beach seine CPUE (1.6 L/haul) was lower than the grand mean (9.8 L/haul; Figure 51).

Discussion

Macroalgae in Maryland's Coastal Bays were investigated consistently over 10 years. The results of this investigation show distribution and abundance of macroalgae encountered by each gear. These data are highly variable and the survey designs were not developed to perform a population assessment for macroalgae. Abundances of *Rhodophyta*, *Chlorophyta*, *Phaeophyta* and *Xanthophyta* may not be accurate because the CBFI Trawl and Beach Seine Surveys did not sample macroalgae habitat such as rocks, jetties and bulkheads where macroalgae have been observed. However, those data show that *Rhodophyta* and *Chlorophyta* were present at high levels in the embayment's closest to high density human population.

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 such as nutrient levels, water temperature, clarity and salinity; however, these effects on macroalgae production are not clear. *Chlorophyta*, specifically sea lettuce abundance was variable, yet appeared able to compete with the *Rhodophytes* when the suitable conditions presented themselves. Chincoteague Bay was the most diverse embayment. Dense macroalgae canopies covering SAV was observed there and in Sinepuxent Bay. Macroalgae may benefit the Coastal Bays in nutrient cycling and by providing cover, food, and habitat for fishes, crustaceans, and other organisms. Macroalgae production should be investigated to ensure the proper balance in the ecosystem.

Management

The State of Maryland began to manage the commercial harvest of macroalgae in 2015. Only one permit was requested and issued. The permit limited the harvester to one bushel per day of wet red or green macroalgae taken by hand or a garden style rake less than 20 inches wide. The harvester was restricted from collecting macroalgae above the mean high tide waterline, west and south of a line from the northern most point of Assateague Island to the western terminus of the Route 50 Bridge, and within 200 meters of any sewage outfall. All bycatch was required to be returned to the water. Monthly landing reports were required; those reports are considered confidential.

Water Quality and Physical Characteristics Results

Temperature

Analysis of the 2015 CBFI Trawl Survey water quality data beginning in April showed increasing average water temperature for Assawoman Bay, Isle of Wight Bay and Chincoteague Bay through July. In Newport and Sinepuxent Bays, the combined average temperatures peaked in June. The temperature was highest in St. Martin River for August (Figure 52). The highest surface temperature (30.0 C) during 2015 trawl sampling was recorded at site T010 on June 19. Both the lowest surface temperature (7.4 C) and lowest bottom temperature (7.4 C) for all bays were recorded in April at site T008, which was the same as 2014.

The overall average from all trawl samples was 22.4 C, which was similar to 2014 (22.0 C). St. Martin River was the warmest with a combined average of 23.7 C, but Assawoman and Chincoteague Bays followed close behind with 23.0 C and 23.4 C, respectively. The system with the lowest combined average water temperature was Sinepuxent (19.5 C).

The CBFI Beach Seine Survey only has two rounds of sampling; therefore, related water quality information does not show the gradual progression of measurements (temperature, salinity, DO and turbidity) possible from graphically representing data. There was an 8.4 C difference between the highest temperature (29.7 C) and lowest temperature (21.0 C) during the month of June. Three months later in September, the temperature ranged from 22.3 C to 28.9 C. There was a slight increase in average temperatures in September for Isle of Wight Bay and the St. Martin River. Change in these systems ranged from 1.2 to 1.6 C. The most abrupt decreases in temperature were seen at the Assawoman, Sinepuxent, Newport and Chincoteague Bay sites in September (2.6 - 3.0 C; Figure 53).

Dissolved Oxygen

As expected, trawl DO levels generally decreased as water temperatures increased (Figure 54). Average DO levels in Assawoman Bay met that expectation whereas the average DO in the St. Martin River did not. Isle of Wight Bay did not show much change in average DO until decreasing in July as anticipated when water temperatures are high. Although Sinepuxent Bay experienced a large decrease in DO from April to July, values remained in the acceptable range. Average DO in Newport Bay steadily decreased through September although there were slight increases in June and October. While Chincoteague Bay experienced some changes in average DO, this body of water remained the most stable of all the bays. Surprisingly, the average DO slightly increased in July.

For the CBFI Beach Seine Survey, Assawoman Bay showed no change in average DO in June and September. The St. Martin River had a slight rise in DO in September. Isle of Wight, Sinepuxent, Newport and Chincoteague Bays had higher DO levels in June compared to September. Newport exhibited the greatest drop (2.6 mg/L) between the two sampling rounds (Figure 55).

Salinity

For 2015, the CBFI Trawl Survey overall average salinity for all bays combined was 27.8 ppt which was higher than 2014 (26.0 ppt). While Chincoteague Bay experienced a drop in average salinity from April to May, overall, salinity increased as the season progressed (Figure 56). When all the salinity averages were analyzed for each bay, Sinepuxent Bay had the highest average at 30.7 ppt and Newport Bay had the lowest (26.2 ppt). Sinepuxent Bay experienced less oscillations compared to other bays in terms of salinity.

For the CBFI Beach Seine Survey, salinity increased at all sites from June to September. Newport and Chincoteague Bays experienced the greatest upswings in salinity (Figure 57).

Turbidity

Results of the CBFI Trawl Survey Secchi analysis showed variations for turbidity levels from April to October for all systems (Figure 58). The most turbid water system was Isle of Wight Bay with an overall average Secchi reading of 70.9 cm. Sinepuxent Bay was the least turbid (overall average of 116.6 cm). Over the course of the CBFI Trawl Survey, visibility in all systems followed a decreasing pattern as the summer progressed. Out of all turbidity measurements, bottom was visible six times (4.3%).

For the CBFI Beach Seine Survey, only Sinepuxent Bay experienced an increase in visibility when the sites were visited in September (Figure 59). The most turbid system was Newport Bay with a combined Secchi average of 51.3 cm. Visibility was far better for both Sinepuxent and Isle of Wight Bays with combined averages of 65.2 cm and 62.5 cm, respectively.

A review of Secchi data from the years, 2015 and 2014, 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 2015 (89.7 cm) was very close in turbidity to 2014 (90.0 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 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, DO concentrations have the greatest immediate impact on fisheries resources. Dissolved oxygen typically decreases from April through the warmer months and then increases again in the fall. Some of the DO concentrations give rise to the concern that hypoxia is occurring in the Maryland Coastal Bays during the summer months. Hypoxia exists when dissolved oxygen levels can no longer support the majority of life; the DO level for this condition is 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 $\leq$ 5 mg/L (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).

In the 2015 CBFI Trawl Survey, there was only one combined average surface DO below 5.0 mg/L (3.5 mg/L) at site T005 in April. Also of concern was the combined bottom average of 3.3 mg/L for the St. Martin River (T004 and T005) in September (3.4 mg/L and 3.2 mg/L, respectively). In 2014, a combined bottom average of 4.6 mg/L was obtained from those same sites in the St. Martin River in June. The lowest DO (2.7 mg/L) for 2015 was observed at site T015 in May near the bottom, however, the bottom DO levels at the other sites in

Chincoteague Bay were high enough to have a combined average of 6.7 mg/L for that month. One possibility for the very low bottom DO at site T015 might lie with the quantity of macroalgae collected at the site during the same month. If there was some decomposition of macroalgae, the DO towards the bottom could be reduced. This site was once an inlet and now has only one opening, which may prevent flushing of the decaying substance as might occur in more open sites. For the 2015 CBFI Beach Seine Survey, Newport Bay sites S011 and S012 produced a DO average of 4.4 mg/L in September, which is below the accepted value for life in Chesapeake Bay. Low DO likely impacts the catch, although, these data have not been examined to determine if decreased DO levels lower overall total catch per tow and the total species number observed in either trawls or beach seines. Overall, 2015 was no exception to this seasonal pattern, overall.

Turbidity can be caused by brown tides, wind and precipitation. 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). Turbidity generally increases in the Coastal Bays as the water becomes warmer and this pattern was observed for 2015. The possible impact of precipitation and wind on our turbidity data has not been examined.

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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 of Dredge Spoil Island across east channel from 4th Street, NE. Corner of the Ocean City Flats	38 20.388	75 05.390
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 06.432	75 12.404
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, 2015. 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*	17,166	39	17,127	2.2	450.7
Atlantic Silverside	*Menidia menidia*	7,429	1,573	5,856	89.6	154.1
Bay Anchovy	*Anchoa mitchilli*	4,819	3,267	1,552	186.1	40.8
Silver Perch	*Bairdiella chrysoura*	3,283	1,798	1,485	102.4	39.1
Spot	*Leiostomus xanthurus*	2,088	615	1,473	35.0	38.8
Pinfish	*Lagodon rhomboides*	1,245	39	1,206	2.2	31.7
Rainwater Killifish	*Lucania parva*	1,004	11	993	0.6	26.1
Mummichog	*Fundulus heteroclitus*	765	54	711	3.1	18.7
Inland Silverside	*Menidia beryllina*	533	43	490	2.4	12.9
White Mullet	*Mugil curema*	523		523		13.8
Striped Anchovy	*Anchoa hepsetus*	299	183	116	10.4	3.0
Striped Killifish	*Fundulus majalis*	290		290		7.6
Weakfish	*Cynoscion regalis*	249	249		14.2	
Sheepshead Minnow	*Cyprinodon variegatus*	187	1	186	0.1	4.9
Sheepshead	*Archosargus probatocephalus*	148	12	136	0.7	3.6
Bluefish	*Pomatomus saltatrix*	137	4	133	0.2	3.5
Oyster Toadfish	*Opsanus tau*	120	33	87	1.9	2.3
Summer Flounder	*Paralichthys dentatus*	118	96	22	5.5	0.6
Atlantic Croaker	*Micropogonias undulatus*	105	105		6.0	
Atlantic Needlefish	*Strongylura marina*	105	1	104	0.1	2.7
Naked Goby	*Gobiosoma bosc*	102	85	17	4.8	0.4
Northern Pipefish	*Syngnathus fuscus*	102	26	76	1.5	2.0
Winter Flounder	*Pseudopleuronectes americanus*	101	12	89	0.7	2.3
Alewife	*Alosa pseudoharengus*	99	2	27	0.1	0.7
Hogchoker	*Trinectes maculatus*	78	52	26	3.0	0.7
Dusky Pipefish	*Syngnathus floridae*	71	12	59	0.7	1.6
Black Sea Bass	*Centropristis striata*	65	35	30	2.0	0.8
Northern Puffer	*Sphoeroides maculatus*	56	32	24	1.8	0.6
Banded Killifish	*Fundulus diaphanus*	43	1	42	0.1	1.1
Gag	*Mycteroperca microlepis*	35	3	32	0.2	0.8
Spotted Hake	*Urophycis regia*	28	28		1.6	
American Eel	*Anguilla rostrata*	27	8	19	0.5	0.5
Inshore Lizardfish	*Synodus foetens*	27	19	8	1.1	0.2
Ladyfish	*Elops saurus*	25	1	24	0.1	0.6
Striped Blenny	*Chasmodes bosquianus*	25	3	22	0.2	0.6
Smallmouth Flounder	*Etropus microstomus*	24	21	3	1.2	<0.1
Pigfish	*Orthopristis chrysoptera*	22	14	8	0.8	0.2

Table 4. List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2015. 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
White Perch	*Morone americana*	21		21		0.5
Striped Burrfish	*Chilomycterus schoepfii*	19	9	10	0.5	0.3
Striped Bass	*Morone saxatilis*	17	3	14	0.2	0.4
Southern Kingfish	*Menticirrhus americanus*	16	2	14	0.1	0.4
Spotfin Mojarra	*Eucinostomus argenteus*	15	1	14	0.1	0.4
Northern Kingfish	*Menticirrhus saxatilis*	13	7	6	0.4	0.2
Atlantic Herring	*Clupea harengus harengus*	12	12		0.7	
Halfbeak	*Hyporhamphus unifasciatus*	11		11		0.3
Northern Searobin	*Prionotus carolinus*	10	10		0.6	
Striped Searobin	*Prionotus evolans*	9	8	1	0.5	<0.1
Skilletfish	*Gobiesox strumosus*	8	5	3	0.3	<0.1
Brown Bullhead	*Ameiurus nebulosus*	7		7		0.2
Golden Shiner	*Notemigonus crysoleucas*	7		7		0.2
Lined Seahorse	*Hippocampus erectus*	7	6	1	0.3	<0.1
Tautog	*Tautoga onitis*	7	3	4	0.2	0.1
Planehead Filefish	*Stephanolepis hispida*	6	2	4	0.1	0.1
Southern Stingray	*Dasyatis americana*	6	4	2	0.2	<0.1
Black Drum	*Pogonias cromis*	5	1	4	0.1	0.1
Gray Snapper	*Lutjanus griseus*	4	1	3	0.1	<0.1
Green Goby	*Microgobius thalassinus*	4	4		0.2	
Butterfish	*Peprilus triacanthus*	3	3		0.2	
Gizzard Shad	*Dorosoma cepedianum*	3		3		<0.1
Striped Mullet	*Mugil cephalus*	3		3		<0.1
Windowpane	*Scophthalmus aquosus*	3	3		0.2	
American Shad	*Alosa sapidissima*	2	2		0.1	
Blueback Herring	*Alosa aestivalis*	2		2		<0.1
Bluegill	*Lepomis macrochirus*	2		2		<0.1
Northern Sennet	*Sphyraena borealis*	2		2		<0.1
Permit	*Trachinotus falcatus*	2		2		<0.1
Atlantic Spadefish	*Chaetodipterus faber*	1	1		0.1	
Blue Runner	*Caranx crysos*	1		1		<0.1
Bluespotted Cornetfish	*Fistularia tabacaria*	1	1		0.1	
Crevalle Jack	*Caranx hippos*	1		1		<0.1
Fourspot Flounder	*Hippoglossina oblonga*	1	1		0.1	
Lookdown	*Selene vomer*	1	1		0.1	
Pumpkinseed	*Lepomis gibbosus*	1		1		<0.1
Striped Cusk-eel	*Ophidion marginatum*	1	1		0.1	

Table 4. List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2015. 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
	Total Finfish	**41,777**	**8,568**	**33,139**		

Table 5. List of crustaceans collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2015. 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*	8,323	4,924	3,399			280.4	89.4
Grass Shrimp	*Palaemonetes sp.*	7,393	84	3,304	1,210	2,795	73.7	160.5
Sand Shrimp	*Crangon septemspinosa*	3,799	108	220	2,150	1,321	128.6	40.5
Brown Shrimp	*Farfantepenaeus aztecus*	808	722	86			41.1	2.3
Say Mud Crab	*Dyspanopeus sayi*	353	313	33	7		18.2	0.9
Long-armed Hermit Crab	*Pagurus longicarpus*	205	178	27			10.1	0.7
Lady Crab	*Ovalipes ocellatus*	63	4	59			0.2	1.6
Atlantic Rock Crab	*Cancer irroratus*	39	39				2.2	
Iridescent Swimming Crab	*Portunus gibbesii*	8	8				0.5	
Portly Spider Crab	*Libinia emarginata*	3	3				0.2	
Mud Crab	*Panopeus sp.*	2	2				0.1	
Atlantic Ghost Crab	*Ocypode quadrata*	1		1				<0.1
Atlantic Mud Crab	*Panopeus herbstii*	1	1				0.1	
Mantis Shrimp	*Squilla empusa*	1	1				0.1	
Mud Crabs	*Panopeidae*	1	1				0.1	
	Total Crustaceans	**21,000**	**6,388**	**7,129**	**3,367**	**4,116**		

Table 6. List of molluscs collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2015. 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 Vol. (T) #/Hect	CPUE Vol. (S) #/Haul
Convex Slippersnail	*Crepidula convexa*	316	16			300					0.9	7.9		
Solitary Glassy Bubble Snail	*Haminoea solitaria*	105	10		95						6.0			
Eastern Mudsnail	*Nassarius obsoletus*	64	3	11		50					0.2	1.6		
Atlantic Brief Squid	*Lolliguncula brevis*	31	31								1.8			
Mudsnails	*Nassarius sp.*	12	1	11							0.1	0.3		
Common Atlantic Slippersnail	*Crepidula fornicata*	10				10						0.3		
Dwarf Surfclam	*Mulinia lateralis*	8	8								0.5			
Atlantic Jackknife	*Ensis directus*	5	5								0.3			
Atlantic Razor	*Siliqua costata*	2	2								0.1			
Bruised Nassa	*Nassarius vibex*	2	2								0.1			
Eastern White Slippersnail	*Crepidula plana*	2				2						<0.1		
Purplish Tagelus	*Tagelus divisus*	2	2								0.1			
Thick-lip Drill	*Eupleura caudata*	2	2								0.1			
Threeline Mudsnail	*Nassarius trivittatus*	2	1	1							0.1	<0.1		
Atlantic Oyster Drill	*Urosalpinx cinerea*	1	1								0.1			
Atlantic Surfclam	*Spisula solidissima*	1	1								0.1			
Blue Mussel	*Mytilus edulis*	1		1								<0.1		
Stout Tagelus	*Tagelus plebeius*	1	1								0.1			
	Total Molluscs	**567**	**86**	**24**	**95**	**362**								

Table 7. List of other species collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2015. 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*	766	36		730		10.3		0.3		43.6		0.6	
Comb Jellies	*Ctenophora*	106	75	1	30		263.6	7.9	6.4	5.3	6.0	<0.1	15.4	0.4
Sea Nettle	*Chrysaora quinquecirrha*	105	6	4	95		27.5				5.8	0.1	1.6	
Hairy Sea Cucumber	*Sclerodactyla briareus*	49	40	9							2.3	0.2		
Horseshoe Crab	*Limulus polyphemus*	37	21	16							1.2	0.4		
Moon Jelly	*Aurelia aurita*	27	7		20						1.5			
Common Sea Cucumber	*Cucumaria pulcherrima*	13	12	1							0.7	<0.1		
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	5	2	3							0.1	<0.1		
Sand Dollar	*Echinarachnius parma*	3	3								0.2			
Lion's Mane	*Cyanea capillata*	1	1								0.1			
Bryozoans	*Ectoprocta*						691.5	11.4	<0.1		0.1		39.4	0.3
Goldstar Tunicate	*Botryllus schlosseri*						20.1	3.2					1.1	<0.1
Sea Pork	*Aplidium sp.*						65.3	4.2					3.7	0.1
Rubbery Bryozoan	*Alcyonidium sp.*						135.2	22.9					7.7	0.6
Halichondria Sponge	*Halichondria sp.*						1,229.6	7.2					70.0	0.2
Red Beard Sponge	*Microciona prolifera*						117.1						6.7	
Sulphur Sponge	*Cliona celata*						15.7						0.9	
Serpulid Worms	*Hydroides dianthus*						0.1						<0.1	
	Total Other	**1,112**	**203**	**34**	**875**		**2,576.0**	**56.9**	**6.6**	**5.3**				

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, 2015. 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*	7.3	67.3		
Widgeongrass	*Ruppia*	2.4	3.2		
	Total SAV	**9.7**	**70.5**		
Macroalgae					
Brown					
Common Southern Kelp	*Laminaria*	0.9			
Sour Weeds	*Desmarestia*	0			
Brown Bubble Algae	*Colpomenia*	0			
		0.9			
Green					
Sea Lettuce	*Ulva*	269.1	66.4		<0.1
Green Hair Algae	*Chaetomorpha*	259.5	12.6		
Hollow Green Weed	*Enteromorpha*	12.8	6.5		
Green Tufted Seaweed	*Cladophora*	1.5	125.6		
Green Fleece	*Codium*	1.0	0.7		
Brittlewort	*Nitella*		0		
		543.8	**211.9**		**<0.1**
Red					
Agardh's Red Weed	*Agardhiella*	3,685.0	1,886.8	<0.1	
Graceful Red Weed	*Gracilaria*	127.7	22.0		
Tubed Weeds	*Polysiphonia*	108.2	127.8		
Hairy Basket Weed	*Spyridia*	94.9			
Banded Weeds	*Ceramium*	13.5	0.8		
		4,029.3	**2,037.5**	**<0.1**	
Yellow-Green					
Water Felt	*Vaucheria*	11.3	245.6		
		11.3	**245.6**		
	Total Macroalgae	**4,585.4**	**2,494.9**	**<0.1**	**<0.1**

Table 9. Summary of Maryland recreational fishing regulations for 2015.

Species	Minimum Size Limit (inches)	Creel (person/day)	Season
American Eel	9	25	Open Year Round
Atlantic Croaker	9	25	Open Year Round
Black Sea Bass	12.5	15	May 15 thru Sept.21 Oct. 22 thru Dec. 31
Bluefish	8	10	Open Year Round
Spot	None	None	None
Summer Flounder	16	4	Open year Round
Tautog	16	4	Jan. 1 thru May 15 and Nov. 1 thru Nov. 26
		2	May 16 thru Oct. 31
Weakfish	13	1	Open Year Round
A- Includes Atlantic Ocean, Coastal Bays, Chesapeake Bay, & all tributaries			
B- Includes Atlantic Ocean & Coastal Bay			
C- Includes Chesapeake Bay & tributaries			

Table 10. Summary of Maryland commercial fishing regulations for 2015.

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, eel pot	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 5,628,568 pounds.
Black Sea Bass	B	11 Pot, Trap, Trawl	Open Year Round	Quotas by permit; without permit catch limit is 50 lbs.; Trawling only permitted in Ocean
Bluefish	A	8 All gear	Open Year Round	Commercial quota of 153,662 lbs
Red Drum	A	18-25 All gear	Open Year Round Mon. thru Sun.	5 fish/person/day
Scup	A	9 All gear	Open Year Round	Moratorium permit quotas, dates, net, trap and pot specifications at: https://www.greateratlantic.fisheries.noaa.gov/regs/infodocs/scup_info-final.pdf
Summer Flounder	A	14 All gear other than hook and line	Open Year Round Mon. thru Sun.	Quotas by permit. Coastal: Without a Permit: 100 lbs/person/day. Tidal (Chesapeake & tributaries): Without a Permit: 50 lbs/person/day.
		16 Hook & line		
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.
			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 Trawl & 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 Bays

Table 11. Shannon Index and number of fish species by embayment collected by trawl (1989-2015).

Area	Shannon Index (H)	# of Species
Assawoman Bay	1.65	78
St. Martin River	1.67	73
Isle of Wight	1.80	83
Sinepuxent Bay	2.06	73
Newport Bay	1.66	66
Chincoteague Bay	1.67	91

Table 12. Shannon Index and number of fish species by embayment collected by beach seine (1989-2015).

Area	Shannon Index (H)	# of Species
Assawoman Bay	1.96	85
St. Martin River	1.43	71
Isle of Wight	1.88	87
Sinepuxent Bay	1.56	76
Newport Bay	2.07	64
Chincoteague Bay	2.00	74

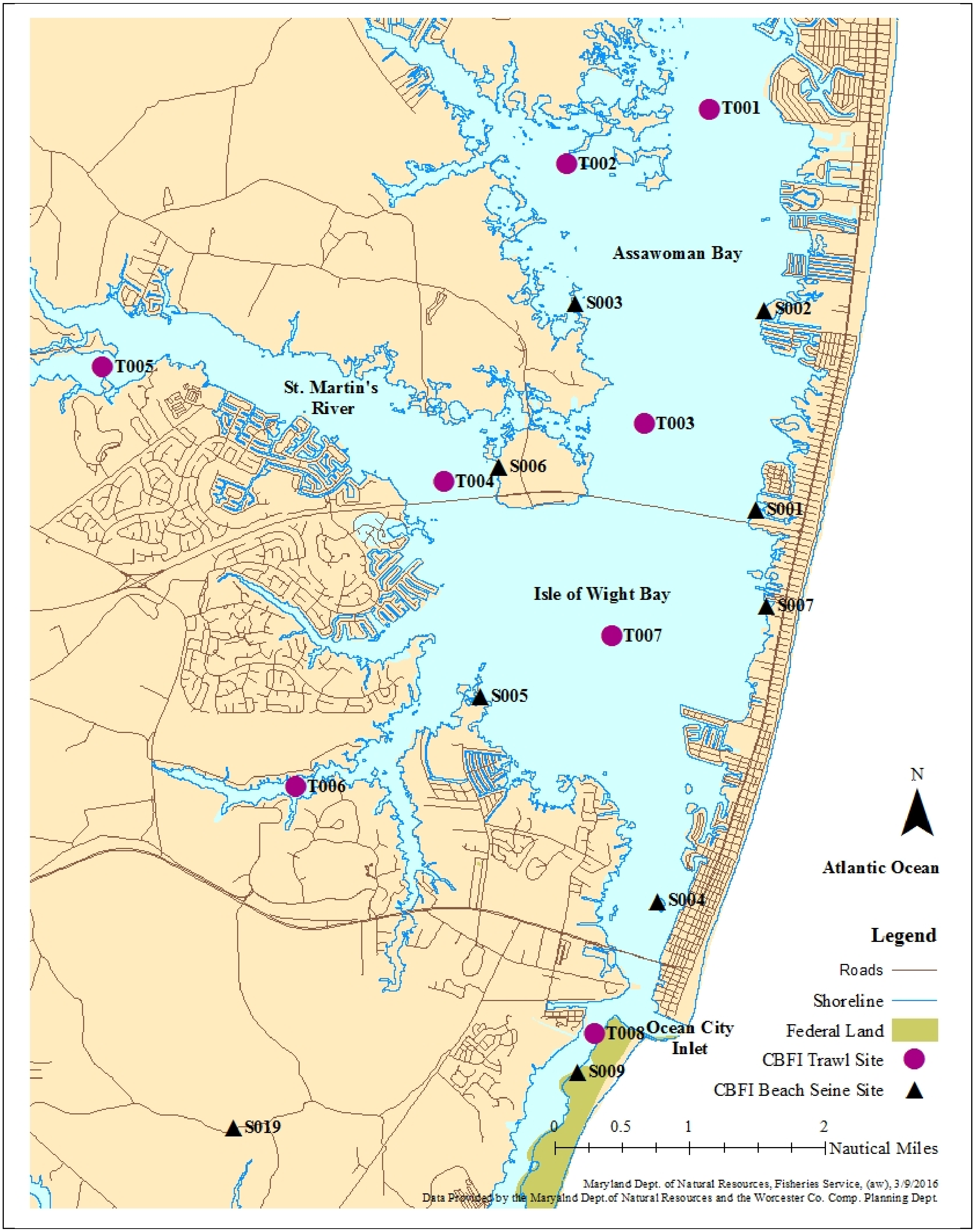

Figure 1. Coastal Bays Fisheries Investigation 2015 sampling locations in the Assawoman and Isle of Wight Bays, Maryland.

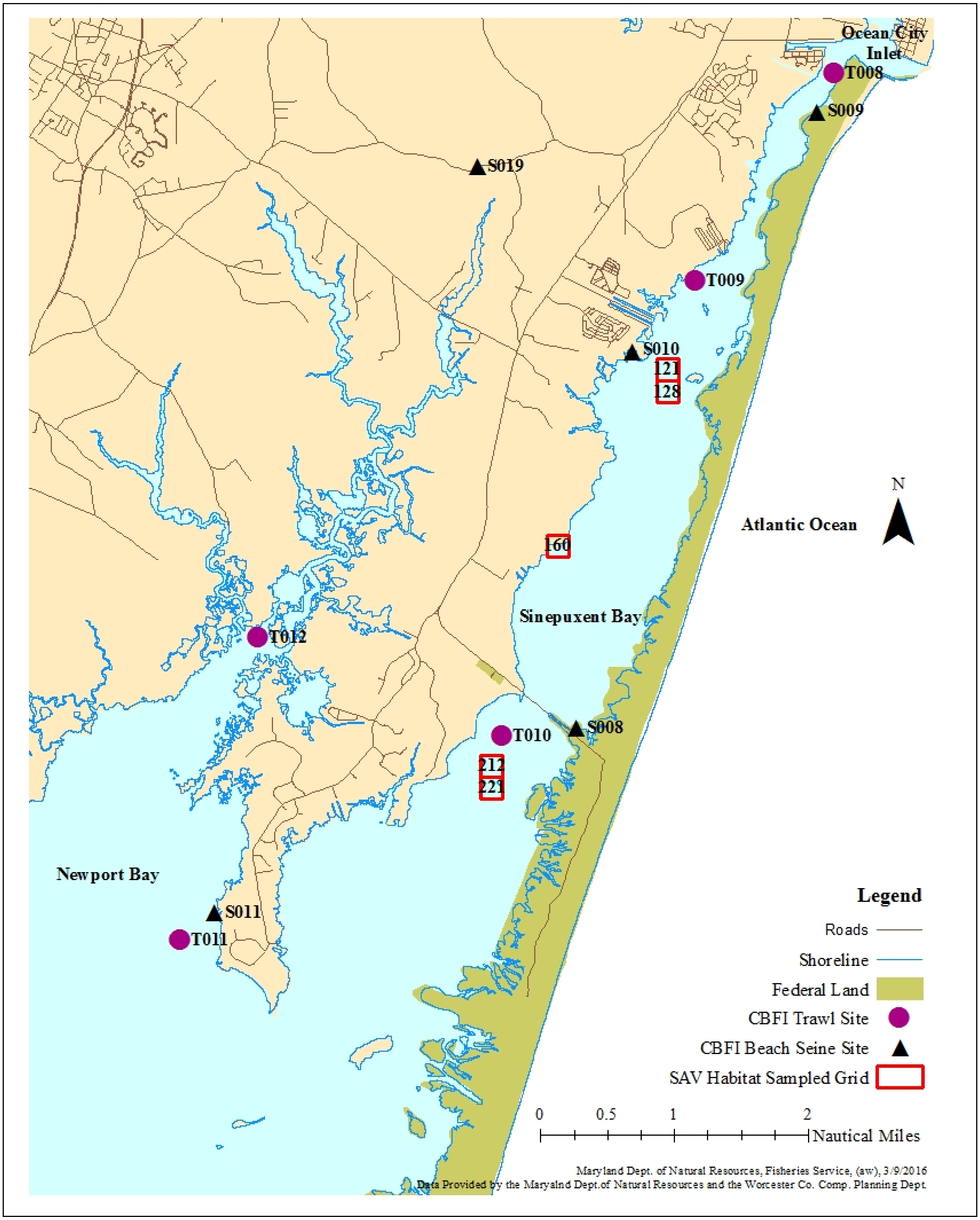

Figure 2. Coastal Bays Fisheries Investigation 2015 sampling locations in the Sinepuxent and Newport Bays, Maryland.

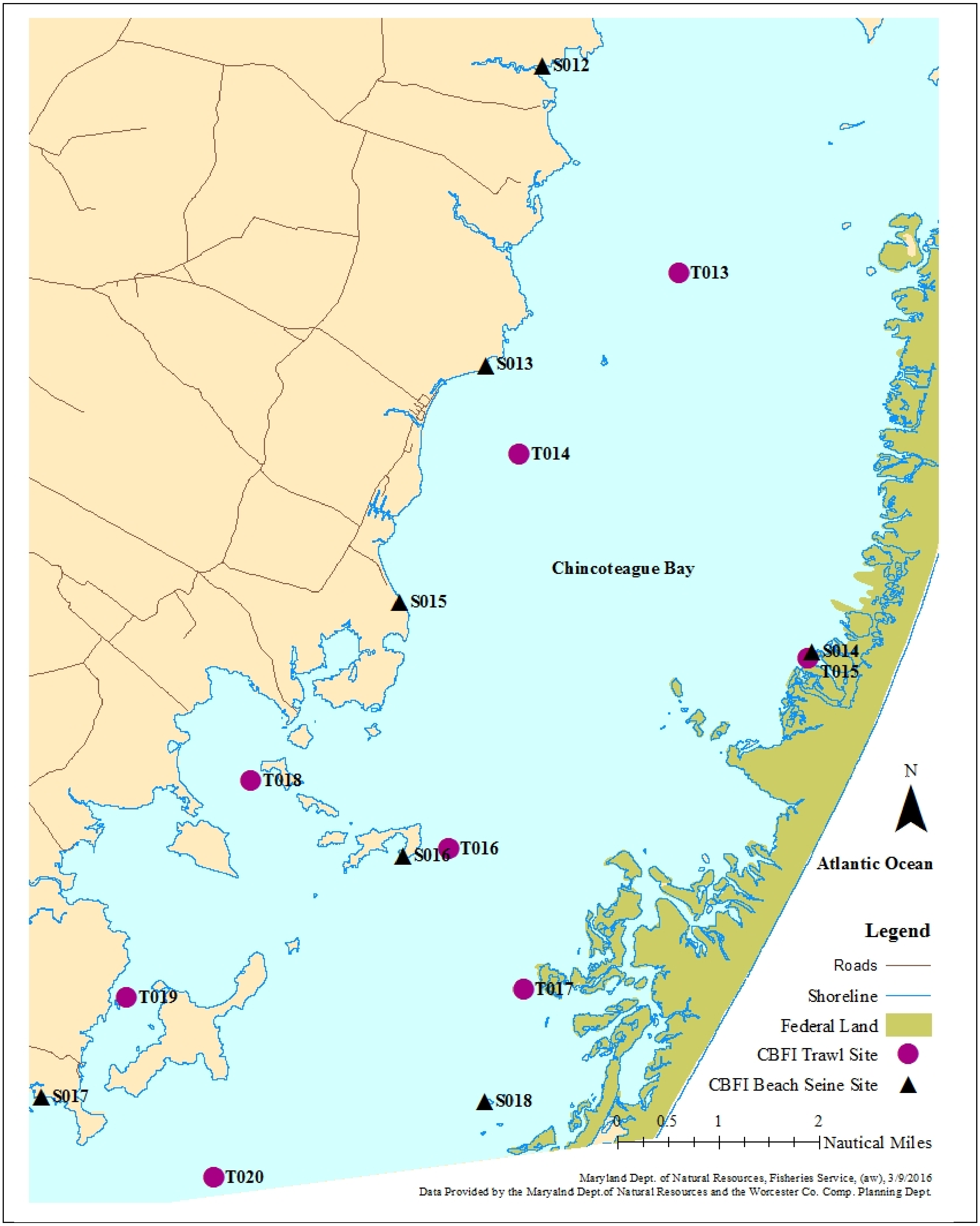

Figure 3. Coastal Bays Fisheries Investigation 2015 sampling locations in Chincoteague Bay, Maryland.

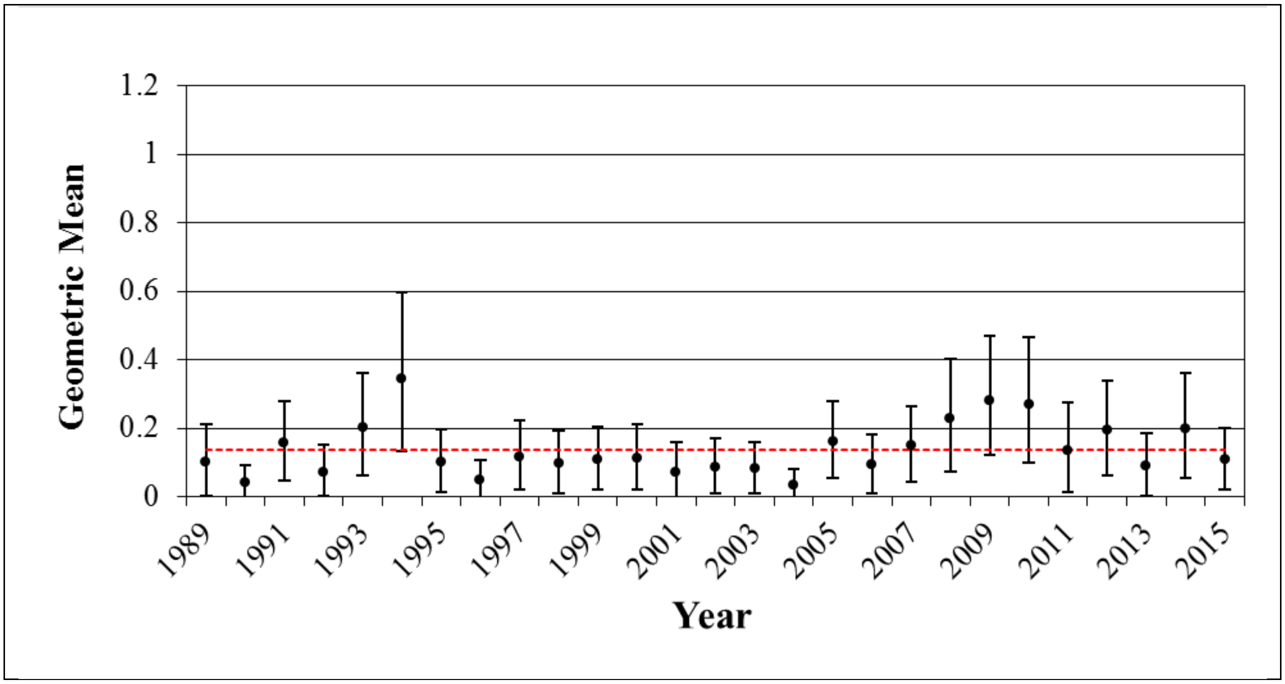

Figure 4. American eel (*Anguilla rostrata)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

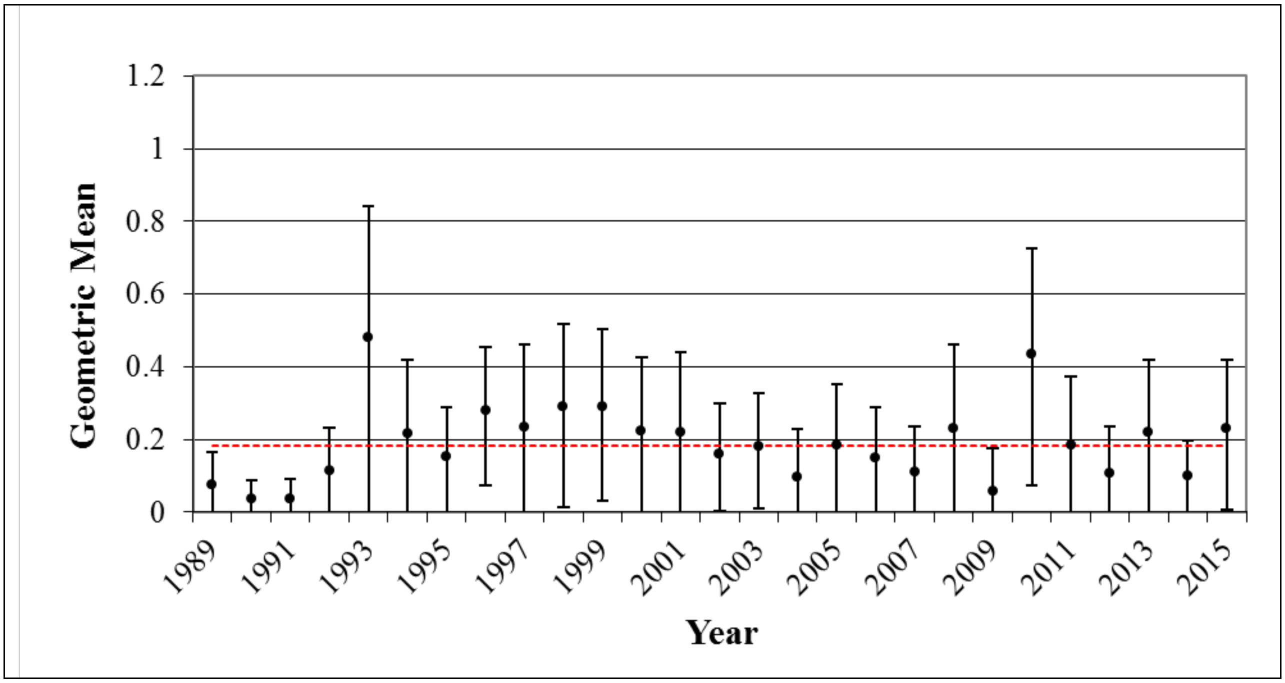

Figure 5. American Eel (*Anguilla rostrata)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

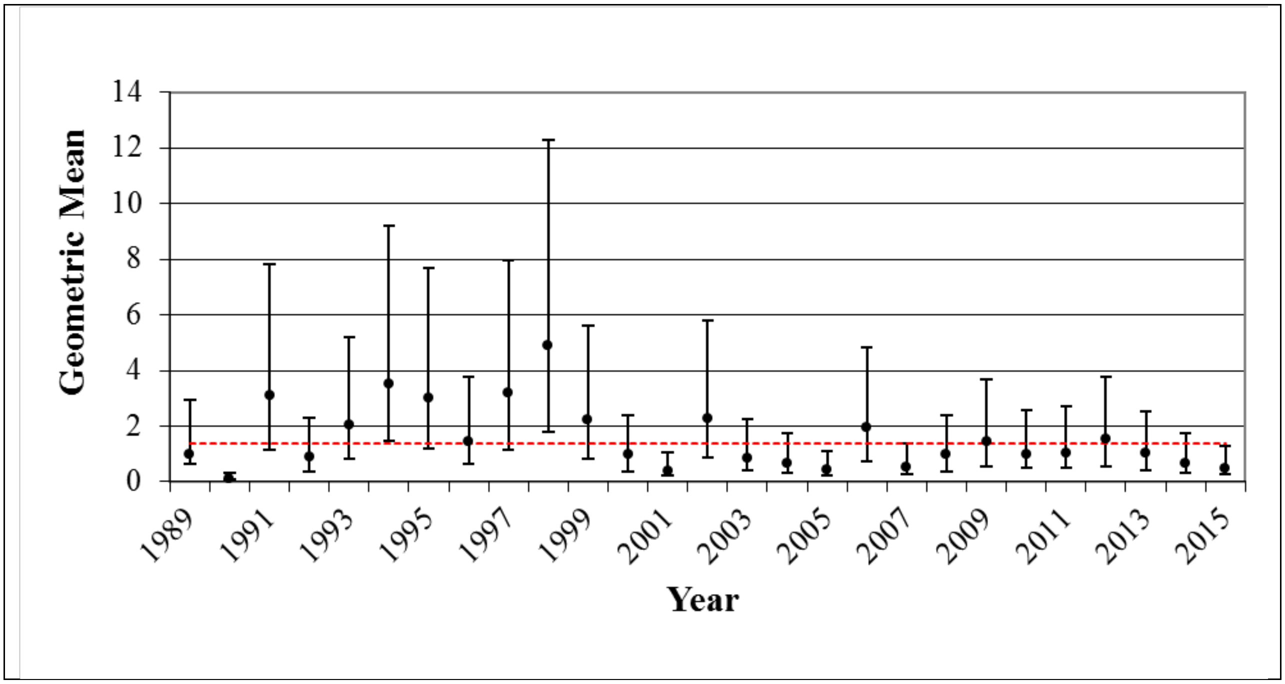

Figure 6. Atlantic croaker (*Micropogonias undulates*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

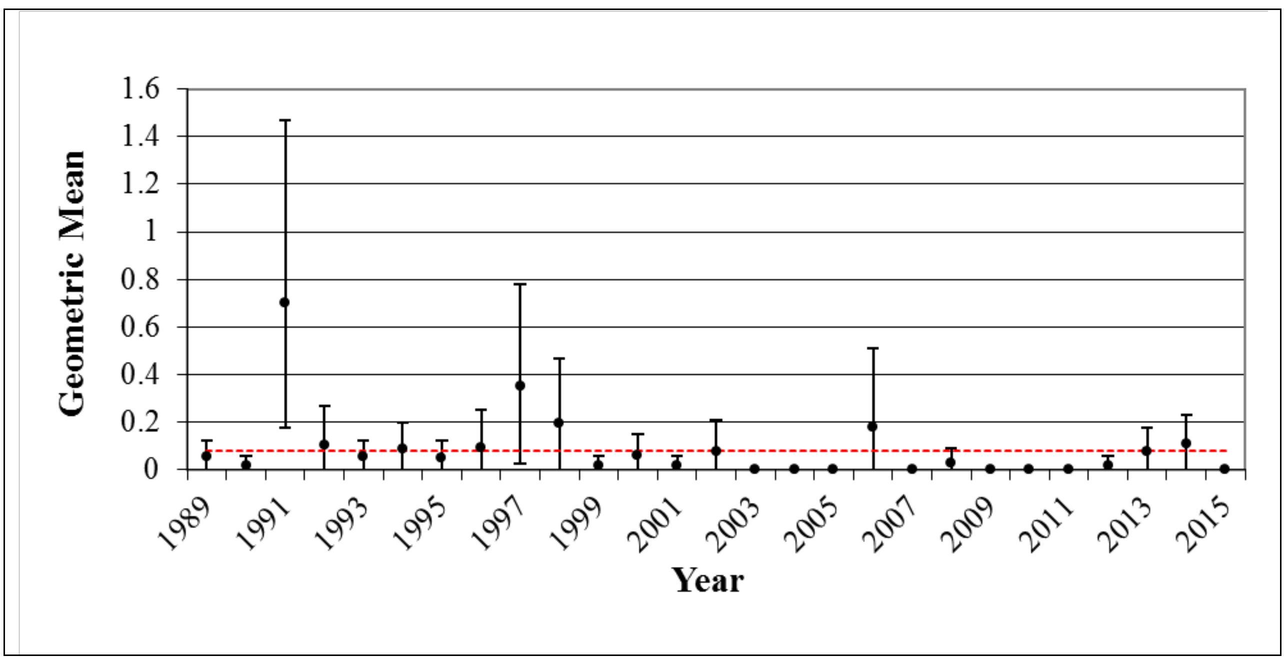

Figure 7. Atlantic croaker (*Micropogonias undulates*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

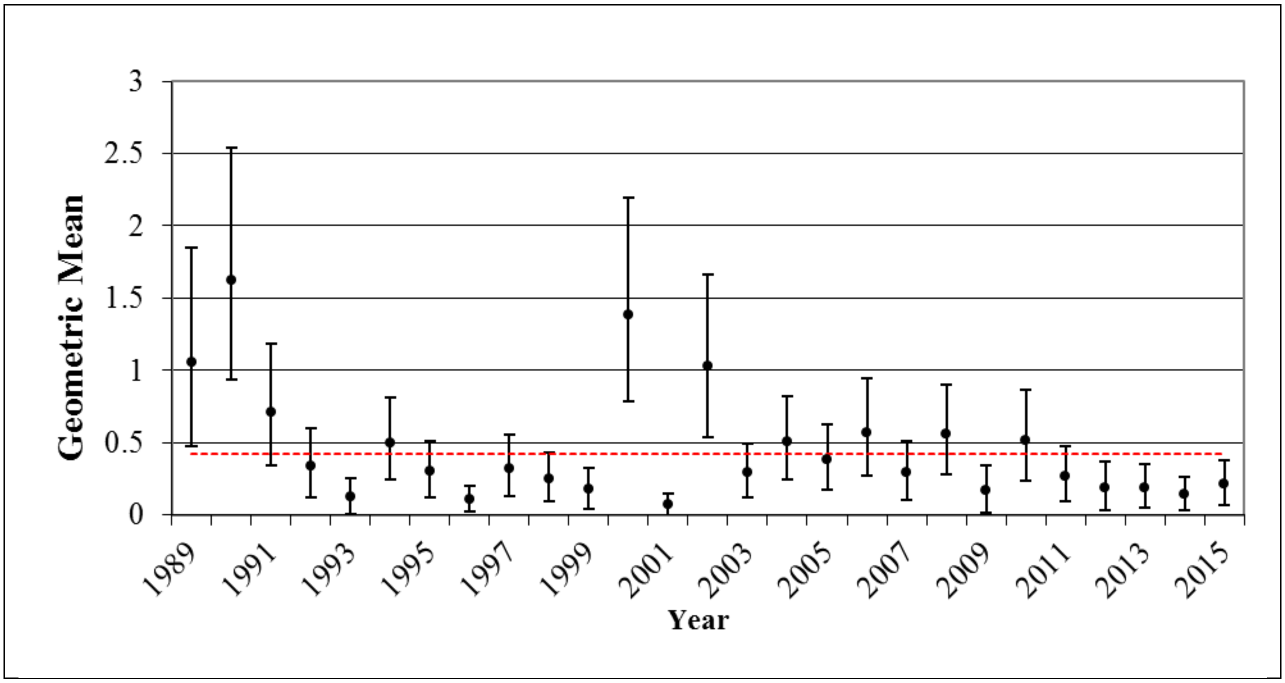

Figure 8. Atlantic menhaden (Brevoortia tyrannus) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

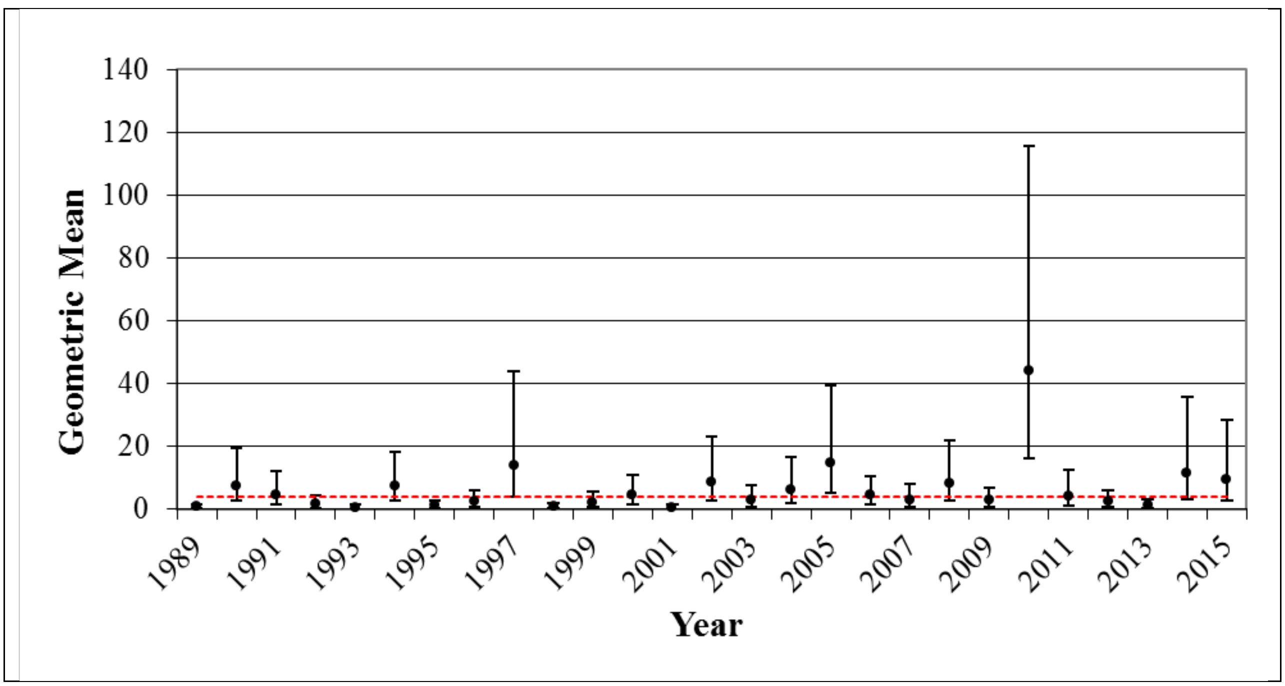

Figure 9. Atlantic menhaden (*Brevoortia tyrannus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

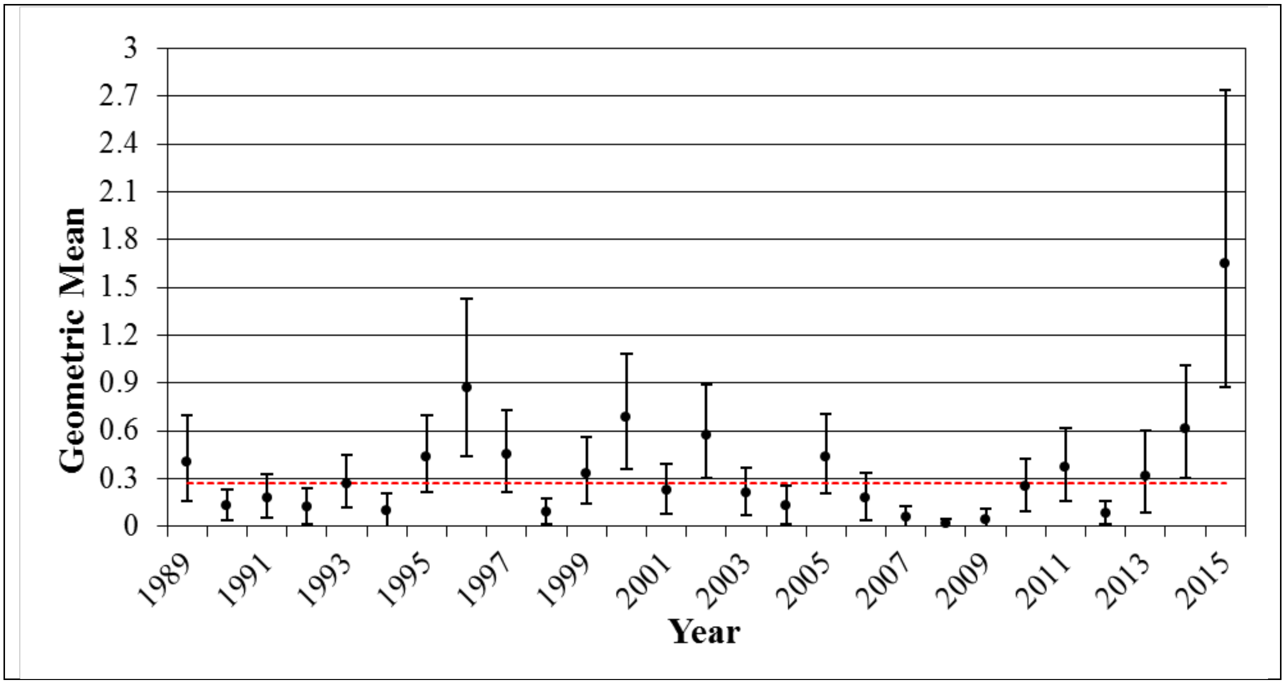

Figure 10. Atlantic silverside (*Menidia menidia*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

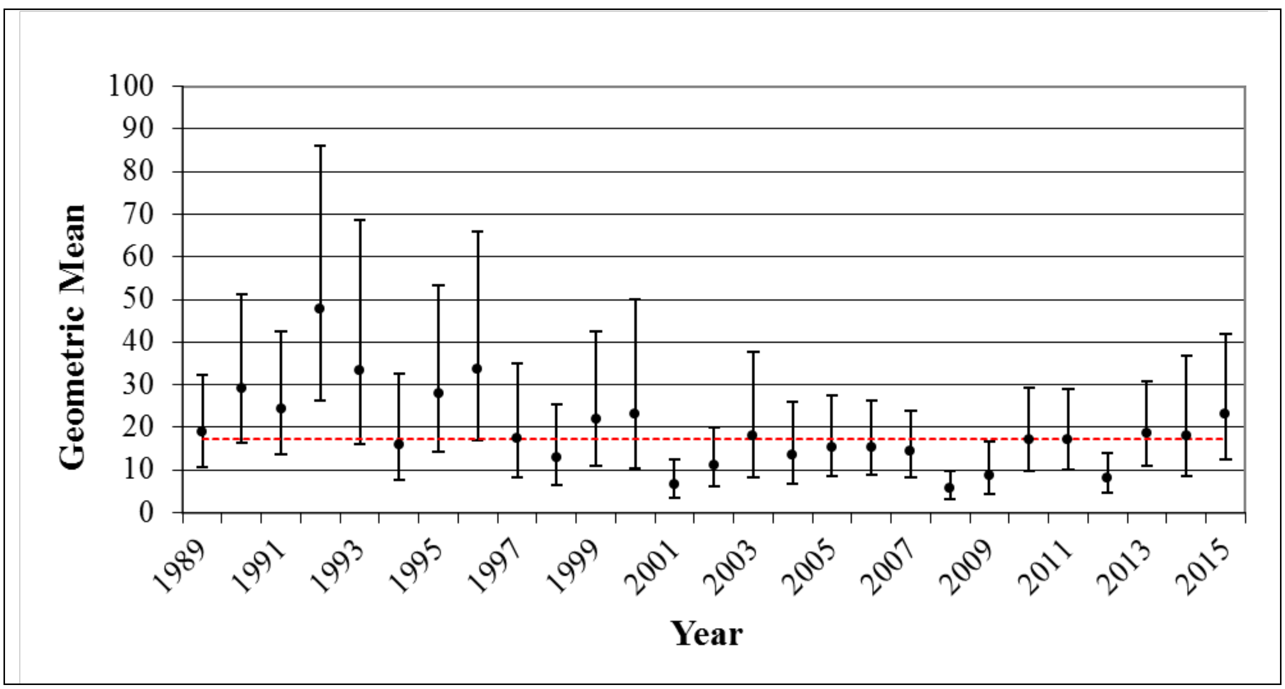

Figure 11. Atlantic silverside (*Menidia menidia*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

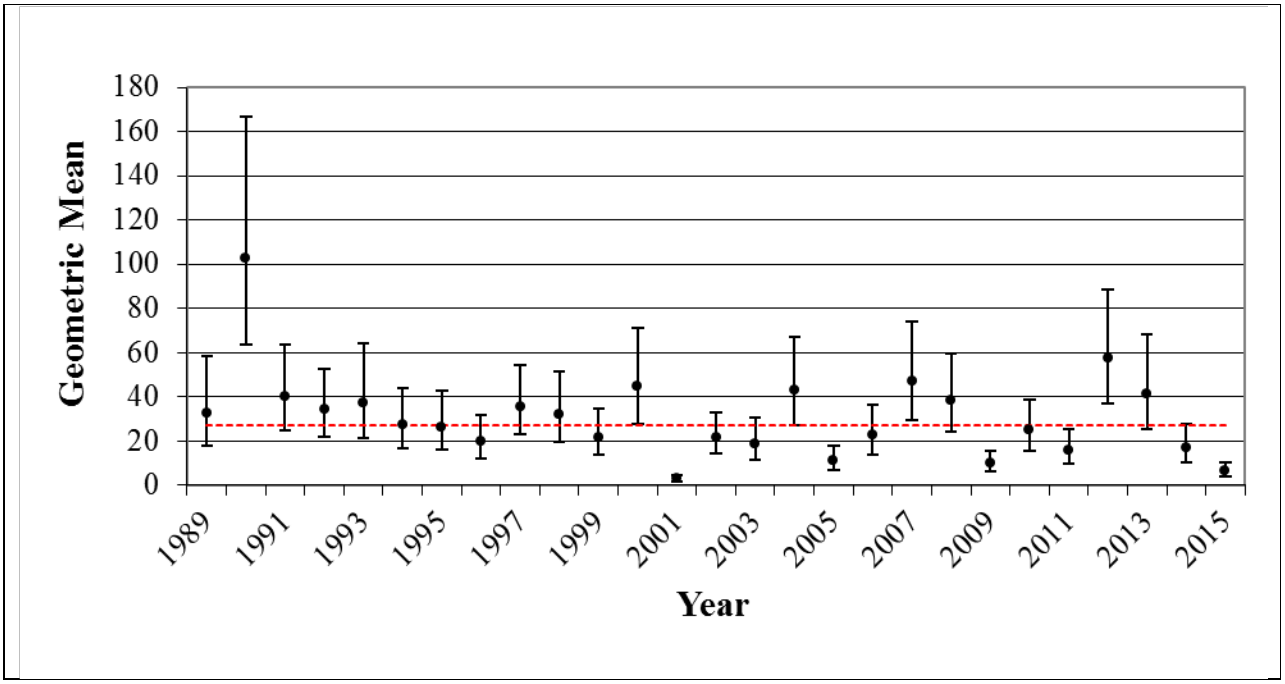

Figure 12. Bay anchovy (*Anchoa mitchilli*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

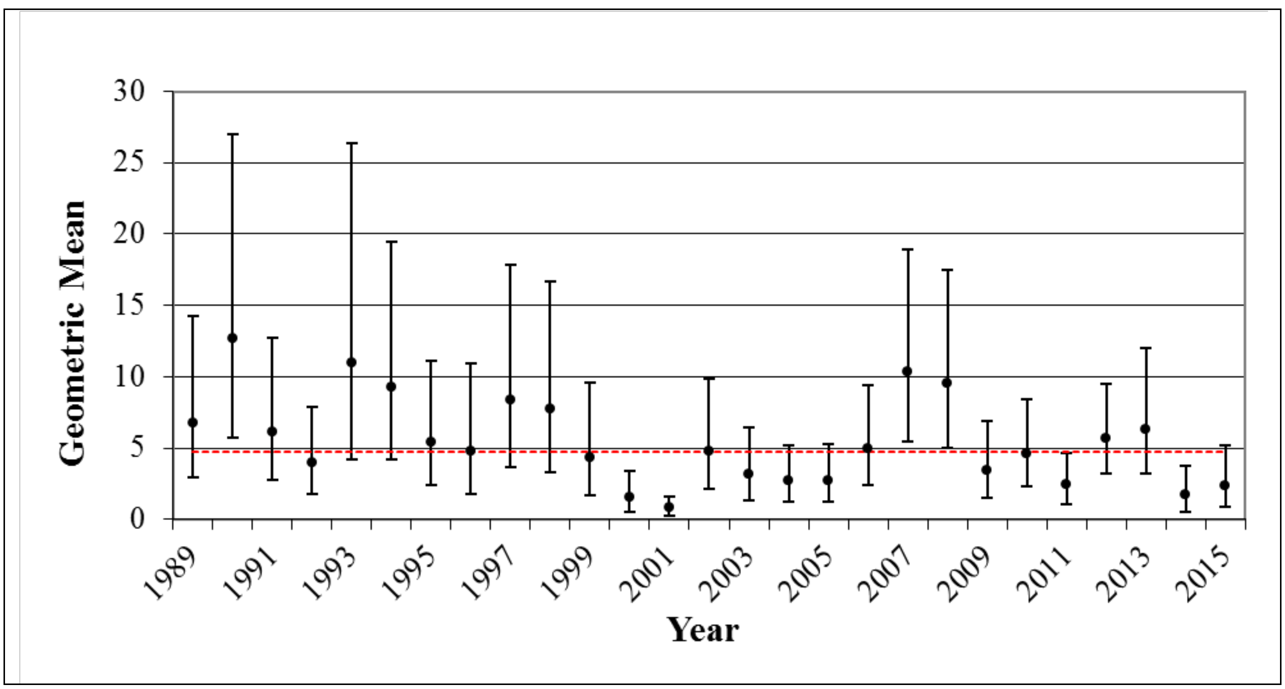

Figure 13. Bay anchovy (*Anchoa mitchilli*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

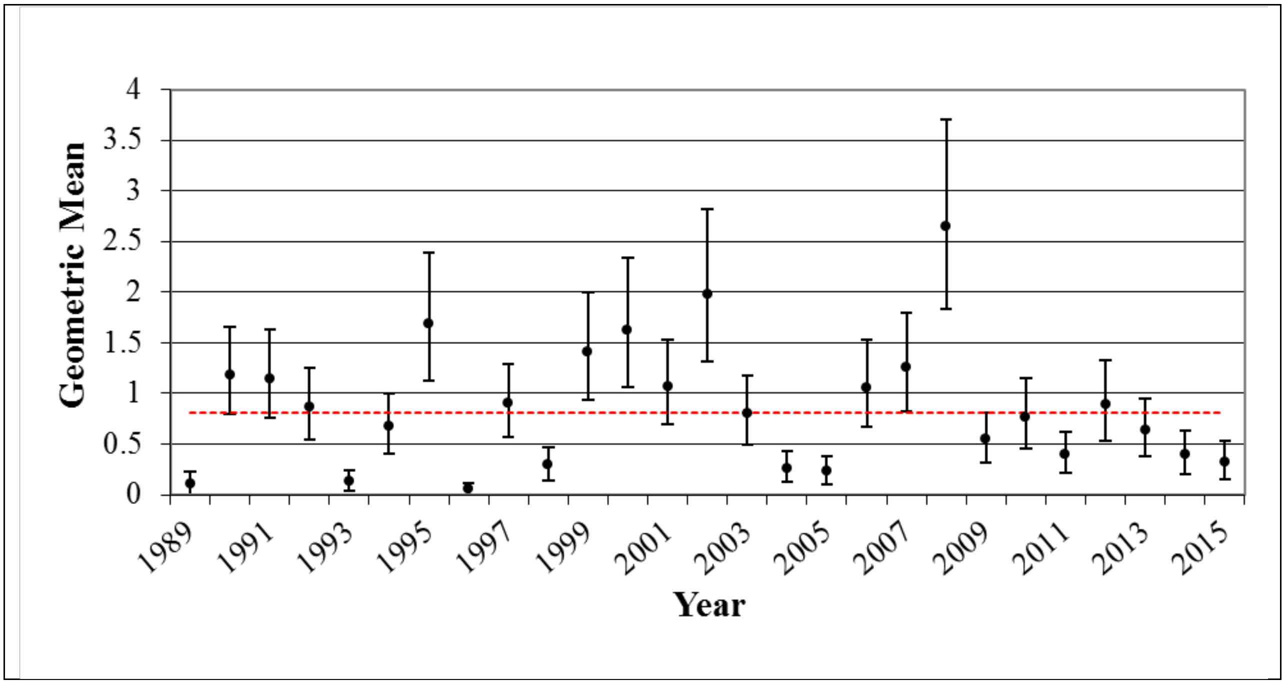

Figure 14. Black sea bass (*Centropristis striata*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

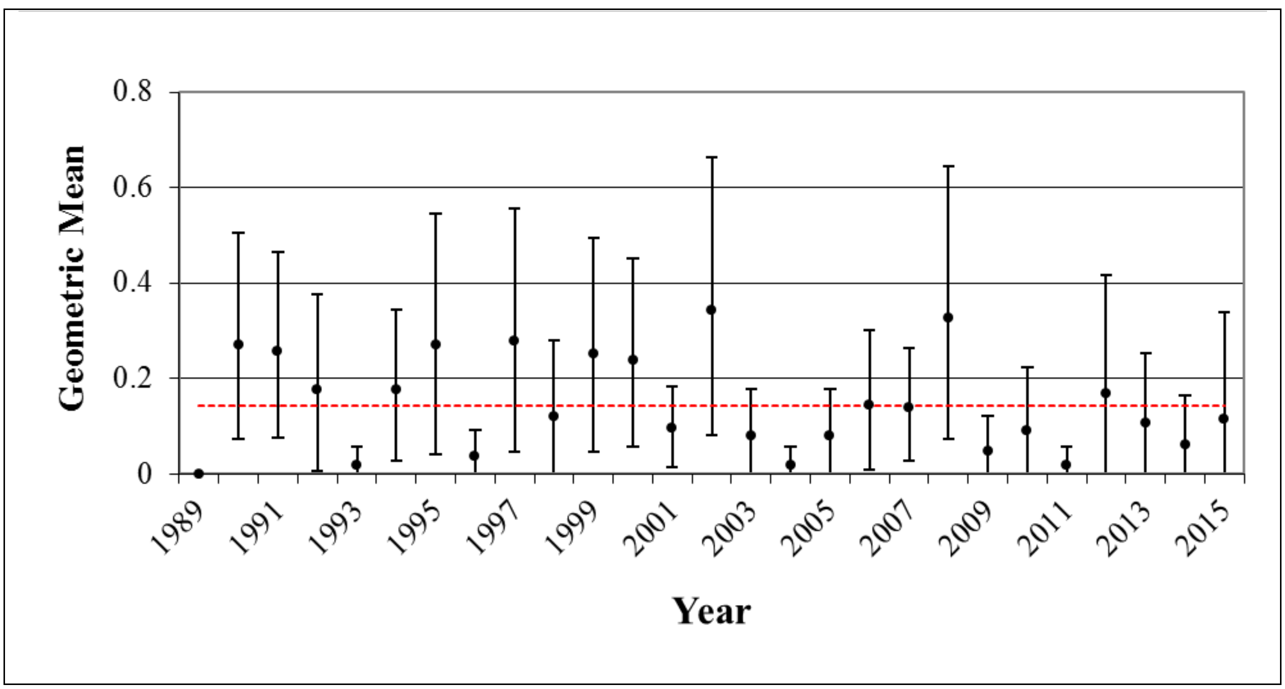

Figure 15. Black sea bass (*Centropristis* striata) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

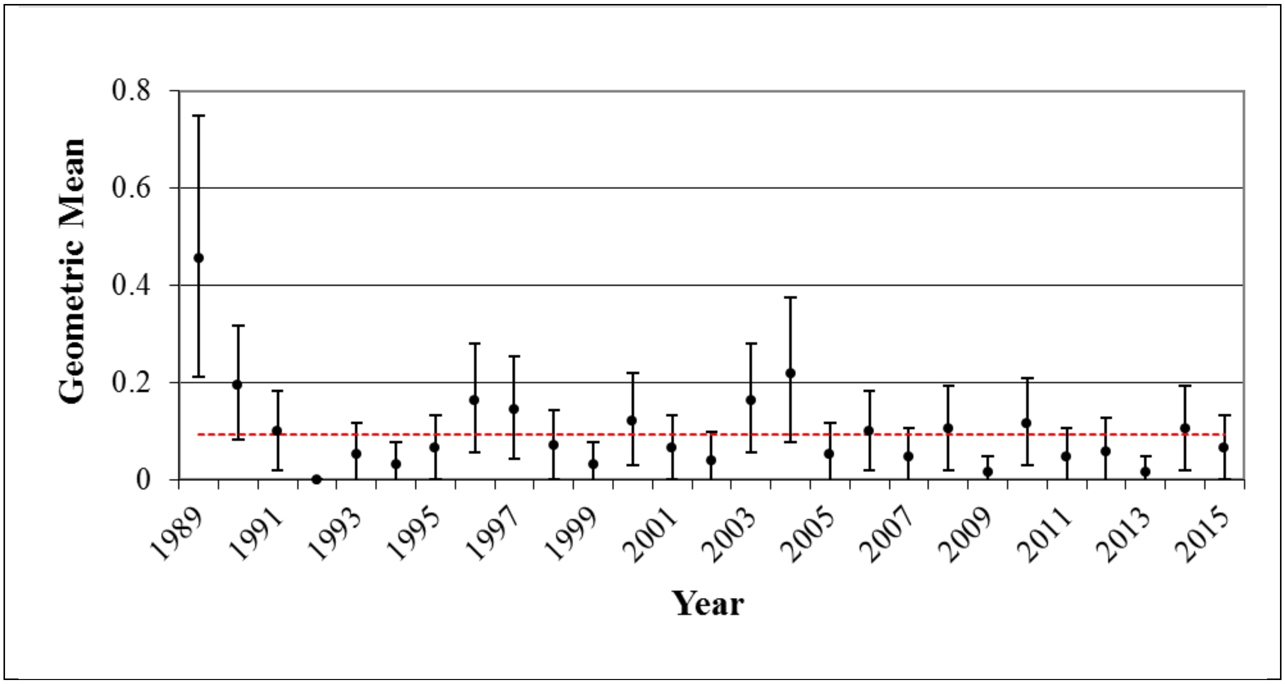

Figure 16. Bluefish (*Pomatomus saltatrix*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

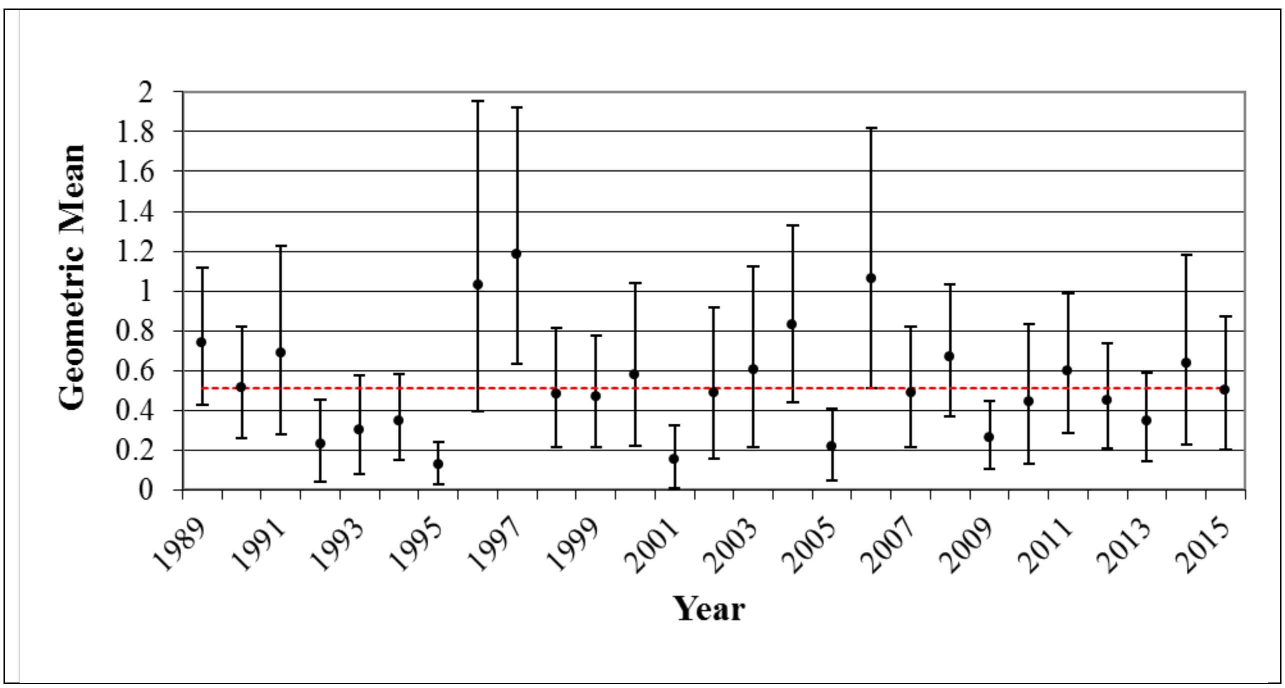

Figure 17. Bluefish (*Pomatomus saltatrix*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

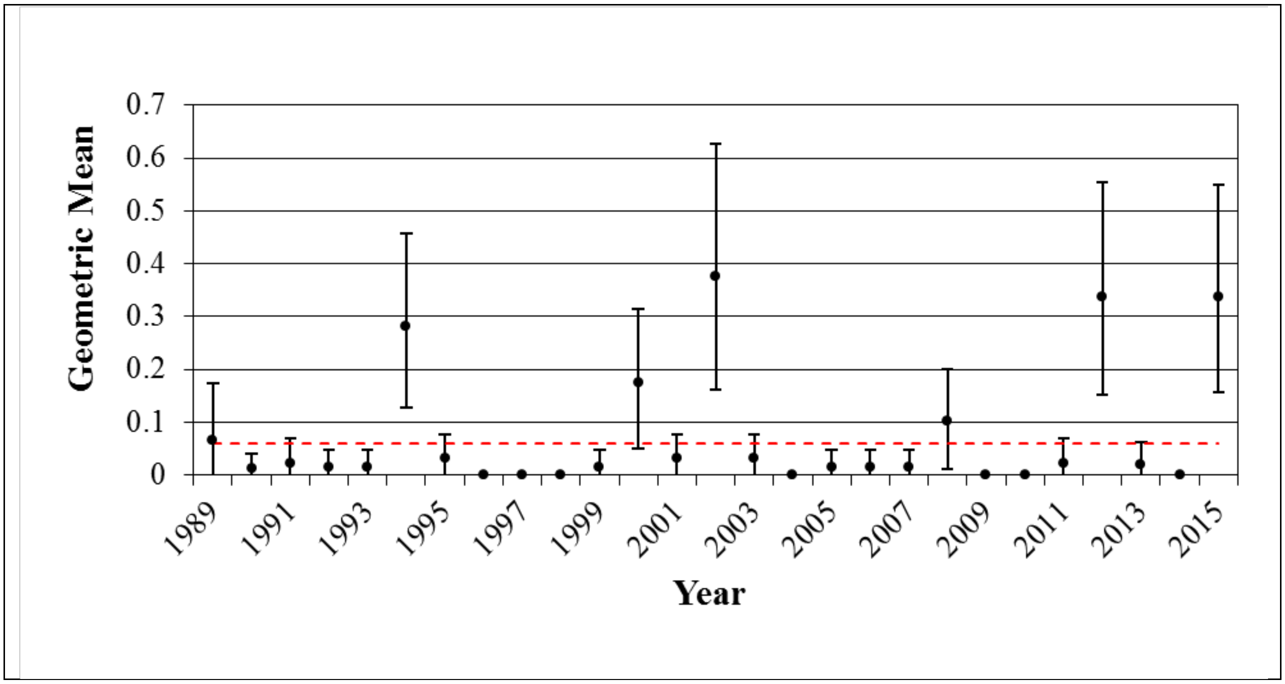

Figure 18. Pinfish **(***Lagodon rhomboides*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

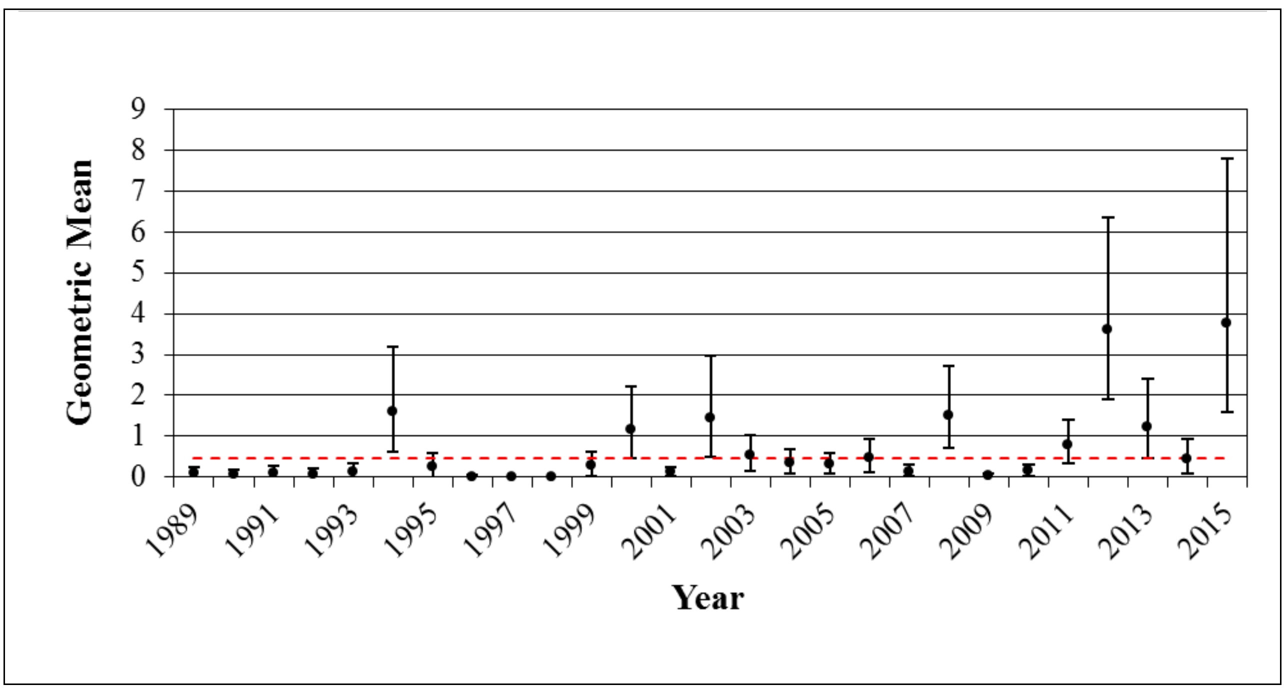

Figure 19. Pinfish (*Lagodon rhomboides*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

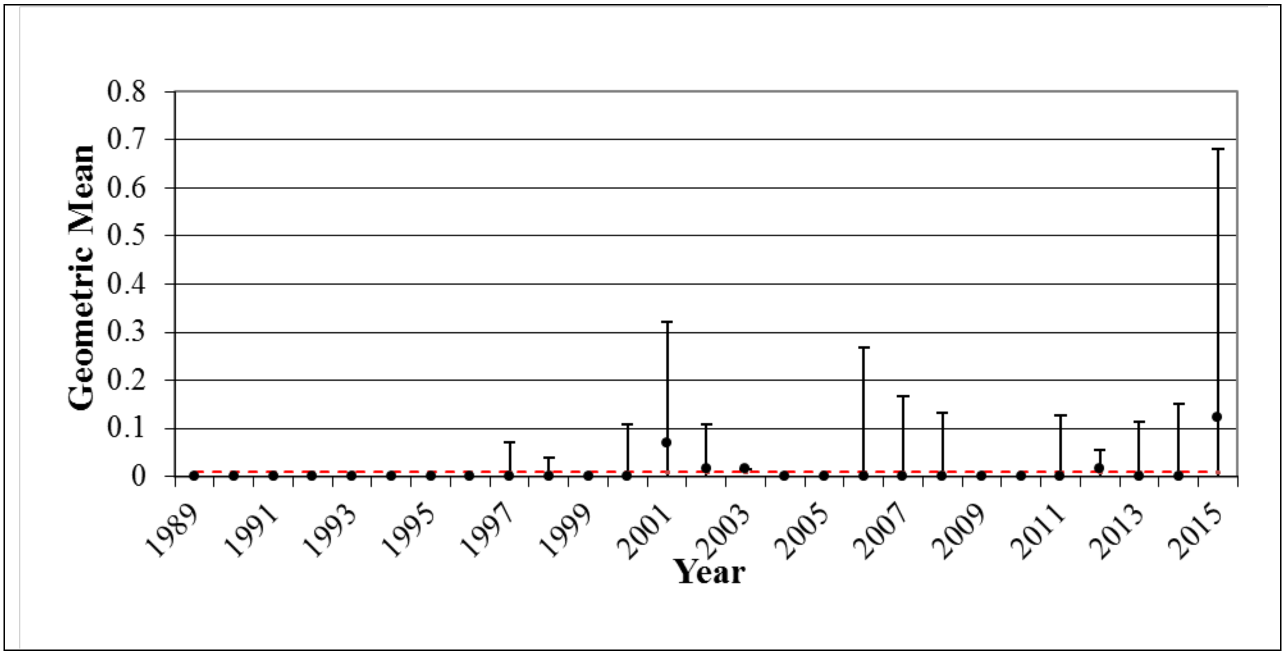

Figure 20. Sheepshead (*Archosargus probatocephalus)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

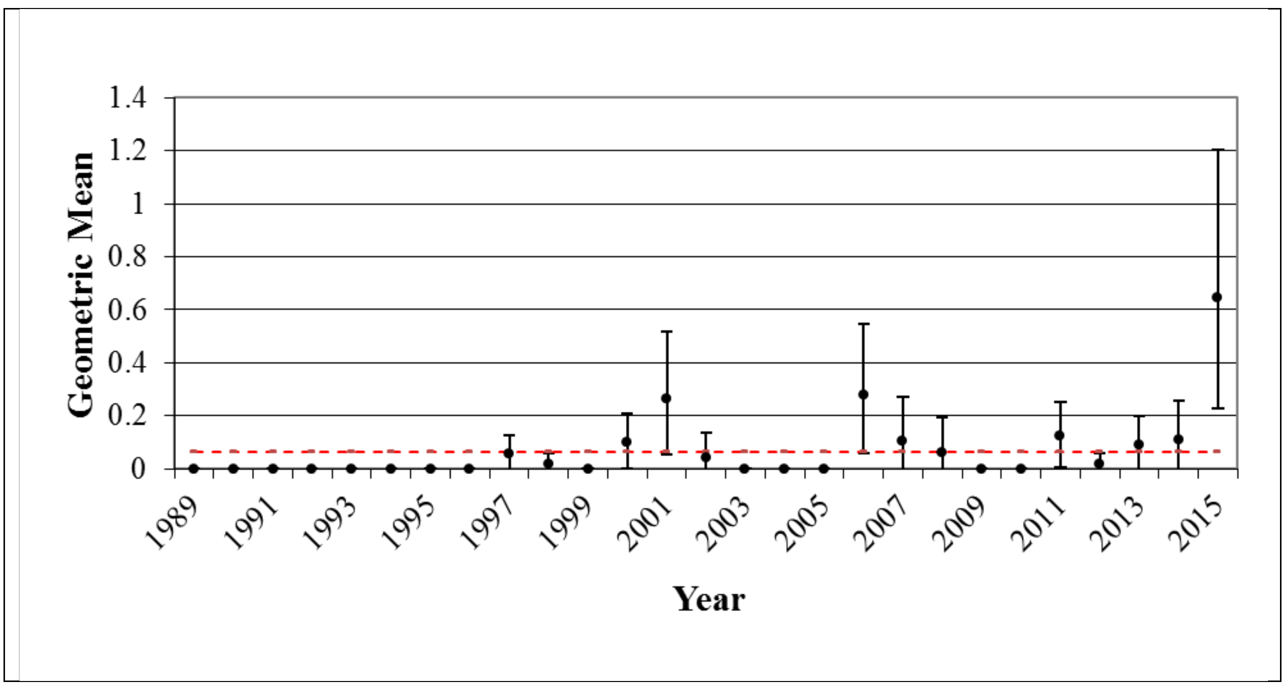

Figure 21. Sheepshead (*Archosargus probatocephalus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

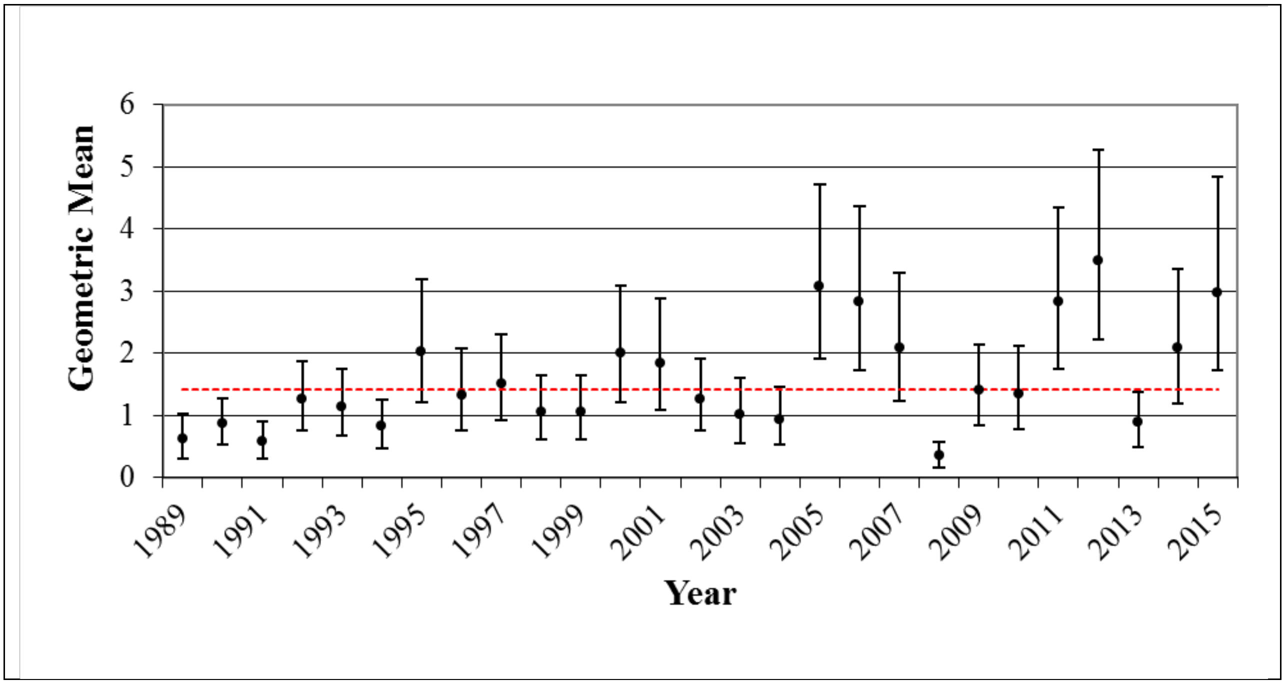

Figure 22. Silver perch (*Bairdiella chrysoura*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

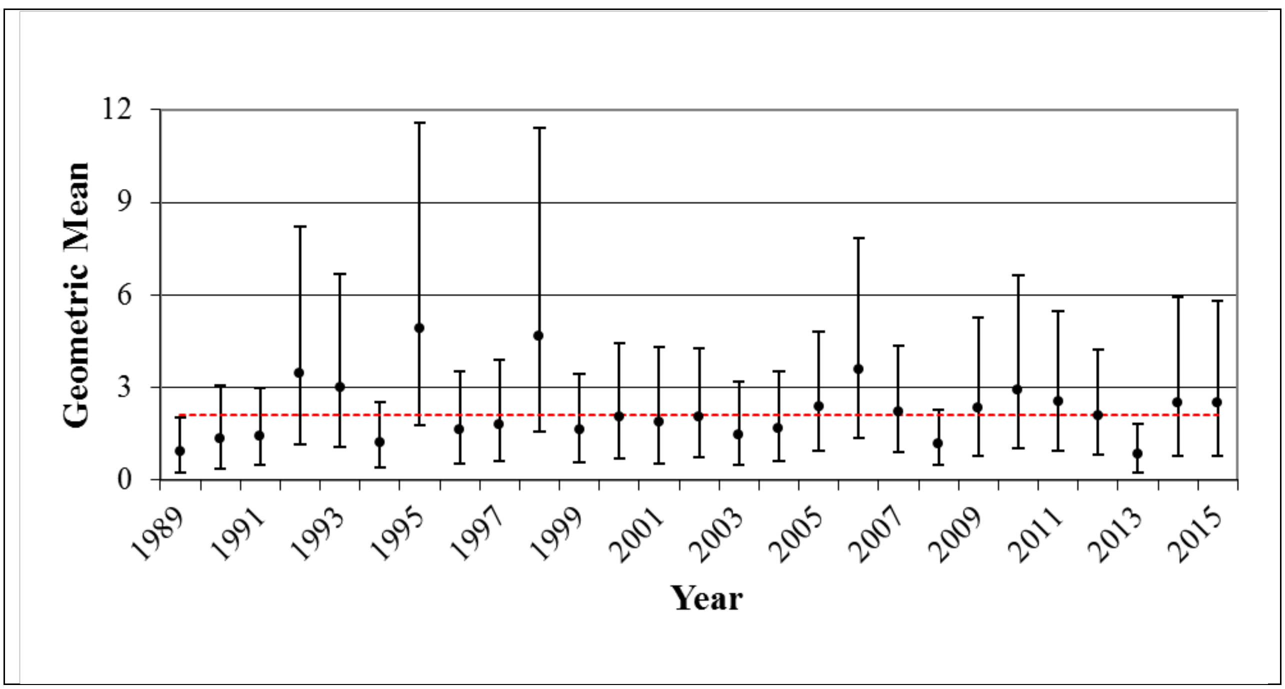

Figure 23. Silver perch (*Bairdiella chrysoura*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

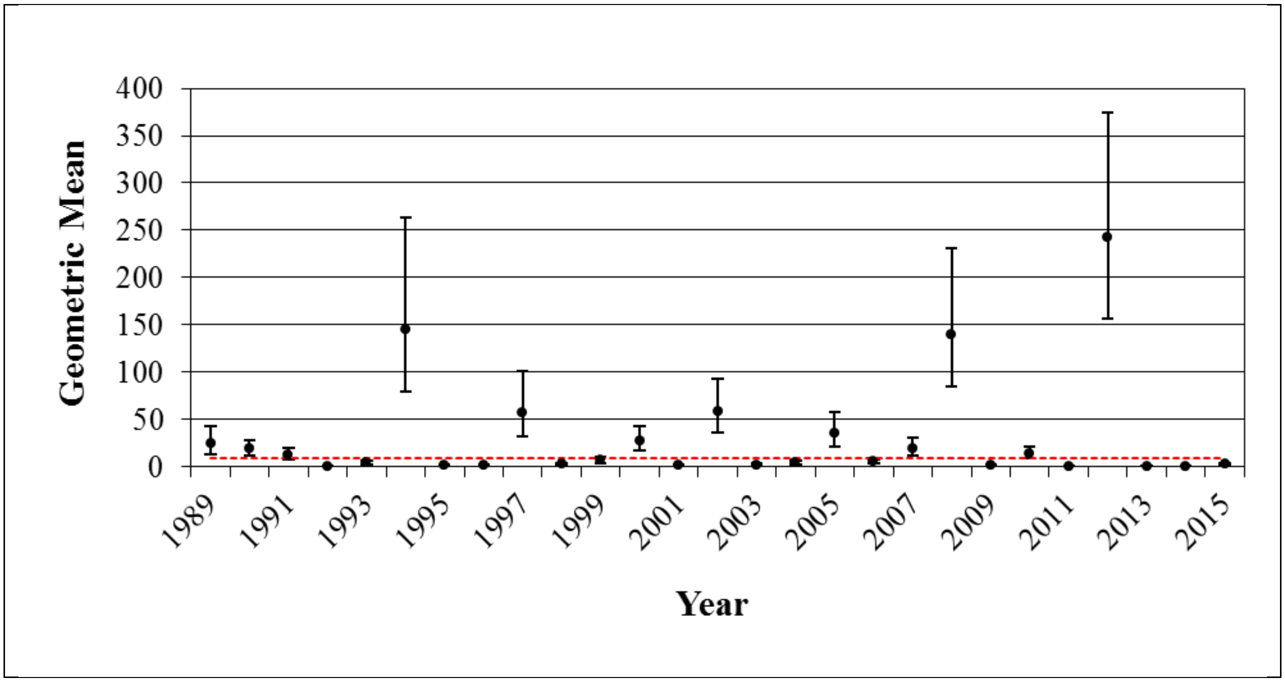

Figure 24. Spot (*Leiostomus xanthurus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

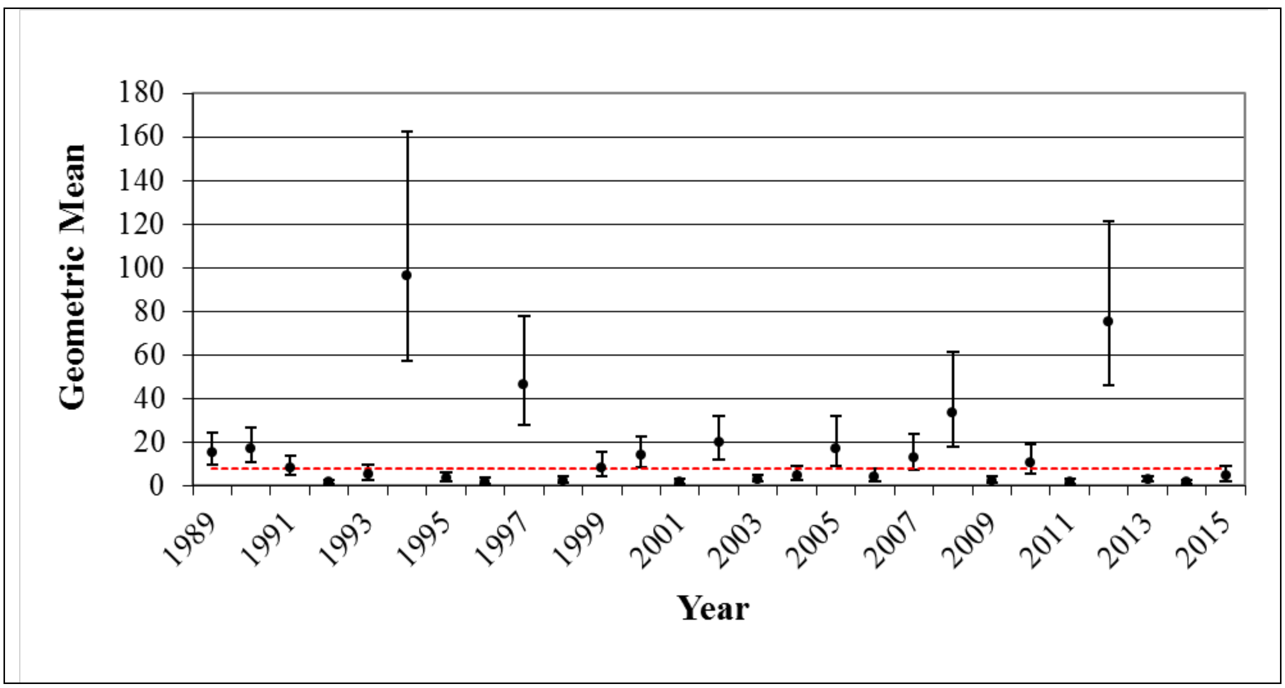

Figure 25. Spot (*Leiostomus xanthurus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-20135. Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

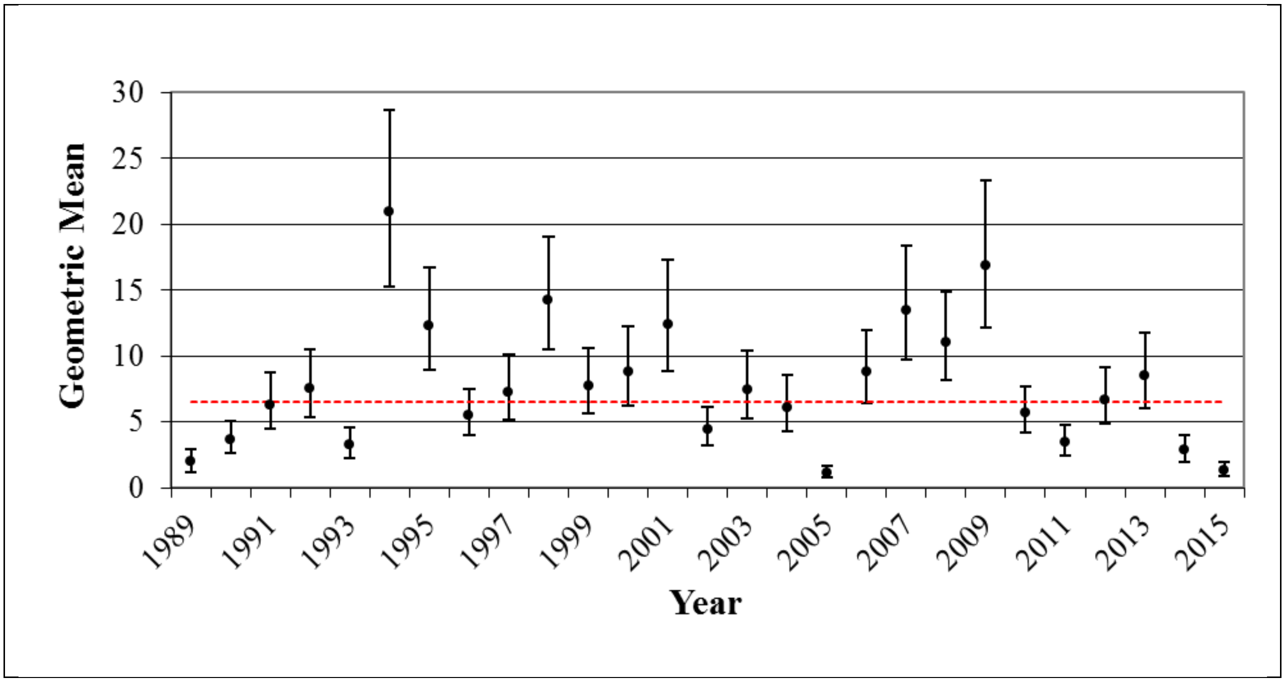

Figure 26. Summer flounder (*Paralichthys dentatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

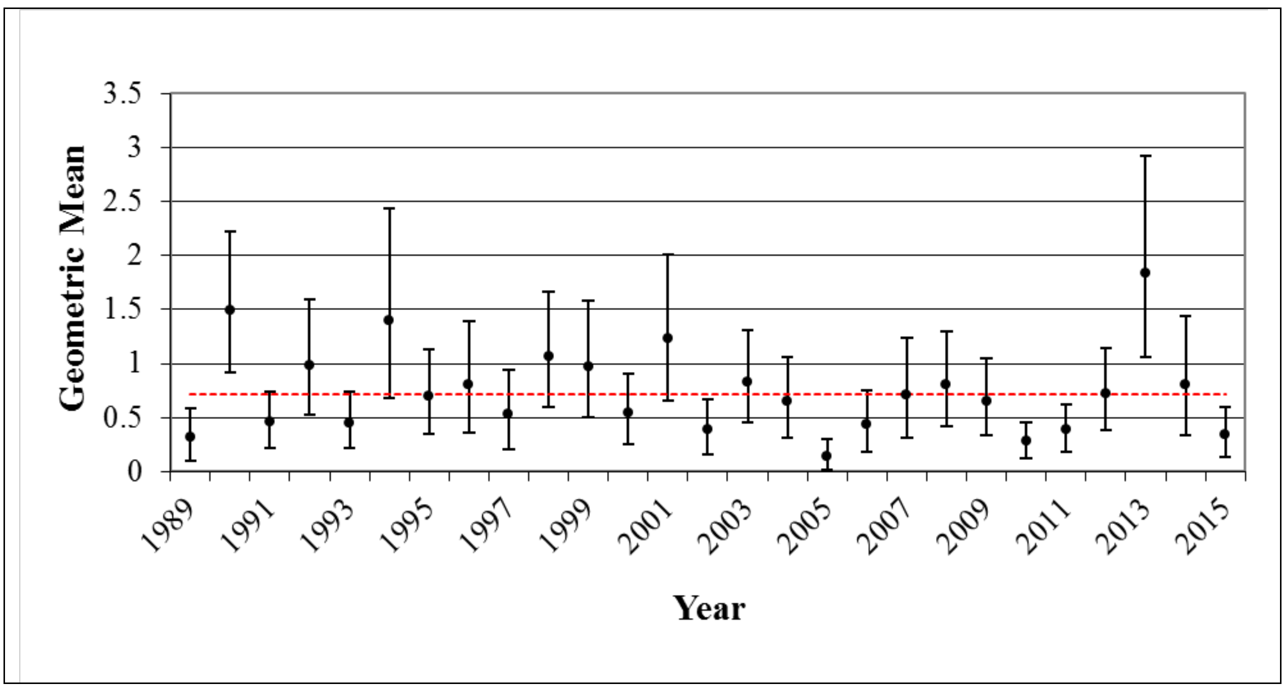

Figure 27. Summer flounder (*Paralichthys dentatus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

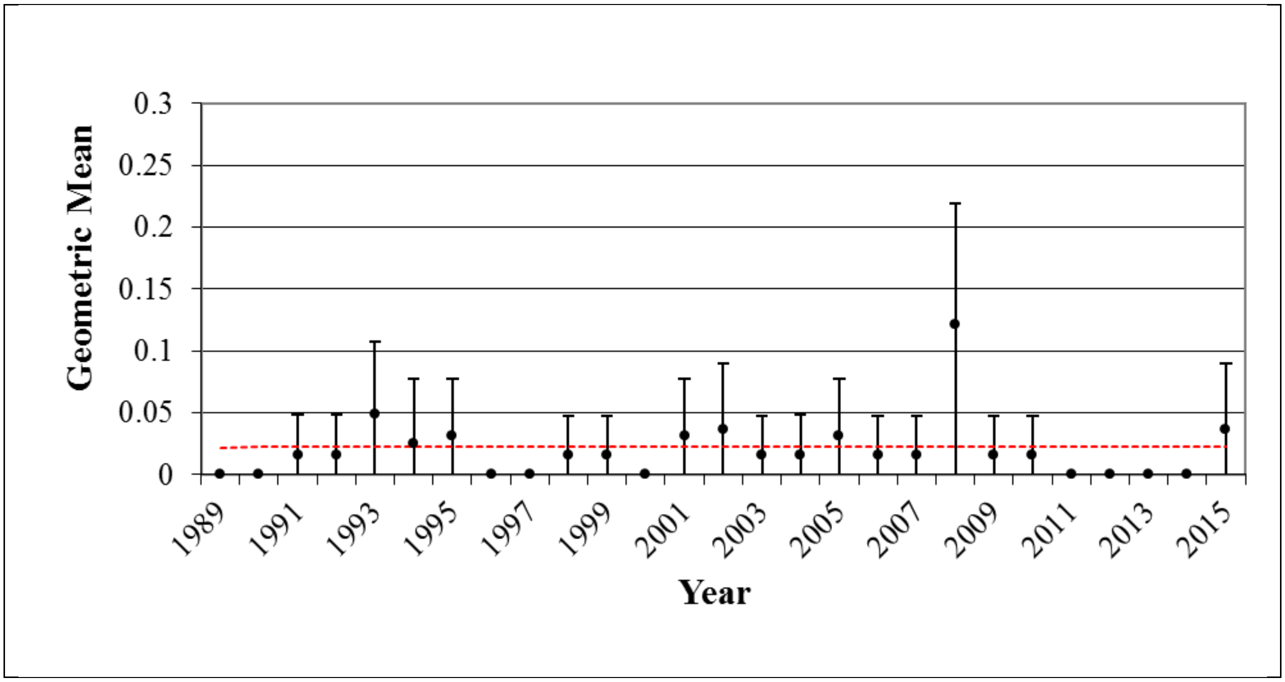

Figure 28. Tautog (*Tautoga onitis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

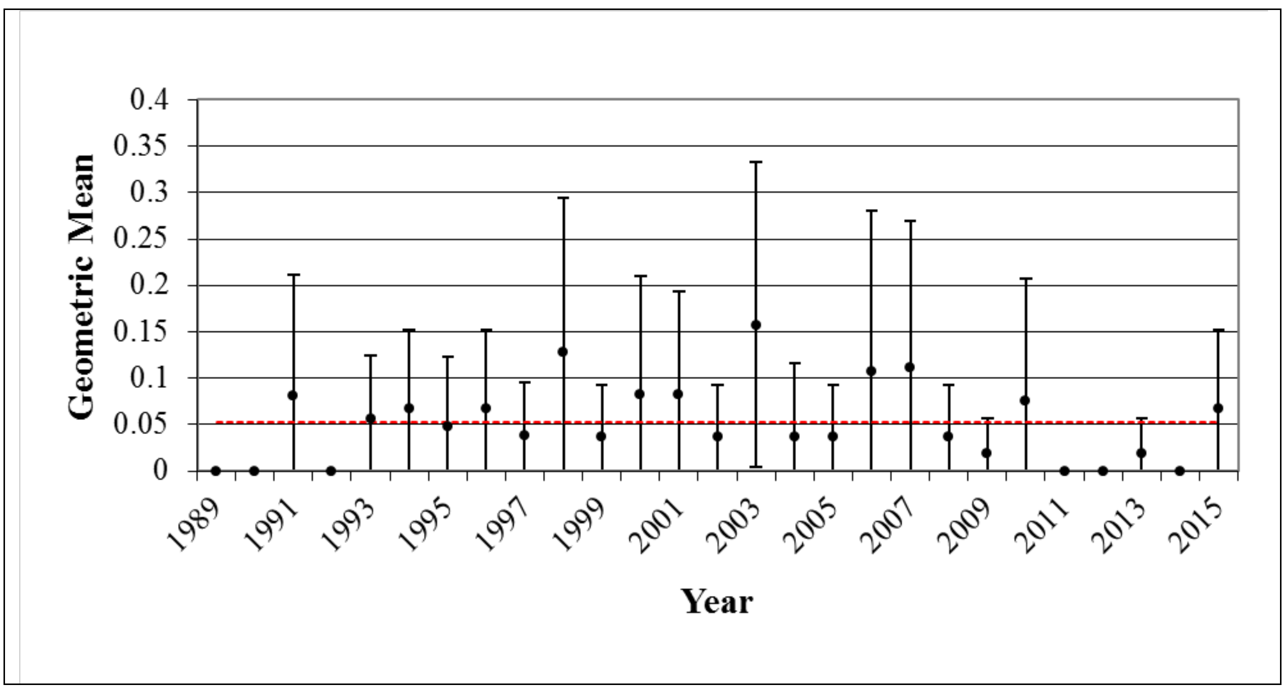

Figure 29. Tautog (*Tautoga onitis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

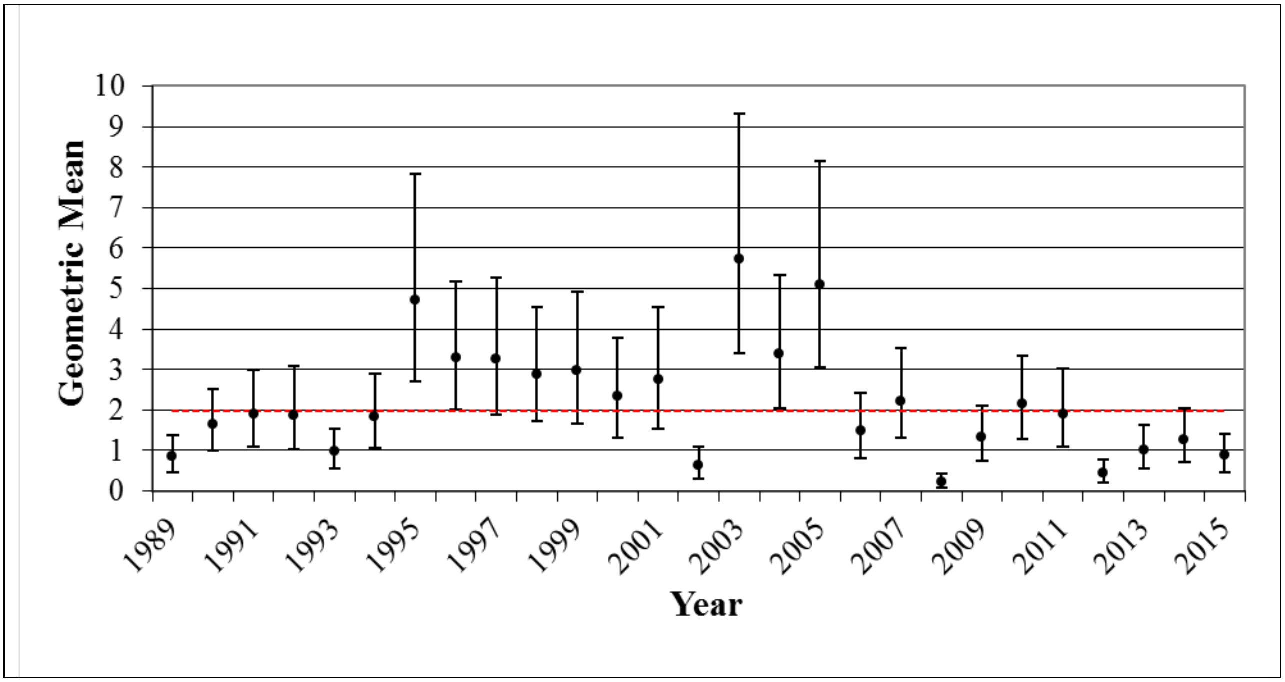

Figure 30. Weakfish (*Cynoscion regalis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

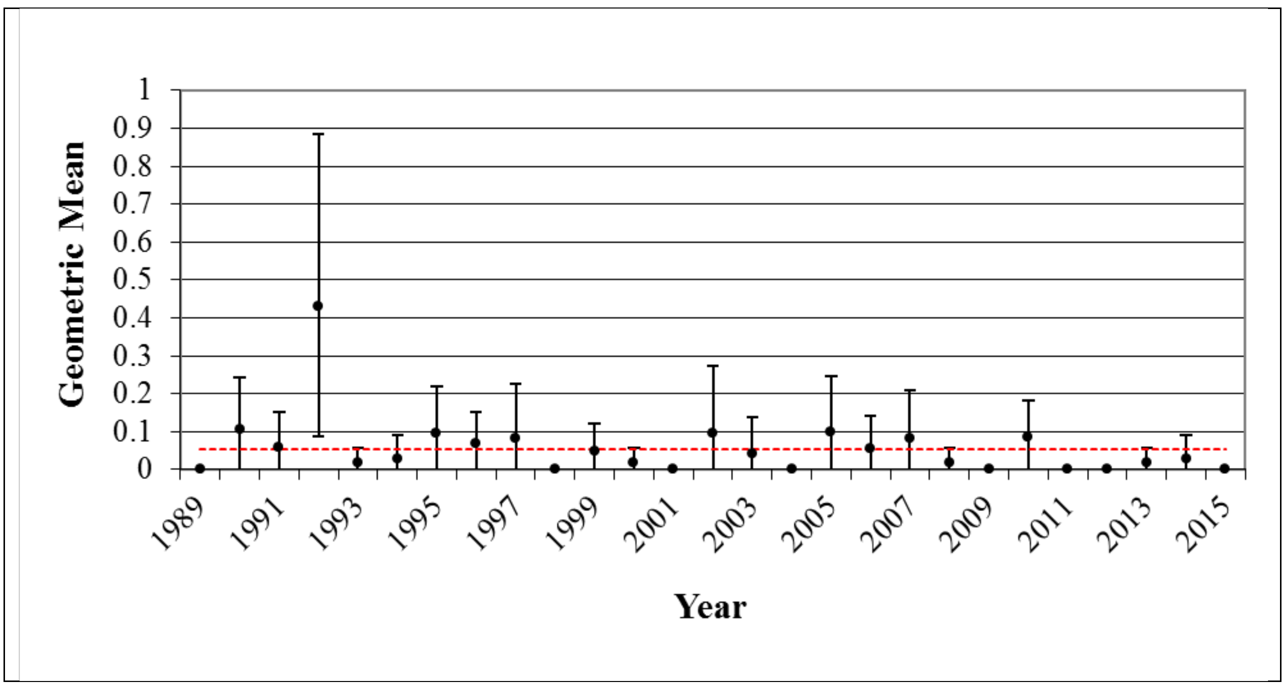

Figure 31. Weakfish (*Cynoscion regalis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

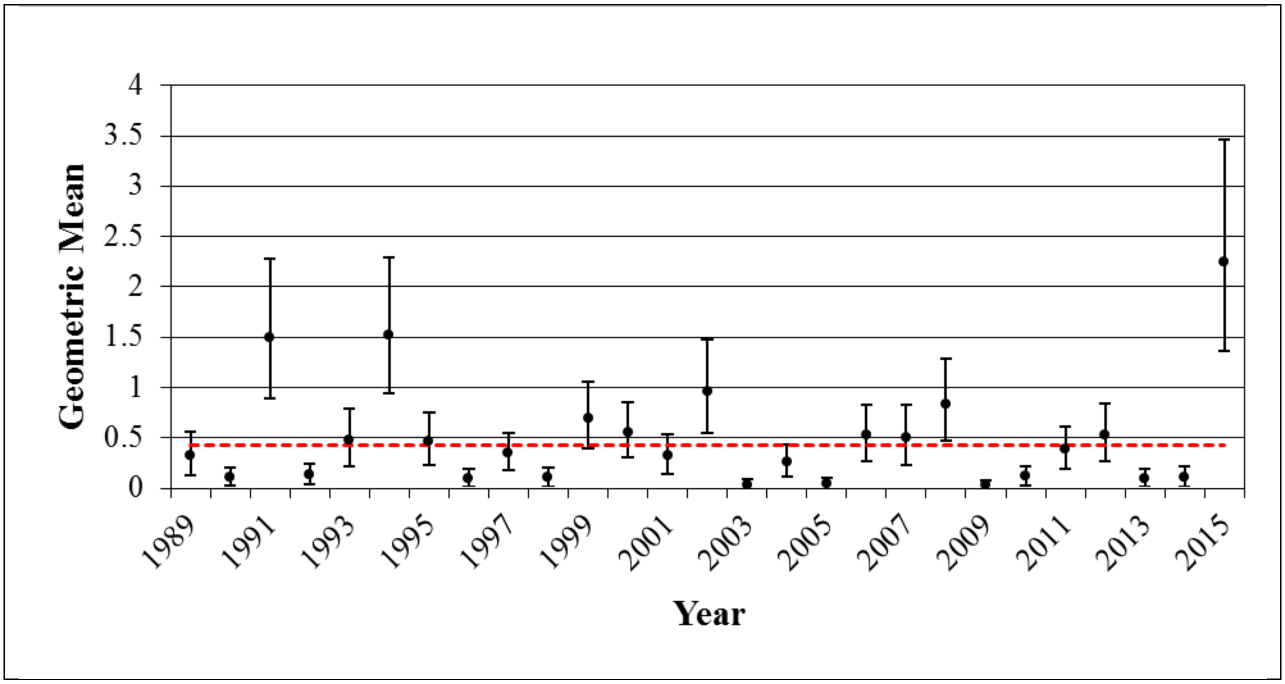

Figure 32. Brown Shrimp (*Farfantepenaeus aztecus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

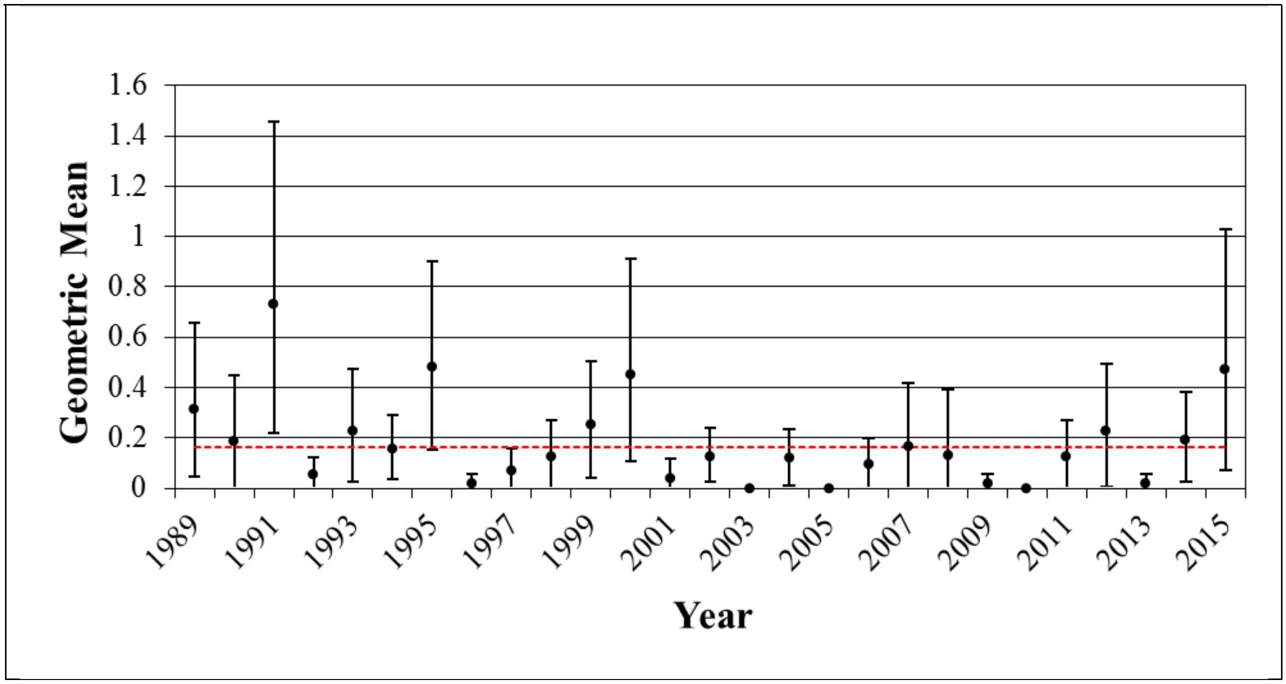

Figure 33. Brown Shrimp (*Farfantepenaeus aztecus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2015). Dotted line represents the 1989-2015 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

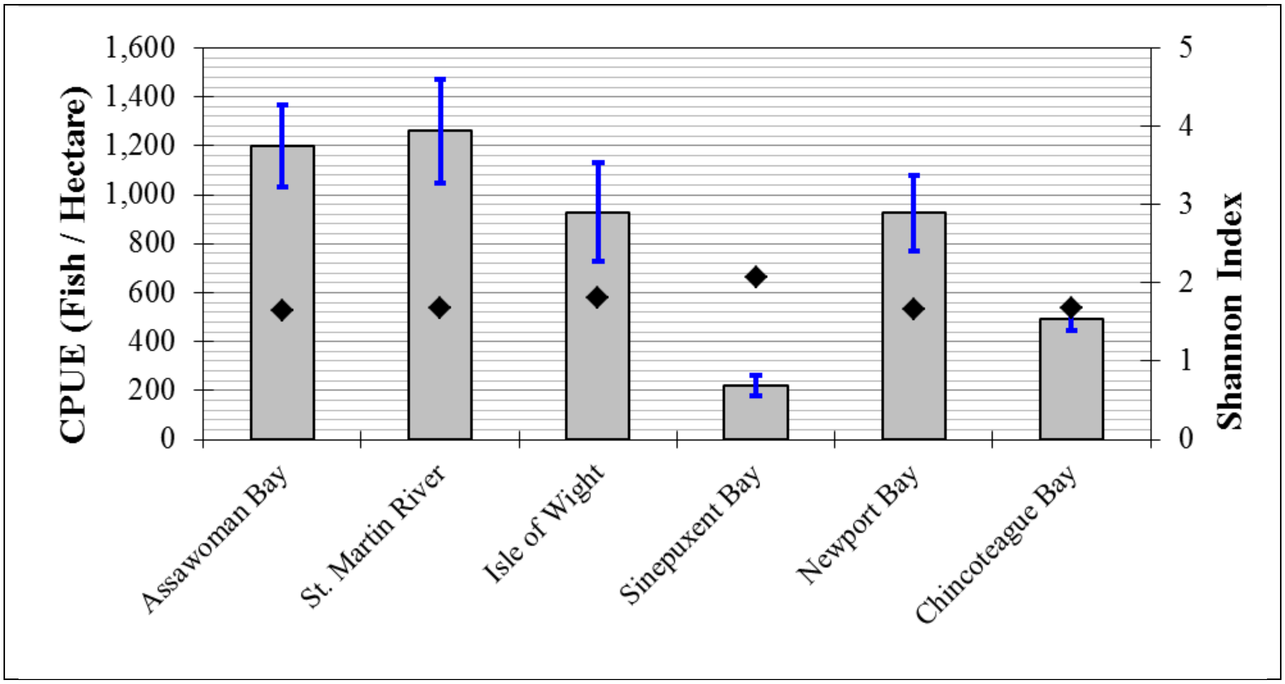

Figure 34. Coastal Bays trawl index of finfish relative abundance (CPUE; L/ha) with 95% confidence intervals (1989-2015). Black diamond represents the 1989-2015 time series Shannon index of diversity.

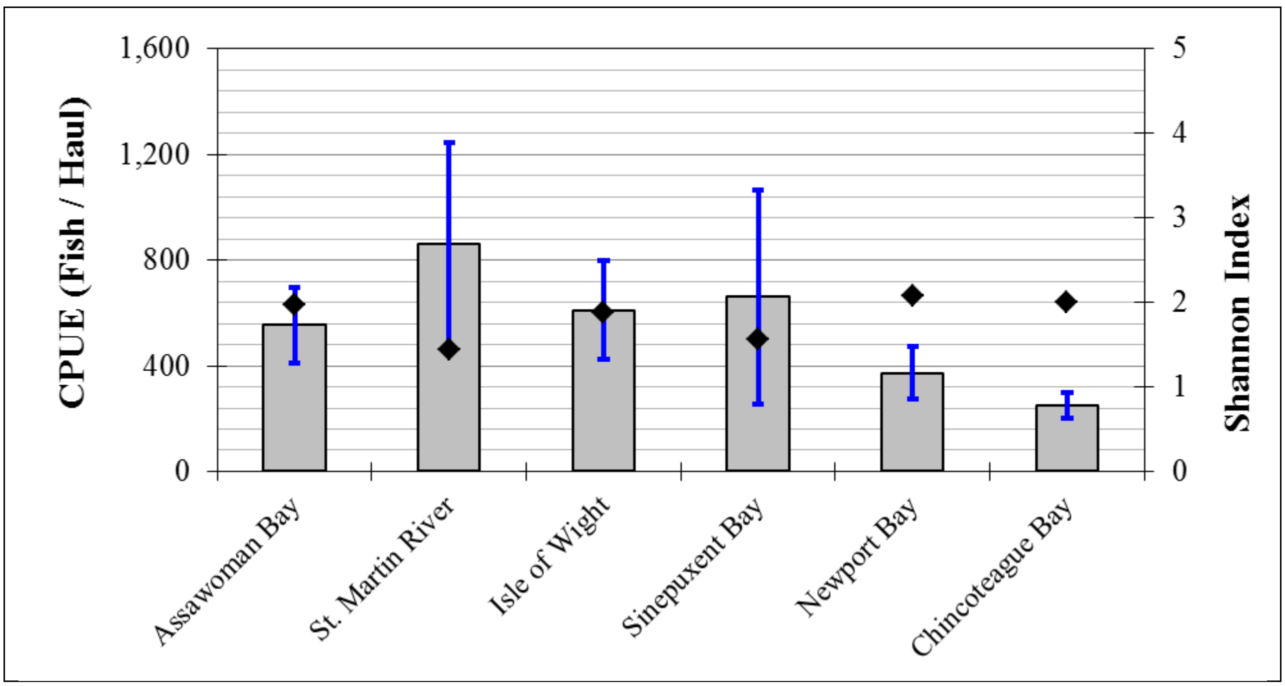

Figure 35. Beach seine index of finfish relative abundance (CPUE; L/haul) with 95% confidence intervals (1989-2015). Black diamond represents the 1989-2015 time series Shannon index of diversity.

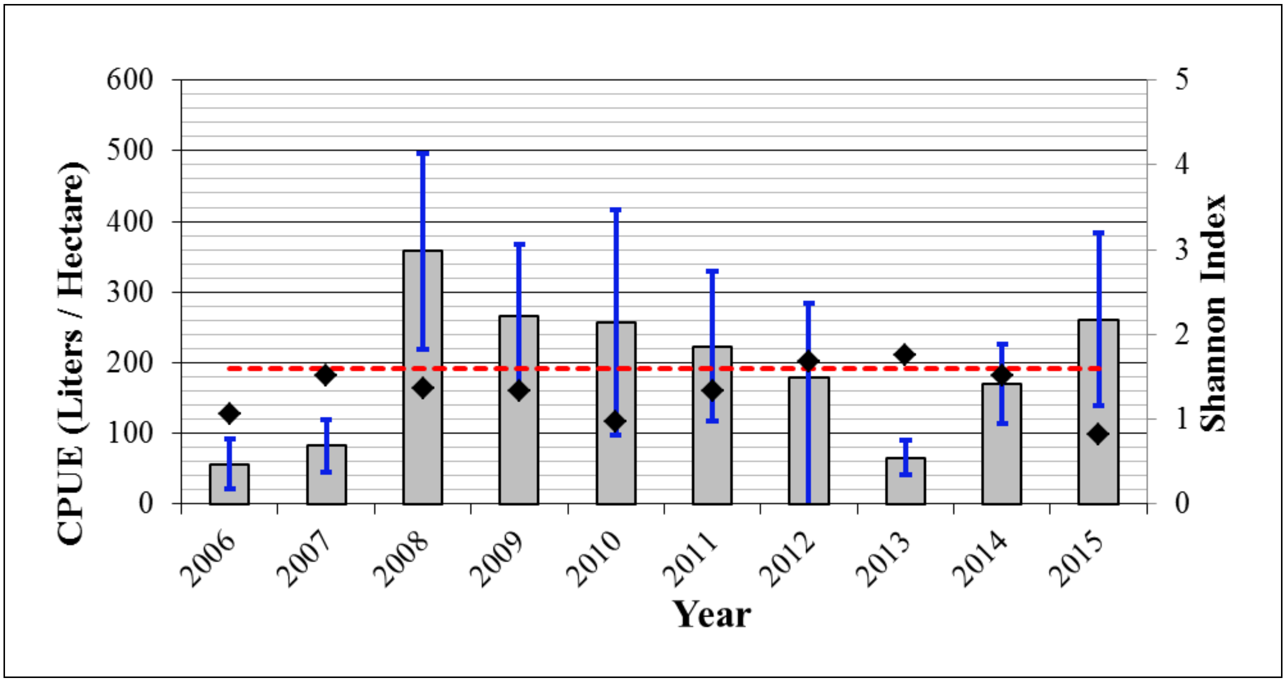

Figure 36. Coastal Bays trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=140/year). Black diamond represents the Shannon index of diversity.

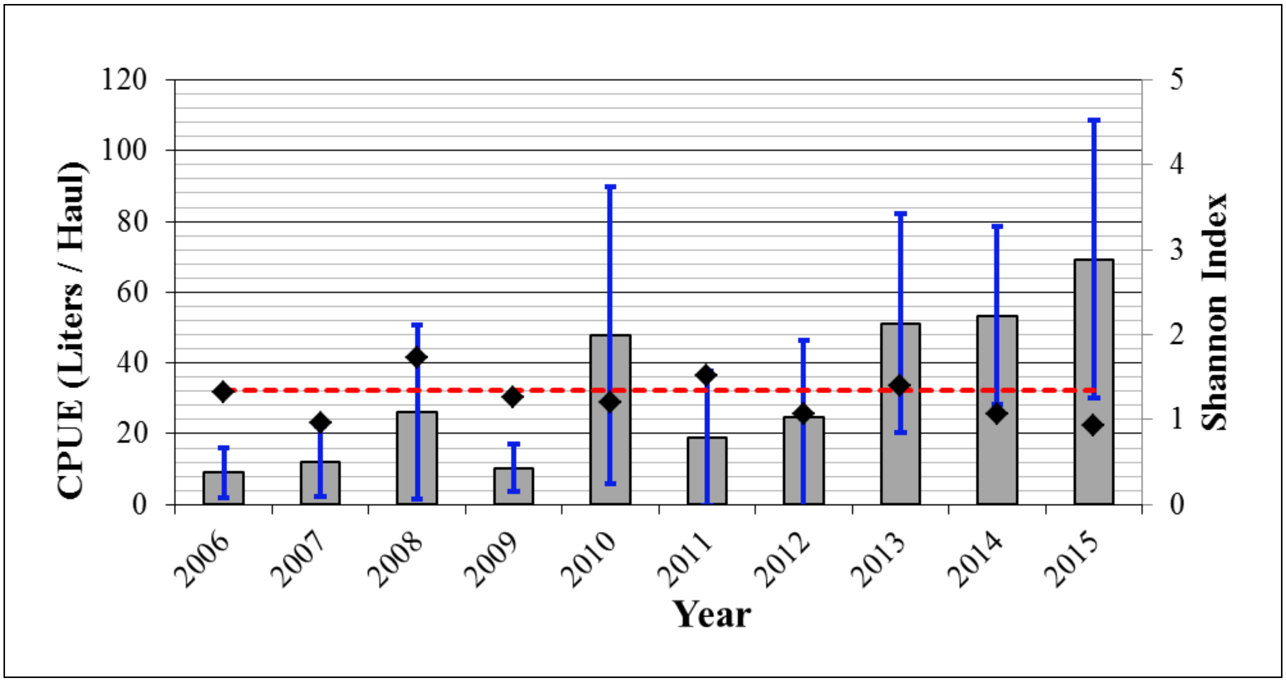

Figure 37. Coastal Bays beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=38/year). Black diamond represents the Shannon index of diversity.

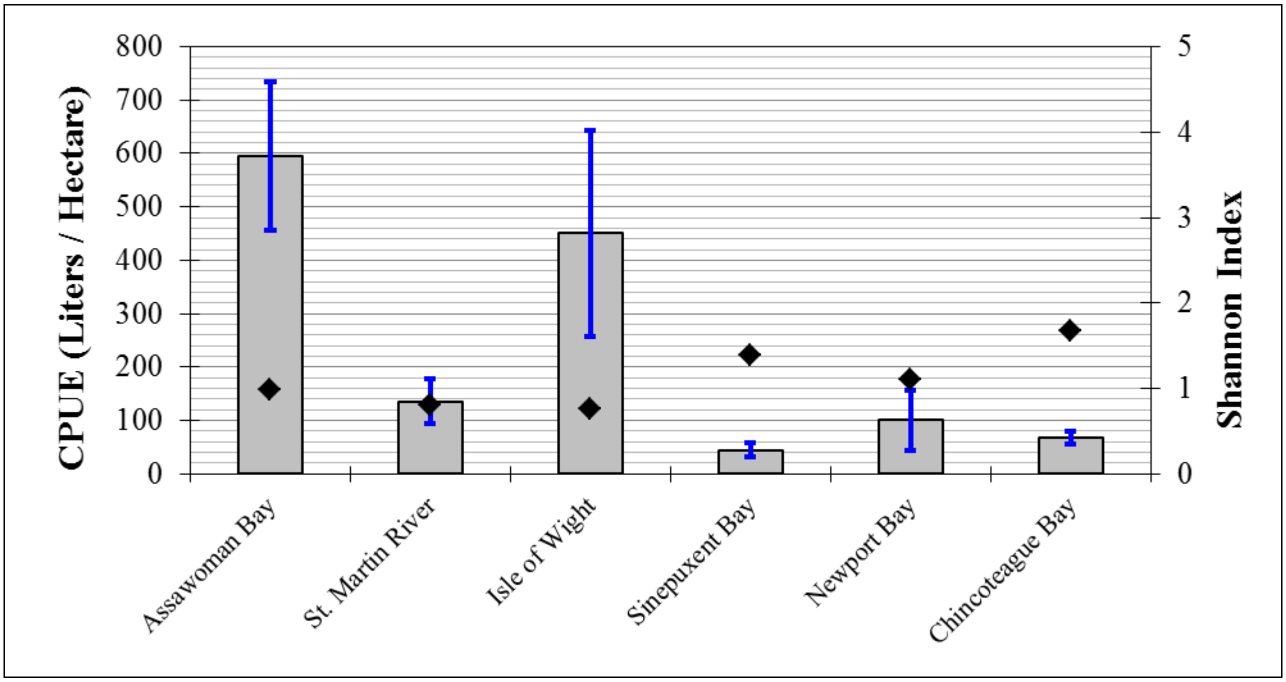

Figure 38. Coastal Bays trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Black diamond represents the 2006-2015 time series Shannon index of diversity.

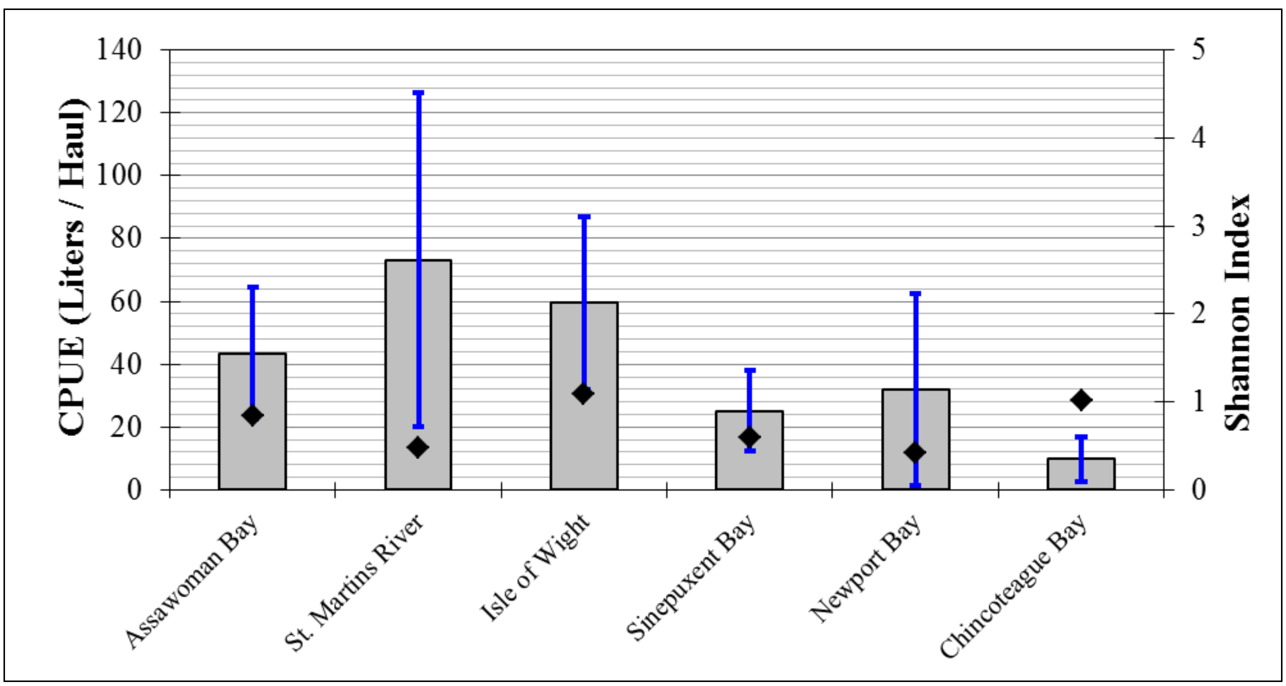

Figure 39. Beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2015). Black diamond represents the 2006-2015 time series Shannon index of diversity.

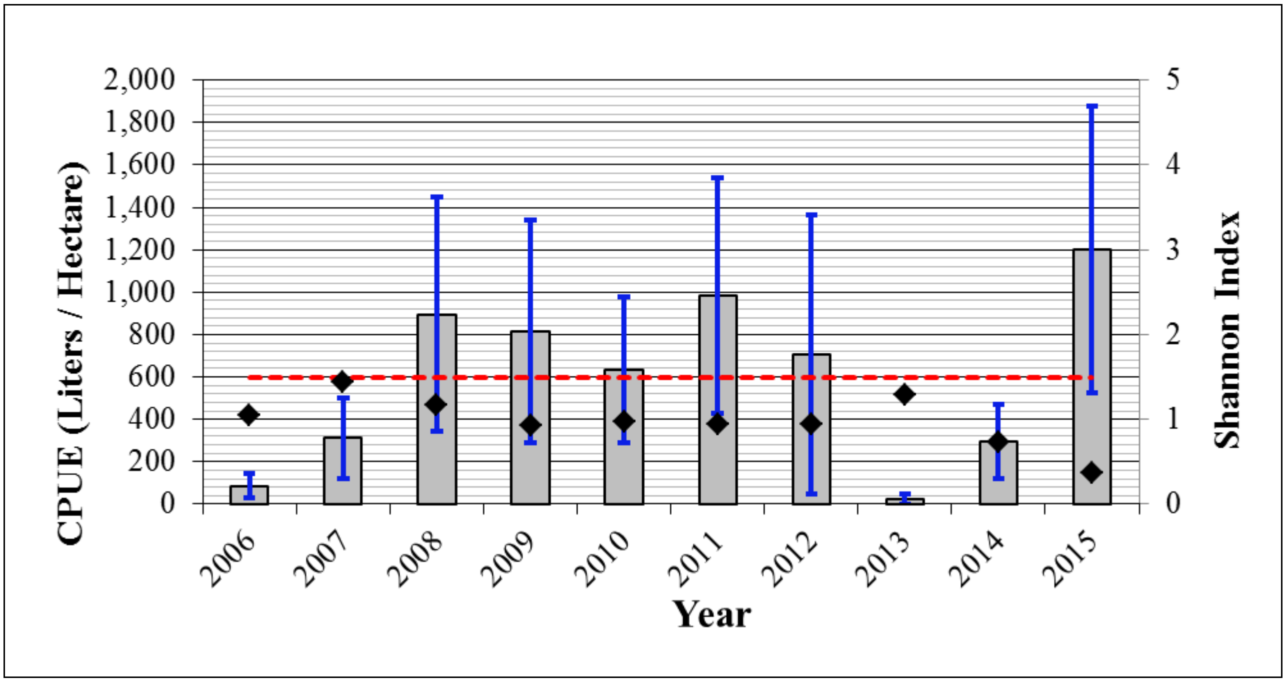

Figure 40. Assawoman Bay trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=21/year). Black diamond represents the Shannon index of diversity.

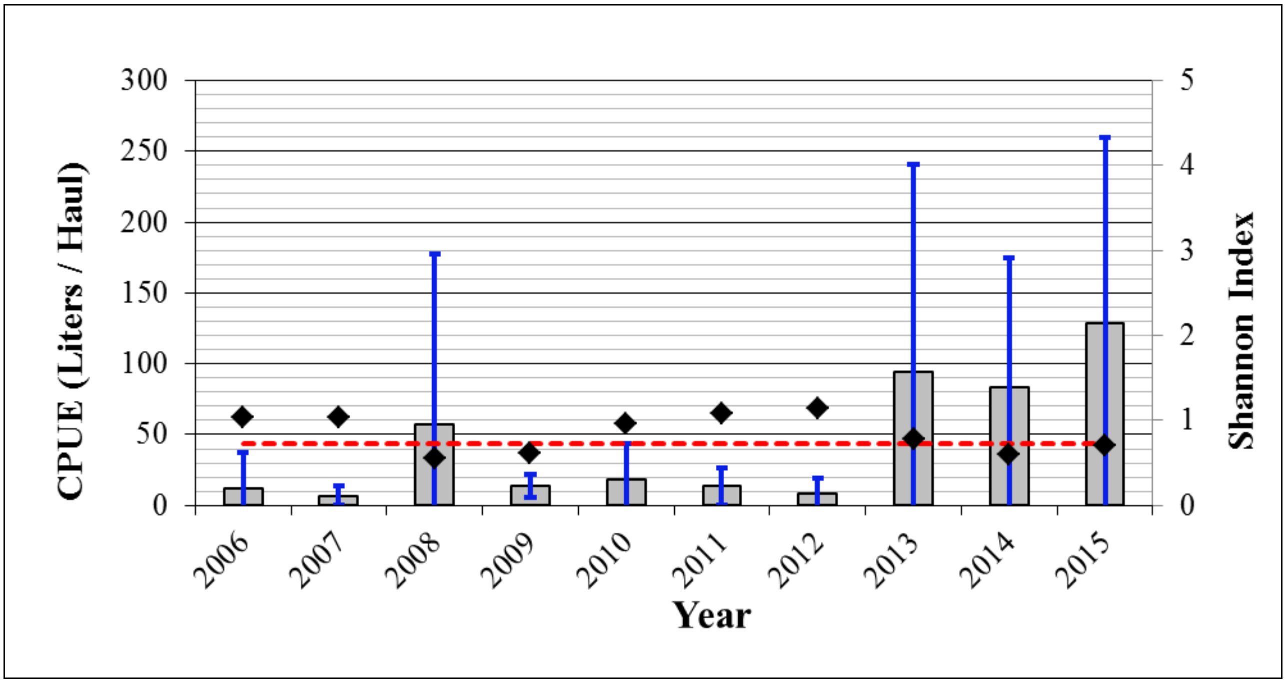

Figure 41. Assawoman Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2015). Dotted line represents the 2006-2015 time series CPUE grand mean, (n=6/year). Black diamond represents the Shannon index of diversity.

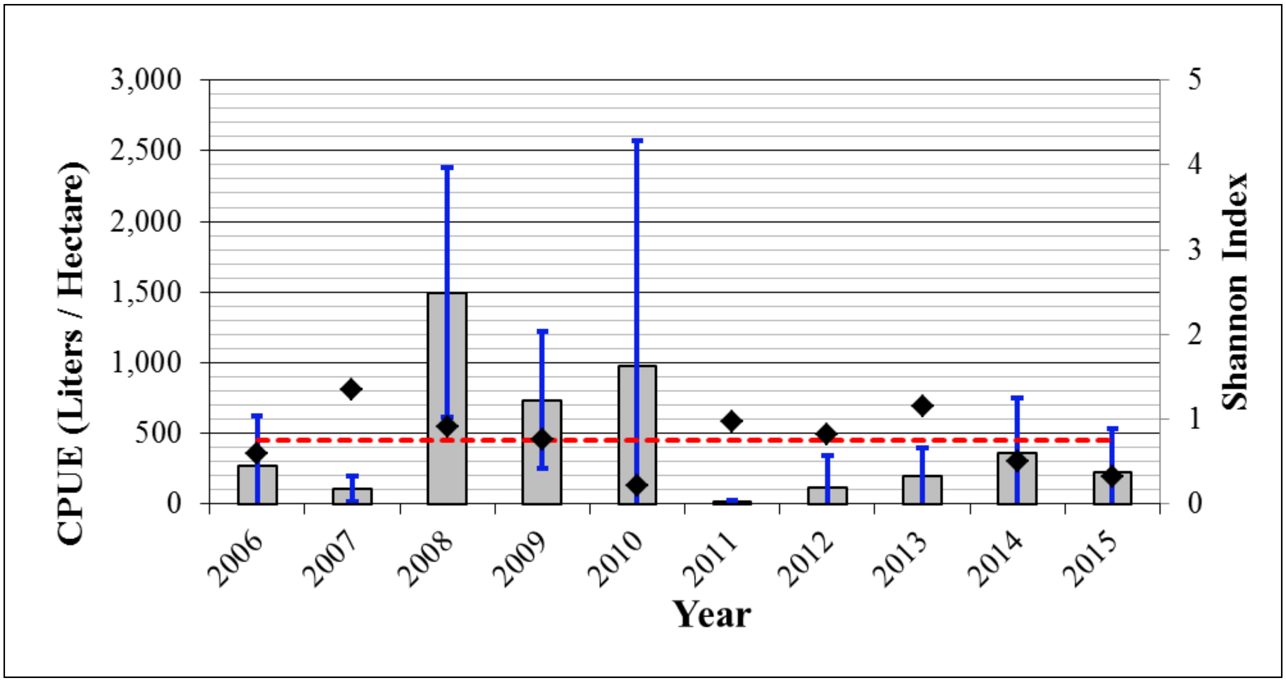

Figure 42. Isle of Wight Bay trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=14/year). Black diamond represents the Shannon index of diversity.

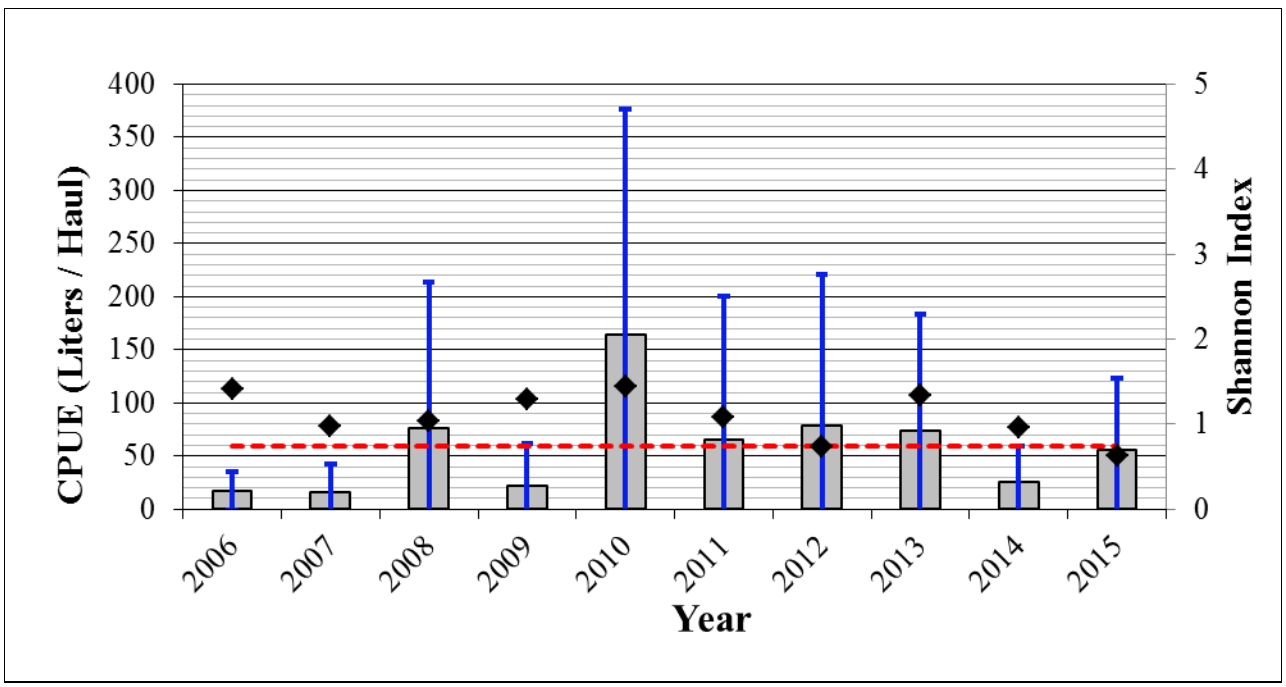

Figure 43. Isle of Wight Bay seine index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=4/year). Black diamond represents the Shannon index of diversity.

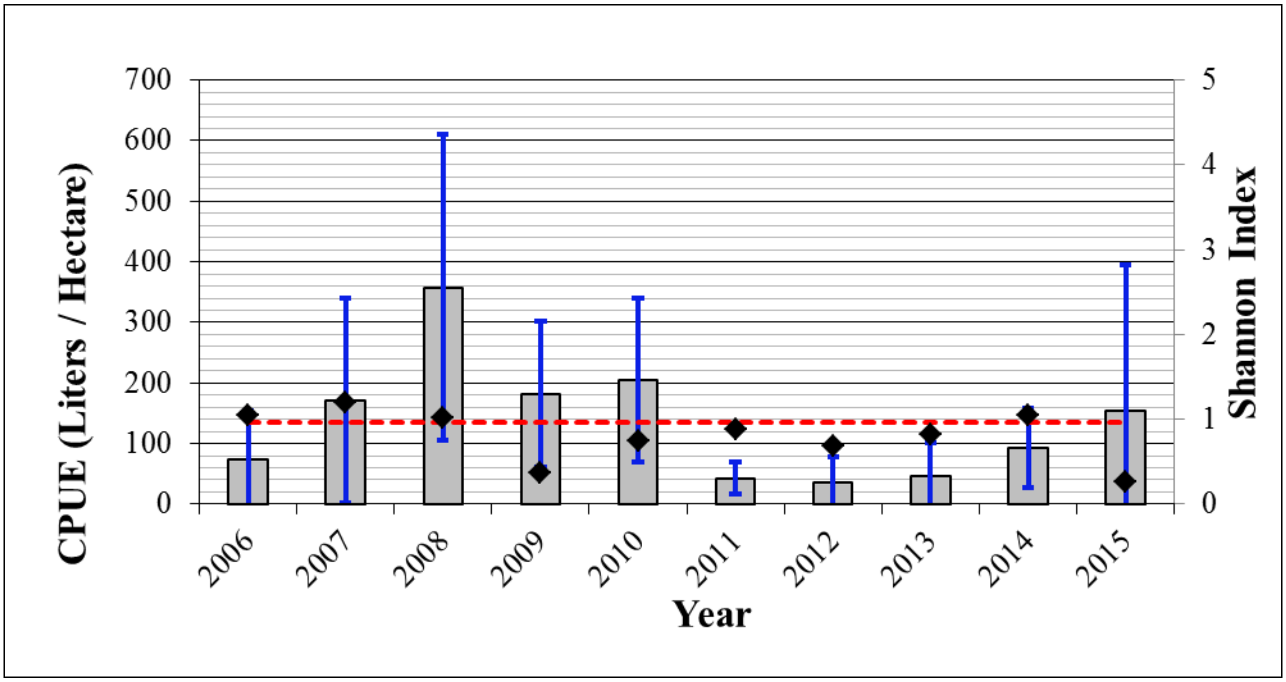

Figure 44. St. Martin River trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=14/year). Black diamond represents the Shannon index of diversity.

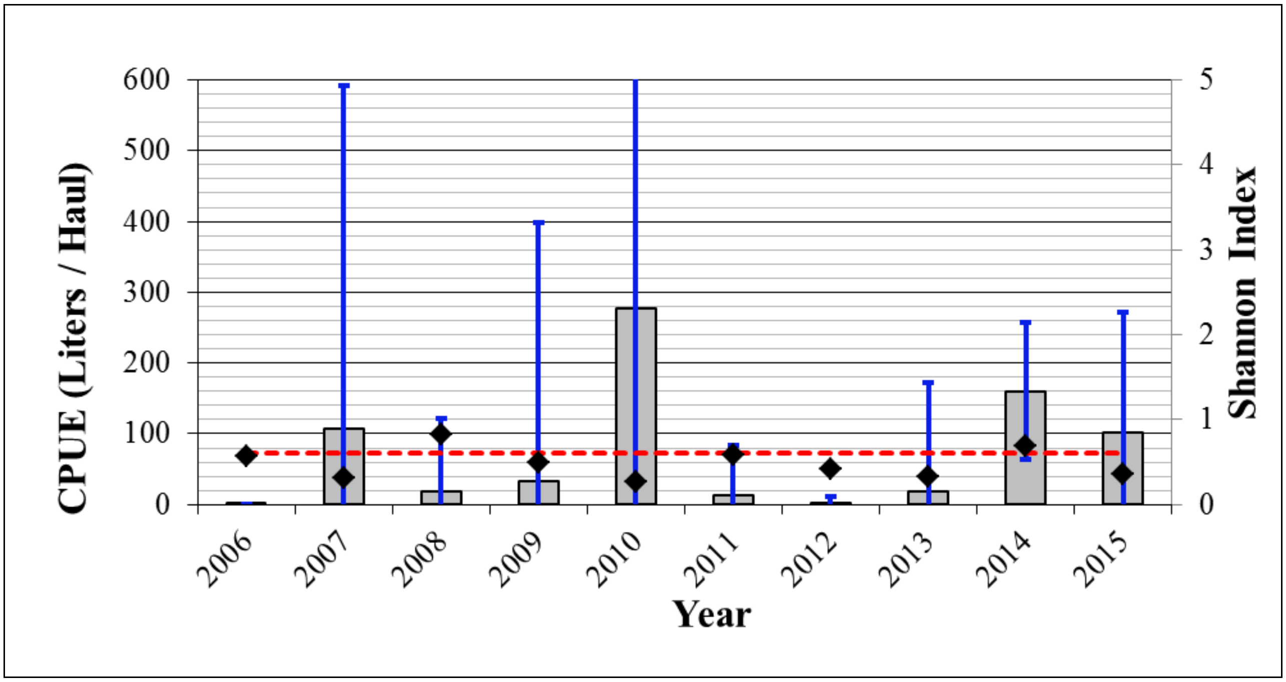

Figure 45. St. Martin River seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=2/year). Black diamond represents the Shannon index of diversity.

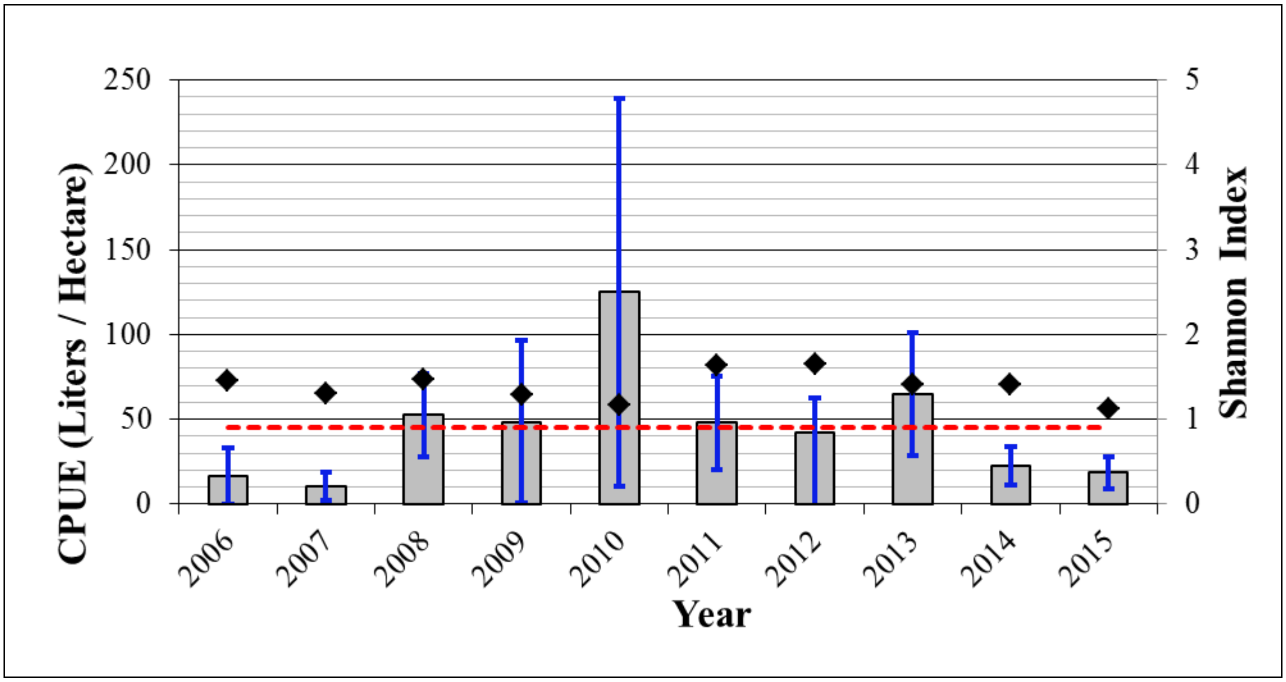

Figure 46. Sinepuxent Bay trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=21/year). Black diamond represents the Shannon index of diversity.

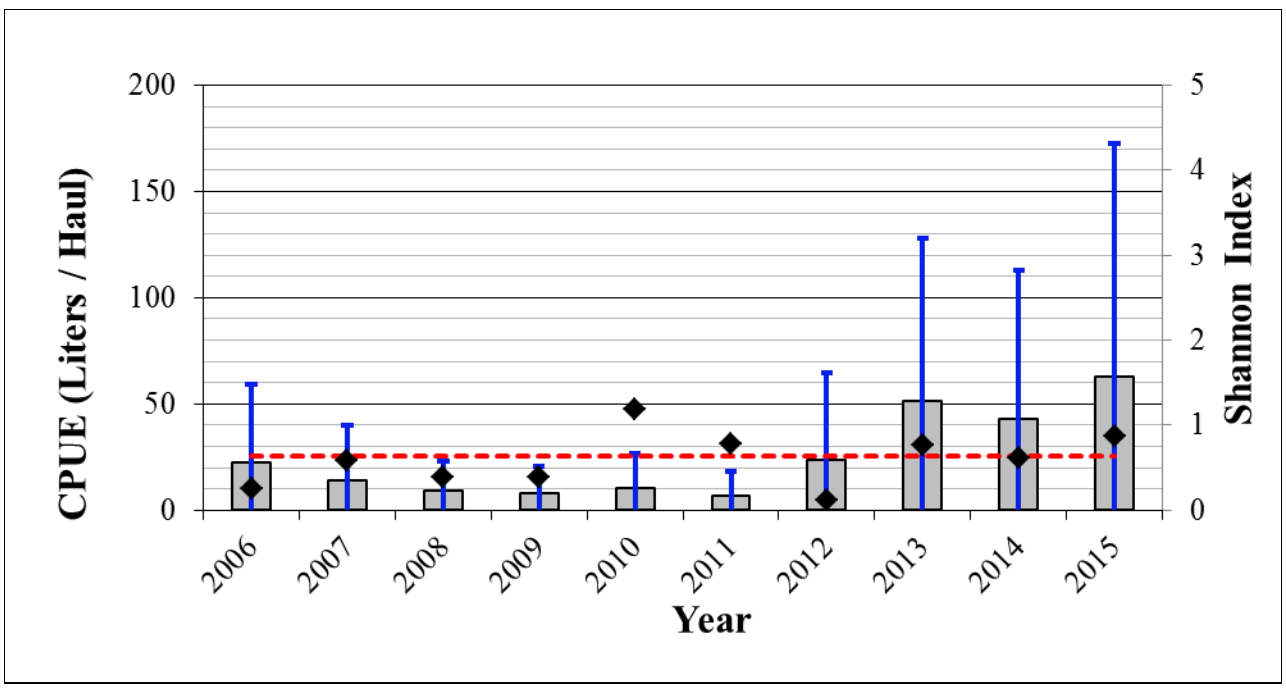

Figure 47. Sinepuxent Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=6/year). Black diamond represents the Shannon index of diversity.

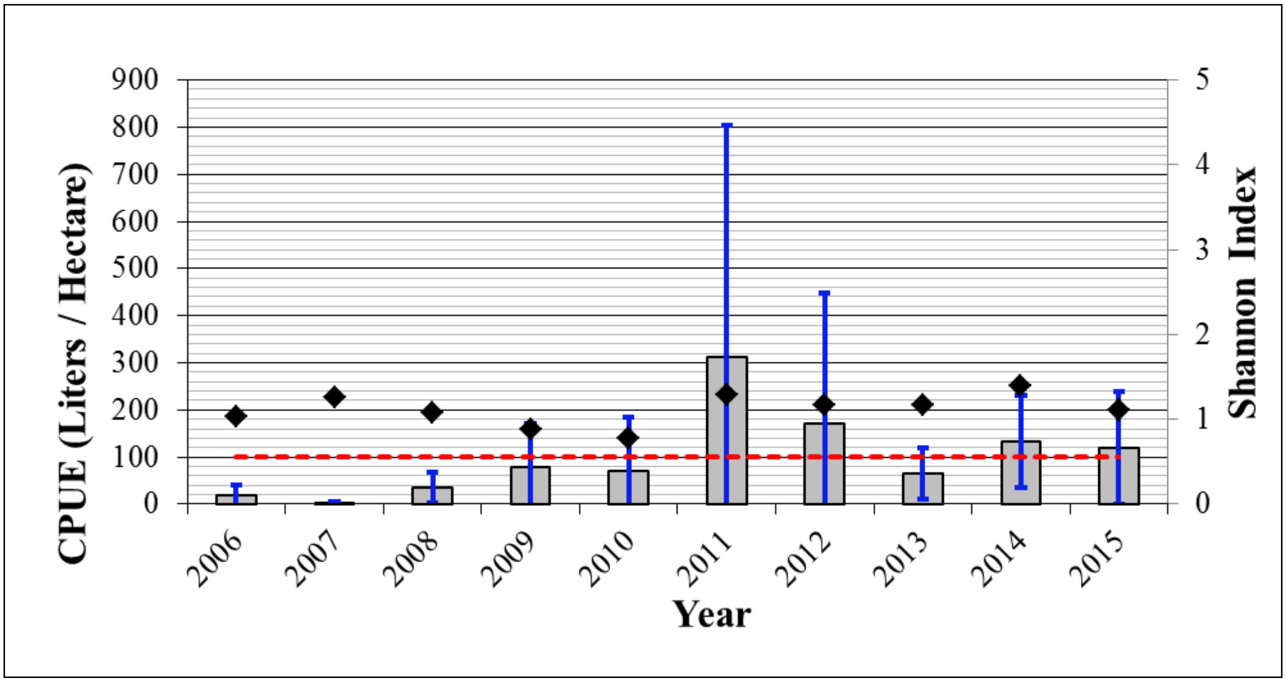

Figure 48. Newport Bay trawl index of relative macroalgae abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=14/year). Black diamond represents the Shannon index of diversity.

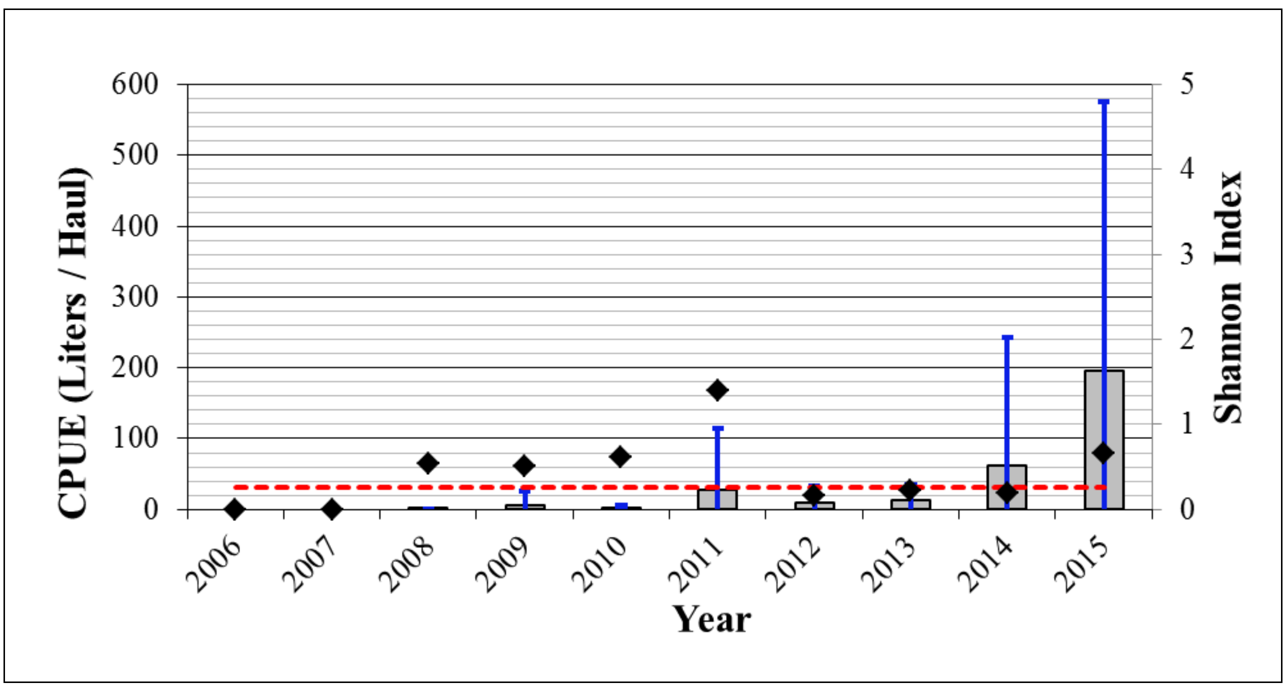

Figure 49. Newport Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=4/year). Black diamond represents the Shannon index of diversity.

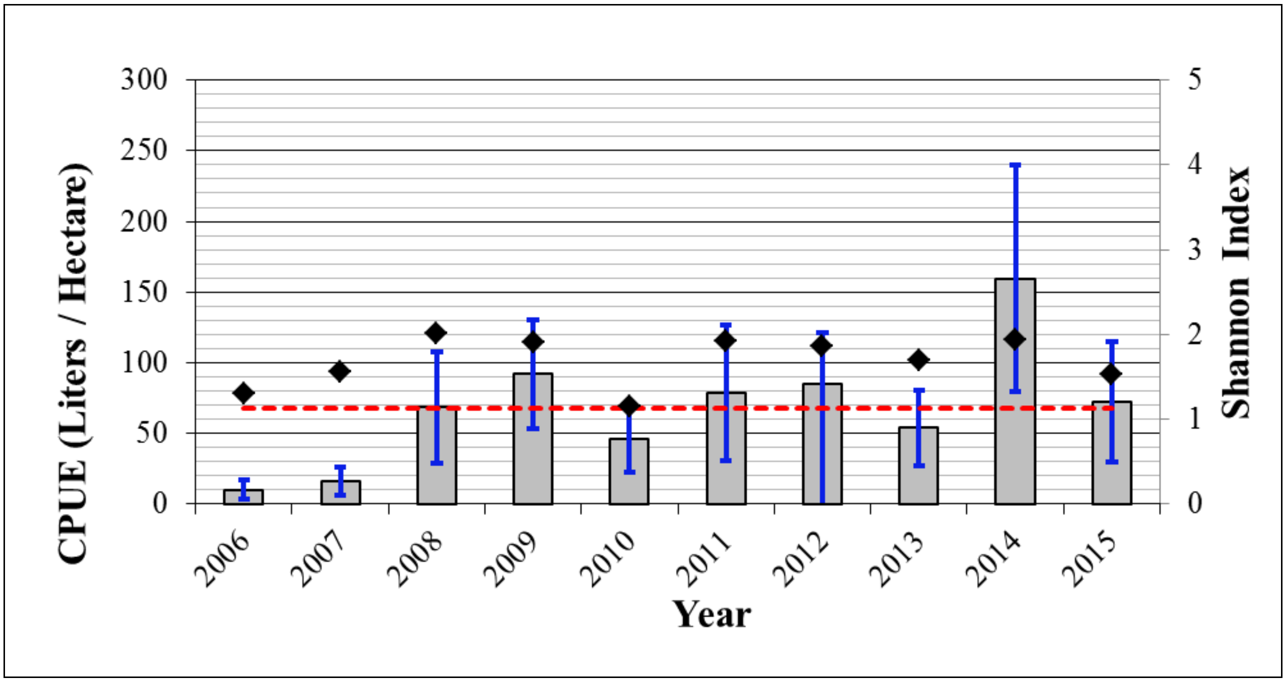

Figure 50. Chincoteague Bay trawl index of macroalgae relative abundance (CPUE; L/ha) with 95% confidence intervals (2006-2015). Dotted line represents the 2006-2015 time series CPUE grand mean, (n=56/year). Black diamond represents the Shannon index of diversity.

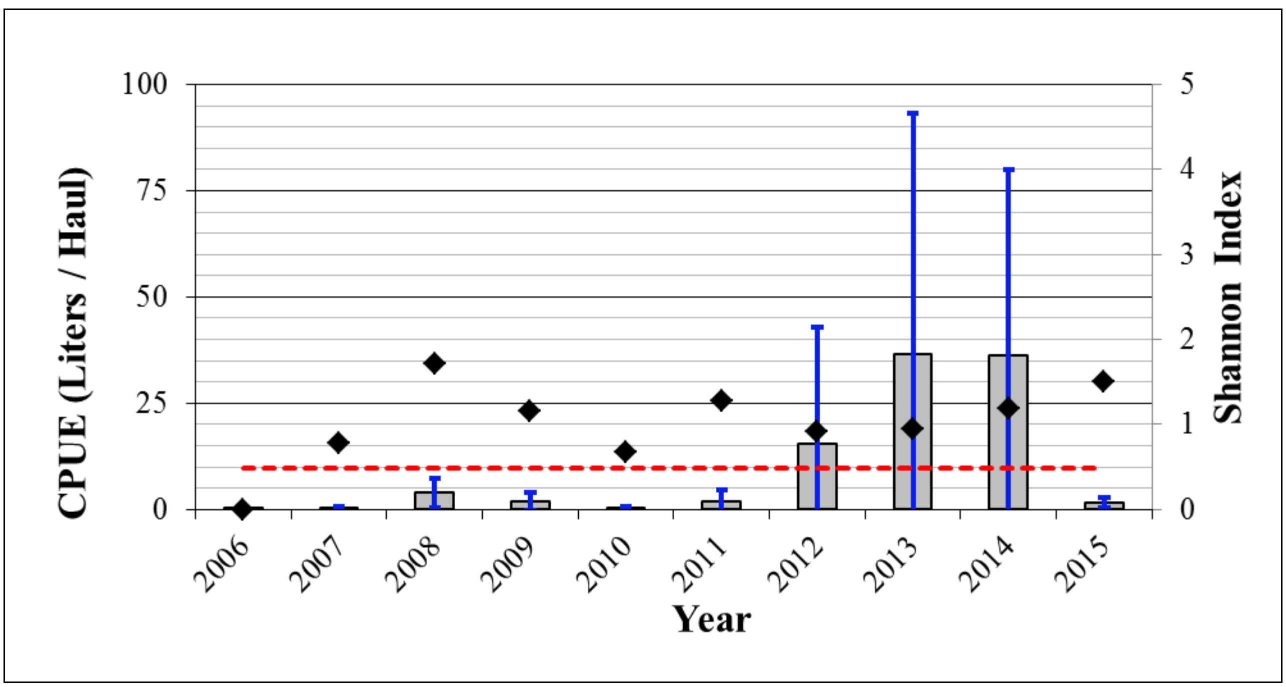

Figure 51. Chincoteague Bay beach seine index of macroalgae relative abundance (CPUE; L/haul) with 95% confidence intervals (2006-2015). Red line represents the 2006-2015 time series CPUE grand mean, (n=12/year). Black diamond represents the Shannon index of diversity.

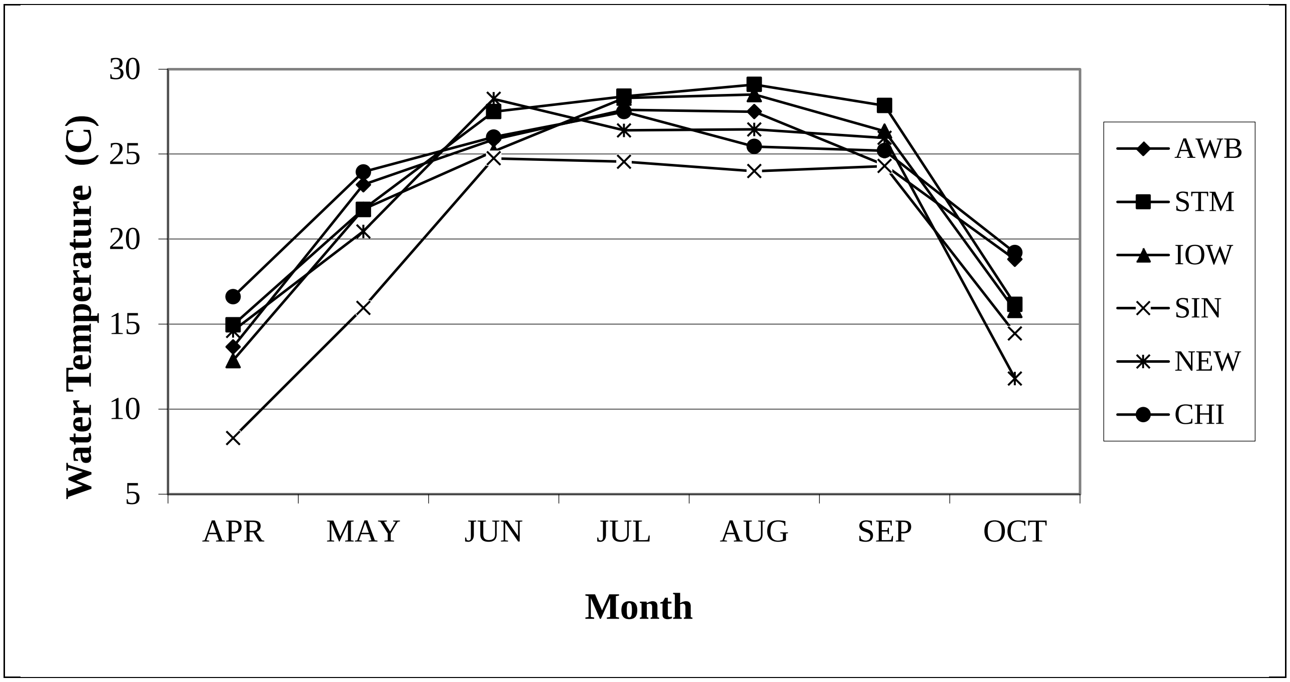

Figure 52. 2015 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

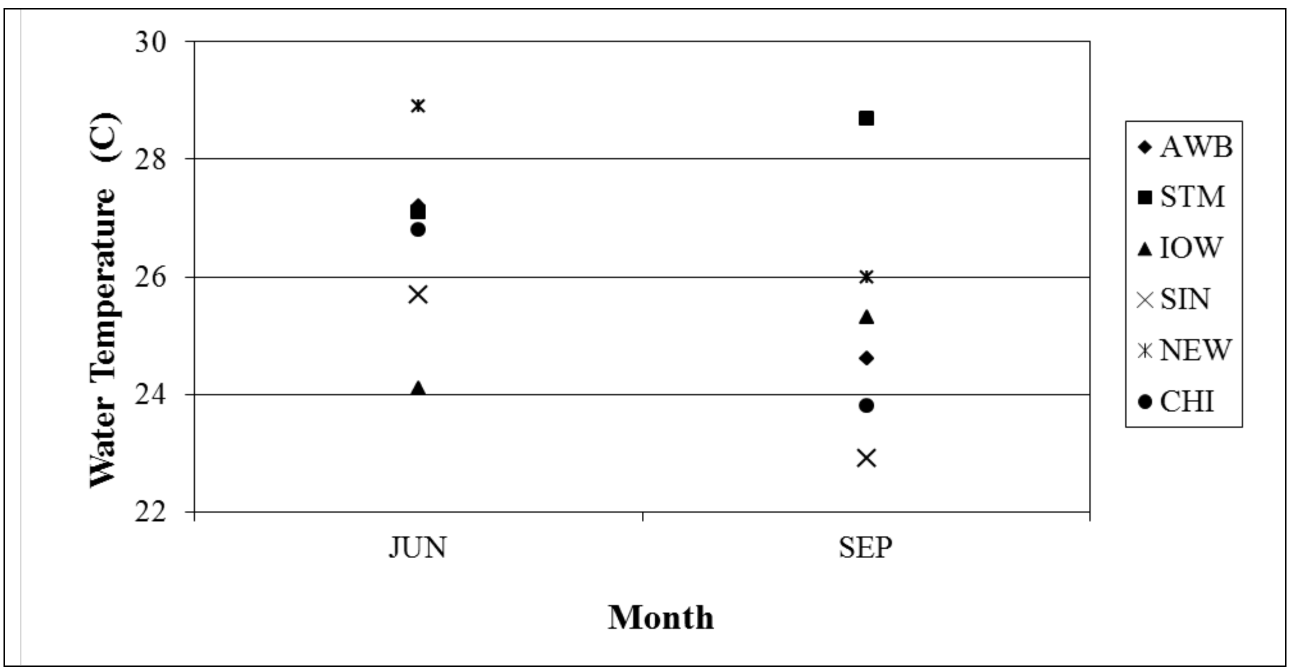

Figure 53. 2015 Coastal Bays Fisheries Investigations Beach Seine Survey mean water temperature (C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

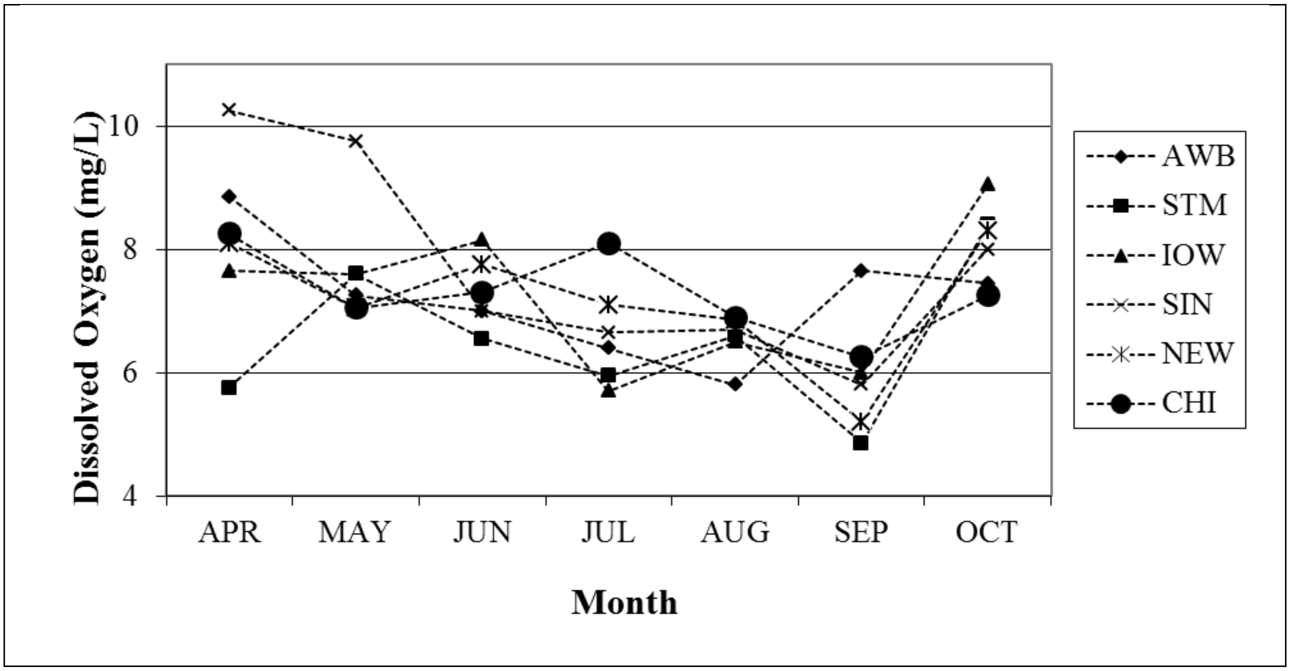

Figure 54. 2015 Coastal Bays Fisheries Investigations Trawl Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

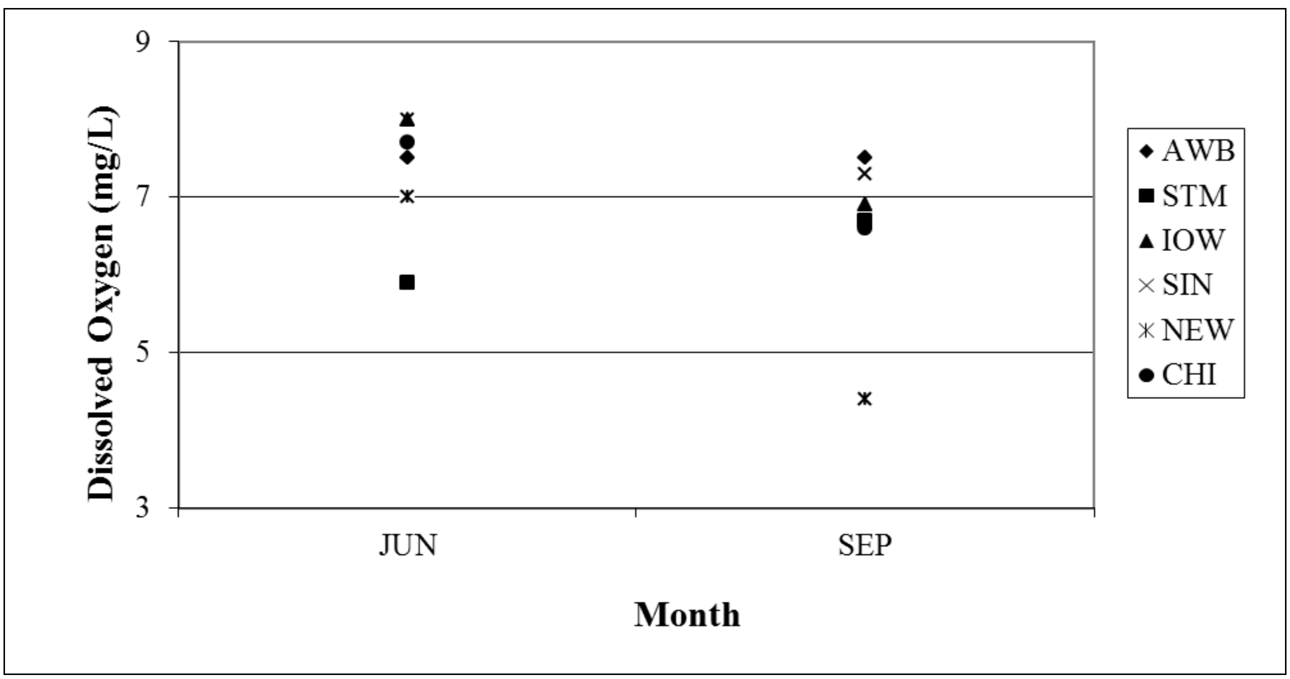

Figure 55. 2015 Coastal Bays Fisheries Investigations Beach Seine Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

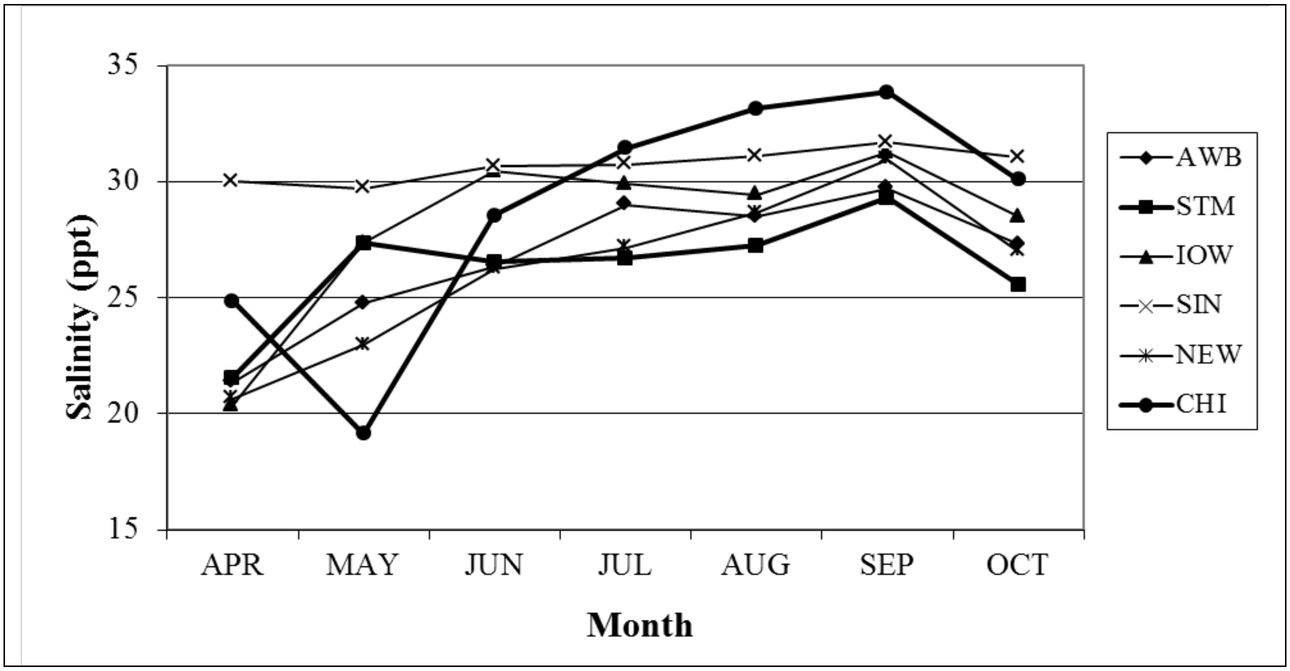

Figure 56. 2015 Coastal Bays Fisheries Investigations Trawl Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

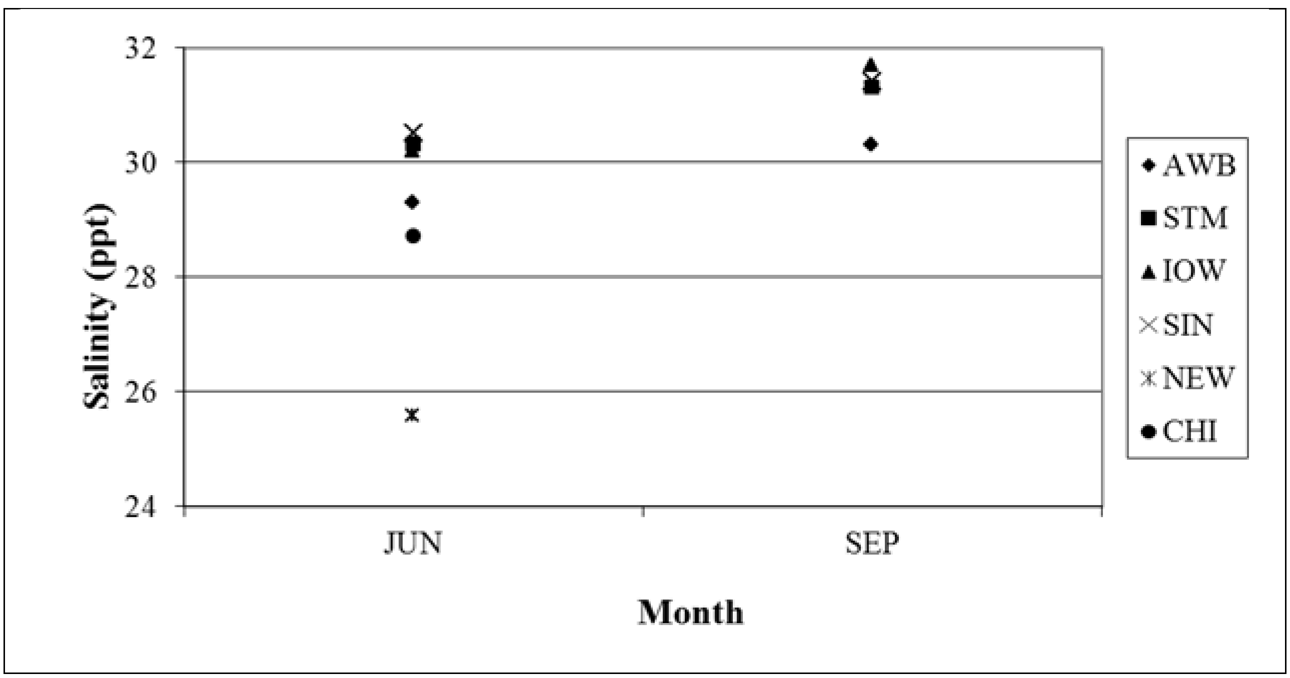

Figure 57. 2015 Coastal Bays Fisheries Investigations Beach Seine Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

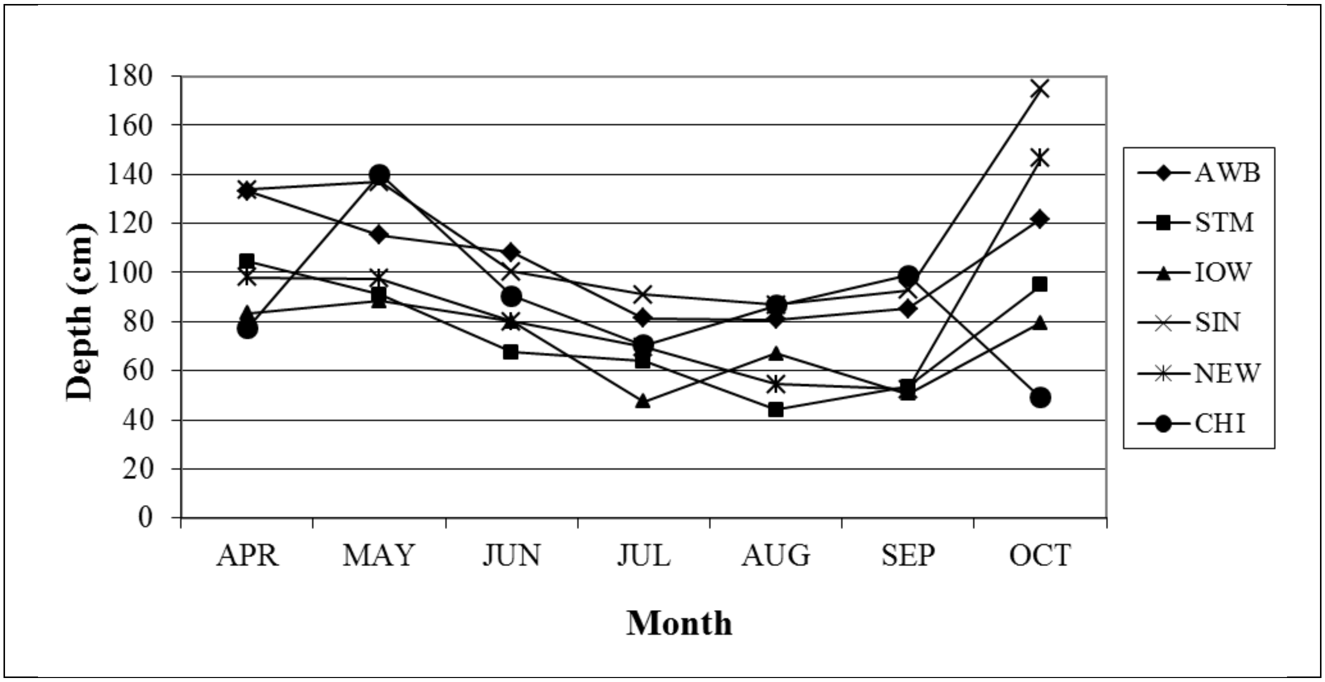

Figure 58. 2015 Coastal Bays Fisheries Investigations Trawl Survey mean turbidity (cm) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

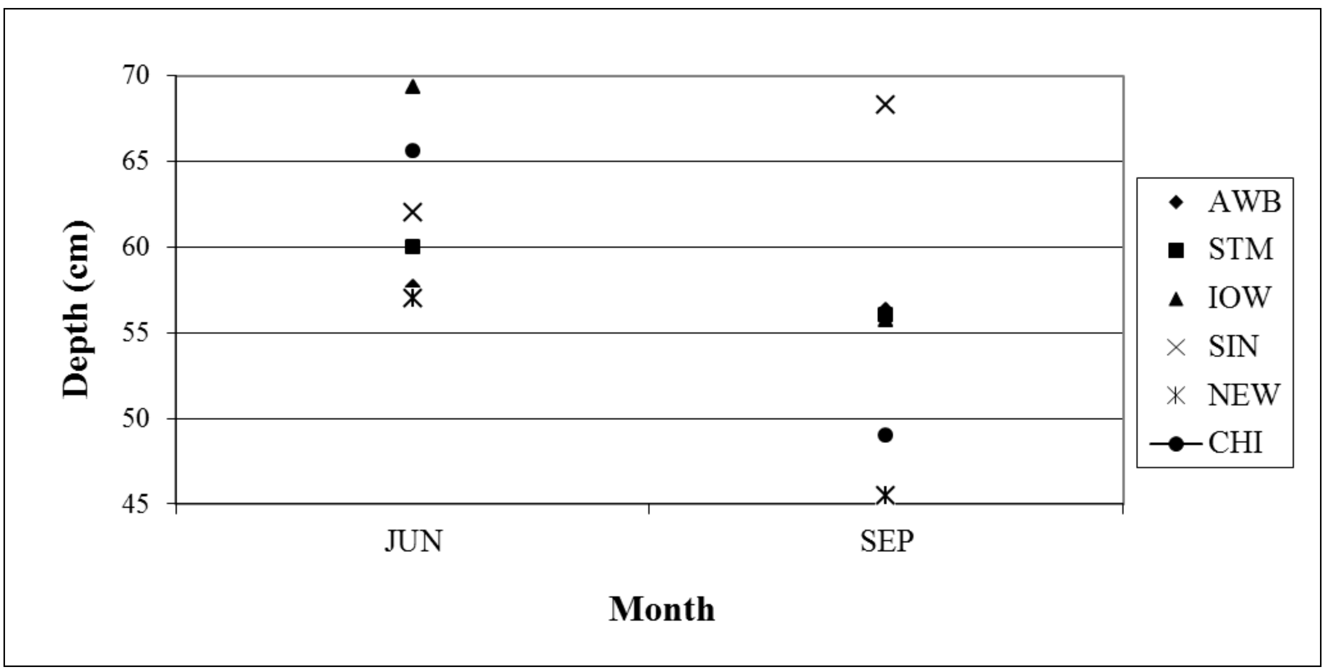

Figure 59. 2015 Coastal Bays Fisheries Investigations Beach Seine Survey mean turbidity (cm) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

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 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.

Methods:

Study Area
Sinepuxent Bay was selected as the 2015 study area following the analysis in 2014 (Figure 1, Table 1). Previously the study area included multiple embayment's within the Coastal Bays, however, it was determined that the independent variable effects of these multiple embayment's were influencing the results.

An initial map reconnaissance was conducted from 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. These potential sites were verified on location by staff in August and again at the time of sampling. If the site lacked SAV, was too deep, or was inaccessible, an alternate site was sampled.

The CBFI Trawl and Beach Seine Surveys had existing sites in Sinepuxent Bay. Those sites had little to no existing SAV and were used to compare to the SAV Habitat Survey results.

Data Collection

A 25-foot C-hawk with a 225 horsepower Evinrude E-tec engine was used as the sampling platform in September. 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. This gear was called the SAV Seine. All sampling was conducted during the daylight in September 2015. 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. Staff ensured that the lead line remained on the bottom until the catch was enclosed in the zipper bag. The catch was taken to the boat for processing. Samples were processed using the same methods described in Chapter 1.

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).

Data Analysis

Measures of Fish Abundance and Diversity

Catch per unit of effort (CPUE) was calculated as the number of fish per hectare for the SAV seine, the beach seine and the trawl. Fish CPUE was also calculated for SAV coverage categories. CPUE were compared using Fisher's Least Significant Difference (LSD) and Duncan's Multiple Range Test. The Shannon Index was used to calculate fish diversity.

Results

Sample Size and Distribution

These results were based on 12 samples collected by the SAV Habitat Survey within five SAV grid sites. The samples were evenly distributed between two categories of SAV coverage: Category A (50-75% SAV coverage) and Category B (≤ 25% SAV coverage). The two CBFI Beach Seine sites were both Category B (≤ 25% SAV coverage). The two CBFI Trawl Survey sites were in deeper water with no SAV coverage throughout the duration of the tow. These sites were Category C (No SAV).

Fish Abundance

A total of 2,343 fish were collected by the SAV Habitat Survey. The three most abundant species were silver perch, Atlantic silverside and tautog (Table 2). The CBFI Beach Seine Survey collected a total of 668 fish; the most abundant species were Atlantic silverside, sheepshead minnow, and bay anchovy (Table 2). The CBFI Trawl Survey collected a total of 20 fish; the most abundant species were bay anchovy and striped anchovy (Table 2).

The SAV Habitat Survey fish abundance results showed preference for greater SAV coverage, this difference was significant ($p < 0.05$). Category A (8,227 fish/ha) was greater compared to Category B (1,523 fish/ha; Figure 2).

Gear type fish abundance comparisons resulted in higher CPUE for the SAV Habitat Survey (4,875 fish/ha). The CBFI Beach Seine Survey (3,683 fish/ha) and CBFI Trawl Survey (79 fish/ha) were lower. There was no significant difference in CPUE among surveys ($p > 0.05$; Figure 3).

Combining the data from the three surveys and comparing fish abundance across SAV categories showed a preference for greater SAV coverage. Category A (8,227 fish/ha) was higher compared to Category B (2,063 fish/ha) and to Category C (79 fish/ha). These differences were significant ($p < 0.05$). The difference between Category B and Category C was not significant ($p > 0.05$; Figure 4).

Managed Fish Abundance
Tautog was the only managed species collected with abundance to compare SAV Categories within and among the survey data. SAV Habitat mean length (TL) for tautog was 94 mm and ranged from 64-195 mm. The CBFI Beach Seine Survey tautog length (TL) was 120 mm; the CBFI Trawl Survey did not encounter this species.

Tautog mean abundance within the SAV Habitat data resulted in SAV preference for Category A (83.23 fish/ha) compared to Category B (29.13 fish/ha). This difference was not significant ($p > 0.05$; Figure 5).

Gear type tautog abundance resulted in higher CPUE for the SAV seine (56.18 fish/ha) compared to the beach seine (5.51 fish/ha) and trawl (0 fish/ha). This difference was not significant ($p > 0.05$; Figure 6).

Combining the data from the three surveys and comparing fish abundance across SAV categories showed a preference for greater SAV coverage. Category A (83.23 fish/ha) was higher compared to Category B (23.22 fish/ha) and Category C (0 fish/ha). This difference was significant ($p < 0.05$; Figure 7).

Fish Diversity
The SAV Habitat fish diversity results showed a preference for less SAV coverage. Category B ($H = 1.33$) showed great diversity when compared to Category A ($H = 0.68$; Figure 2). Category B consisted of 16 species: Atlantic silversides (42.6%) and silver perch (42.3%) were the majority of the catch. Other fish that contributed 1% or more to the sample population were halfbeak (4%), sheepshead (3%), tautog (1.9%), and pinfish (1.9%). Category A consisted of 16 species but was dominated by silver perch (78.4%). Atlantic silversides (18.4%) and tautog (1%) were the only species that contributed 1% or more to the sample population.

Gear type fish diversity comparisons showed the highest diversity from the trawl (H = 2.04), followed by the beach seine (H = 1.65) and the lowest diversity measured by the SAV seine (H = 0.83; Figure 3). Trawl catch consisted of nine species of which bay anchovy (20%) and striped anchovy (20%) were the most abundant (33.3%). The other fish collected by trawl were northern puffer (10%), smallmouth flounder (10%), pinfish (10%), and the following species each contributed 5% to the sample population: northern kingfish, northern pipefish, oyster toadfish, and pigfish. Beach seine catch consisted of 24 species of which Atlantic silverside (37.6%) was the most abundant. Sheepshead minnow (27.4%), bay anchovy (22.5%), oyster toadfish (2.1%), silver perch (1.9%), spot (1.8%), Atlantic menhaden (1.2%), Atlantic needlefish (1.1%), and spotfin mojarra (1.1%) were the only species that contributed 1% or more to the sample population. SAV Habitat seine catch consisted of 21 species and was dominated by silver perch (72.8%). Atlantic silverside (22.2%) and tautog (1.2%) were the only species that contributed 1% or more to the sample population.

Combining the data from the three surveys and comparing fish diversity across SAV categories showed no preference for greater SAV coverage. The diversity results remained the same for Category A (H = 0.68) and Category C (trawl only; H = 2.04). Category B diversity increased (H = 1.79) and represented 25 species (Figure 4). Atlantic silverside (40.37%), silver perch (24.31%), sheepshead minnow (12.23%), bay anchovy (10.19%), halfbeak (2.40%), sheepshead (2.02%), pinfish (1.26%), and tautog (1.1%) were the only species that contributed 1% or more to the sample population.

Water Quality

The water quality tested at all sampling locations was consistent with fish habitat requirements. The average dissolved oxygen measurement was 6.7 mg/L and ranged from 4.49 -8.54 mg/L. The water temperature average was 25.4 °C and ranged from 23 - 26.7 °C. The salinity averaged 32.3 ppt and ranged from 31.3 – 33.4 ppt. The Secchi disk reading depth average was 79.5 cm and ranged from 53 -103 cm.

Discussion

This is the first year in our three-year investigation of SAV habitat within Sinepuxent Bay. Sinepuxent Bay was selected to reduce the effects of location, specifically the Northern Bays, while increasing the ability to compare results among the long-term surveys discussed in Chapter 1. Sinepuxent was an excellent location to reduce the effects of macroalgae due to its low abundance in this embayment. The month of September was selected to decrease seasonal variability and create efficiencies among staff. Our expected results were to reveal the fish assemblage diversity and abundance within the SAV beds. We attempted to segregate SAV coverage into more than two categories; however, this was not accomplished due to the difficulty of finding SAV beds with coverage greater than 75%. The resulting categories: A (50-75% SAV coverage) and B (≤ 25% SAV coverage) were sufficient to compare fish abundance to determine if SAV is preferred fish habitat within Sinepuxent Bay. The balanced categories among SAV seine samples allowed for basic statistical analysis, however, when comparing the SAV seine data to the beach seine and trawl data, unequal sample sizes did occur. Regardless of statistical significance, the observed means did show that within the SAV beds, fish preferred greater SAV coverage.

Comparisons among the gear types were rudimentary. Each gear covered a specific surface area of water and that area covered was converted to hectares. The SAV seine coverage was a little less than half the coverage of the beach seine, however, the efficiencies of each gear were not factored into the CPUE comparisons. Many would expect the catchability or efficiency of the beach seine to be much greater than an open water SAV seine. Therefore, these and future results may be more in favor of supporting the importance of SAV beds in the Coastal Bays.

The diversity results showed that many species of fish inhabit Sinepuxent Bay in September. While silver perch and Atlantic silverside abundance reduced the overall diversity index value, the most striking result from this survey was the abundance of tautog in our SAV beds. Recent declines in this species' abundance and certain known aspects of its life history and specific habitat requirements have caused coastal fishery resource and habitat managers to believe the species may need further conservation measures (Steimle and Shaheen 1999). In 2015, the Atlantic States Marine Fisheries Commission approved the Tautog Benchmark Stock Assessment and Peer Review Report for management use. Results of these reports state that tautog are overfished and below the spawning stock biomass threshold coast wide. While our recent (2011-2014) Trawl and Beach Seine Survey data indicate that abundance is low in the Coastal Bays, the results from the SAV Habitat Survey are promising for tautog recovery, provided that SAV habitat is protected.

Recommendations

Future work should consider adding additional beach seine and otter trawl sites to balance the sample size. It may be worthwhile to compare the gear efficiency of the SAV Habitat seine and the beach seine to develop a conversion factor, however, this is not a requirement. Future collections should measure all the lengths for all managed fish collected in Sinepuxent Bay during September, currently only twenty lengths per species are recorded per sample. The SAV Habitat Survey has documented tautog abundance that was not discovered by the CBFI Beach Seine and Trawl Survey. Uncovering data gaps missing from existing surveys are important; therefore, the SAV Habitat Survey should be continued as planned in 2016 and 2017.

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Table 1. MDNR Coastal Bays Fisheries Investigation 2015 SAV Habitat Survey site descriptions.

Grid Number	Bay	Site Description	Latitude	Longitude	Number of Samples
121	Sinepuxent Bay	East of Snug Harbor; West of Small Island	38 17.215	75 07.663	4
128	Sinepuxent Bay	South of Duck Blind; East of Green Marker	38 17.127	75 07.752	2
160	Sinepuxent Bay	700 meters northeast of Potfin Road along the shoreline	38 15.900	75 08.761	2
212	Sinepuxent Bay	South of Verrazano Bridge; West of Sandy Point Island; on channel edge	38 14.201	75 09.321	2
221	Sinepuxent Bay	Southwest of Small Island; South of Verrazano Bridge	38 14.165	75 09.425	2

Table 2. List of fishes collected in Maryland's Costal Bays SAV Habitat Survey, Seine Survey and Trawl Survey from Sinepuxent Bay in September 2015.

Common Name	Scientific Name	Total Number Collected from SAV Habitat Survey	Total Number Collected from Seine Survey	Total Number Collected from Trawl Survey
Silver Perch	*Bairdiella chrysoura*	1,705	13	0
Atlantic Silverside	*Menidia menidia*	520	251	0
Tautog	*Tautoga onitis*	27	1	0
Halfbeak	*Hyporhamphus unifasciatus*	23	2	0
Sheepshead	*Archosargus probatocephalus*	16	3	0
Northern Pipefish	*Syngnathus fuscus*	13	3	1
Pinfish	*Lagodon rhomboides*	11	3	2
Northern Puffer	*Sphoeroides maculatus*	4	1	3
Spotfin Butterflyfish	*Chaetodon ocellatus*	4	0	0
Oyster Toadfish	*Opsanus tau*	3	14	1
Bay Anchovy	*Anchoa mitchilli*	2	148	4
Pigfish	*Orthopristis chrysoptera*	2	1	1
Rainwater Killifish	*Lucania parva*	2	2	0
Striped Blenny	*Chasmodes bosquianus*	2	1	0
Summer Flounder	*Paralichthys dentatus*	2	2	0
Bluespotted Cornetfish	*Fistularia tabacaria*	1	0	0
Dusky Pipefish	*Syngnathus foridae*	1	0	0
Gray Snapper	*Lutjanus griseus*	1	1	0
Spot	*Leiostomus xanthurus*	1	12	0
Atlantic Menhaden	*Brevoortia tyrannus*	0	8	0
Atlantic Needlefish	*Strongylura marina*	0	7	0
Black Drum	*Pogonias cromis*	0	1	0
Black Sea Bass	*Centropristis striata*	0	0	0
Bluefish	*Pomatomus saltatrix*	0	1	0
Naked Goby	*Gobiosoma bosc*	0	2	0
Northern Kingfish	*Menticirrhus saxatilis*	0	1	1
Sheepshead Minnow	*Cyprinodon variegatus*	0	183	0
Smallmouth Flounder	*Etropus microstomus*	0	0	3
Southern Stingray	*Dasyatis americana*	0	0	0
Spotfin Mojarra	*Eucinostomus argenteus*	0	7	0
Striped Anchovy	*Anchoa hepsetus*	0	0	4
	Total	**2,339**	**668**	**20**

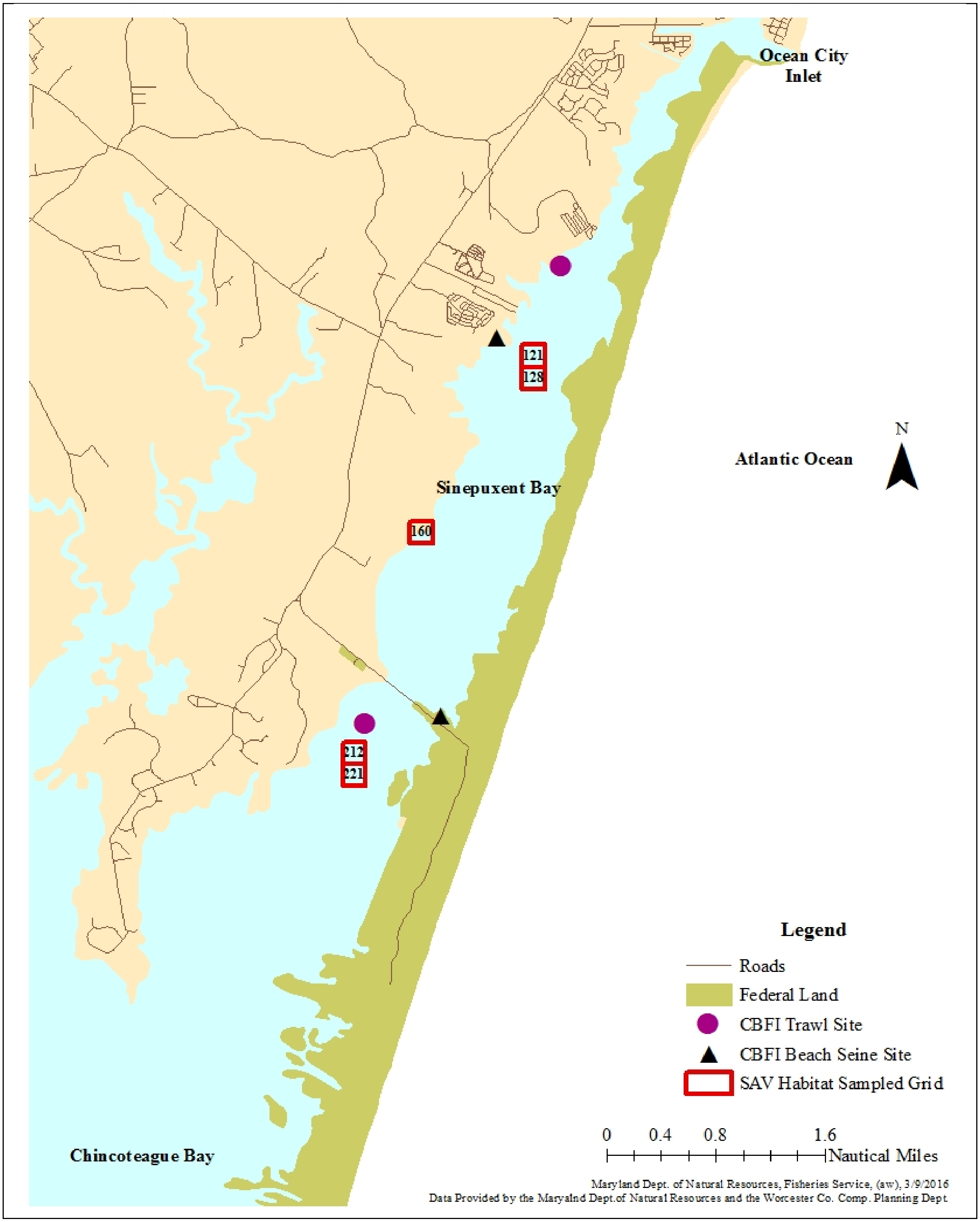

Figure 1. Coastal Bays Fisheries Investigation September 2015 Sinepuxent Bay sample sites for the SAV Habitat Survey and nearby sites for the Trawl and Beach Seine Survey.

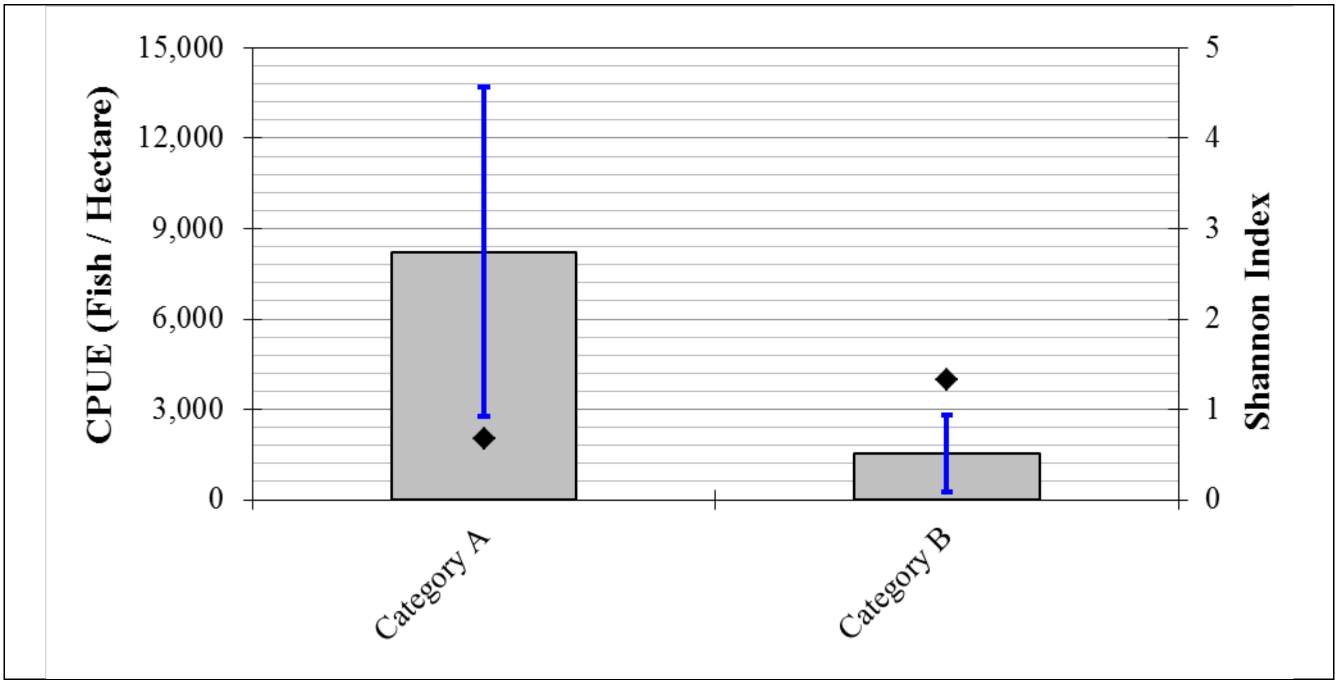

Figure 2. Sinepuxent Bay SAV Habitat Survey relative fish abundance (CPUE; fish/ha) with 95% confidence intervals (September, 2015). Category A (50-75% SAV coverage) and Category B (≤ 25% SAV coverage). Black diamond represents the Shannon index of diversity.

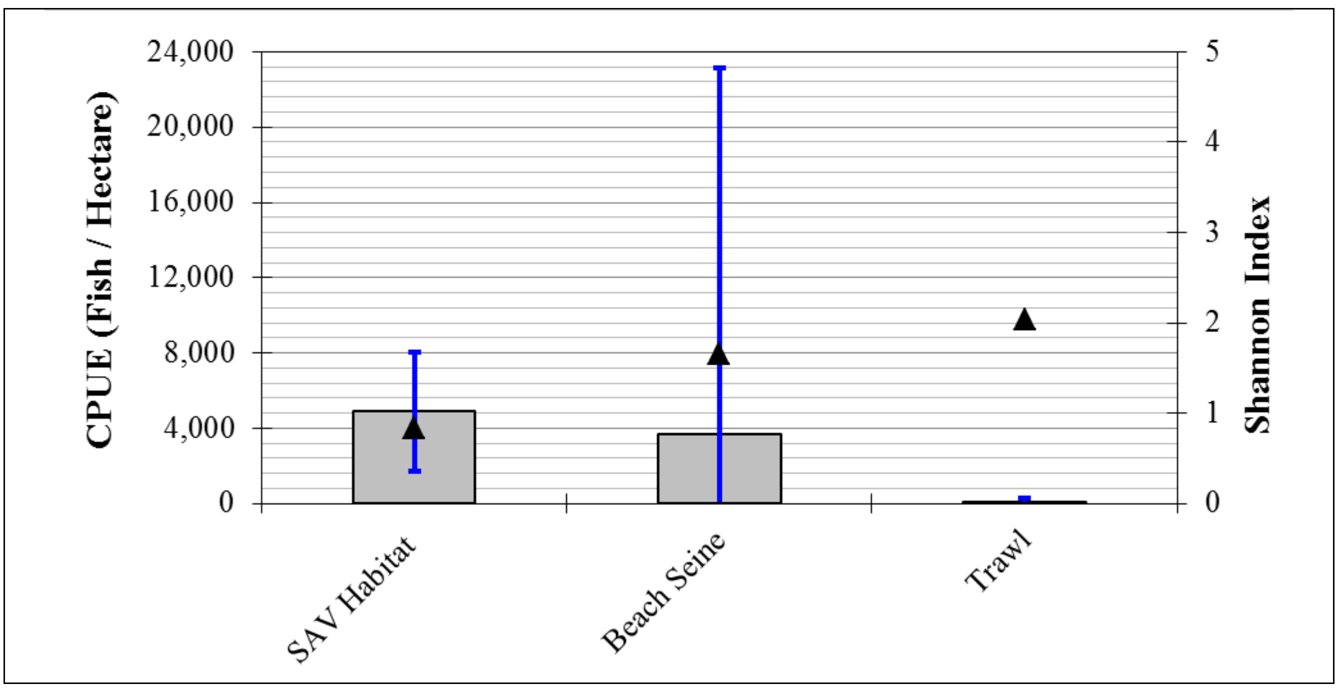

Figure 3. Sinepuxent Bay SAV Habitat Survey relative fish abundance compared to the CBFI Beach Seine and Trawl Survey fish abundance (CPUE; fish/ha) with 95% confidence intervals (September, 2015). Black diamond represents the Shannon index of diversity.

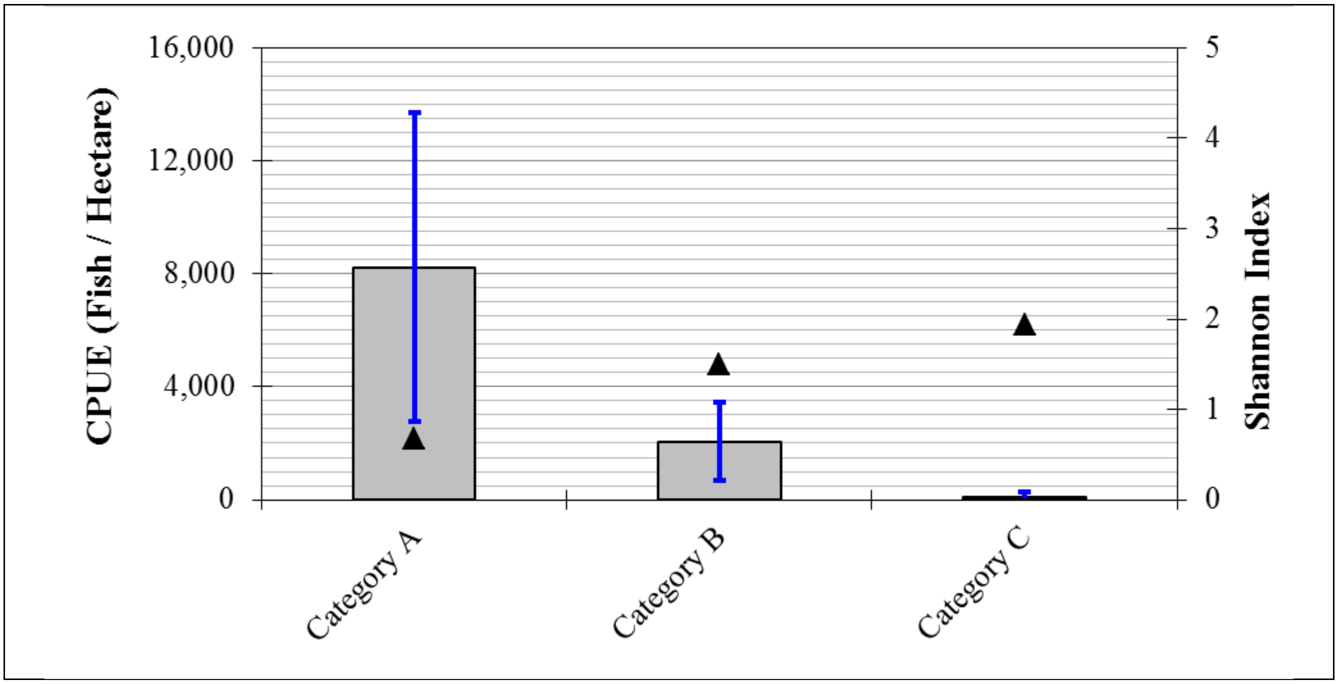

Figure 4. Sinepuxent Bay SAV Habitat Seine, Beach Seine and Trawl Survey (combined) relative fish abundance (CPUE; fish/ha) by SAV Categories with 95% confidence intervals (September, 2015). Category A (50-75% SAV coverage), Category B (≤ 25% SAV

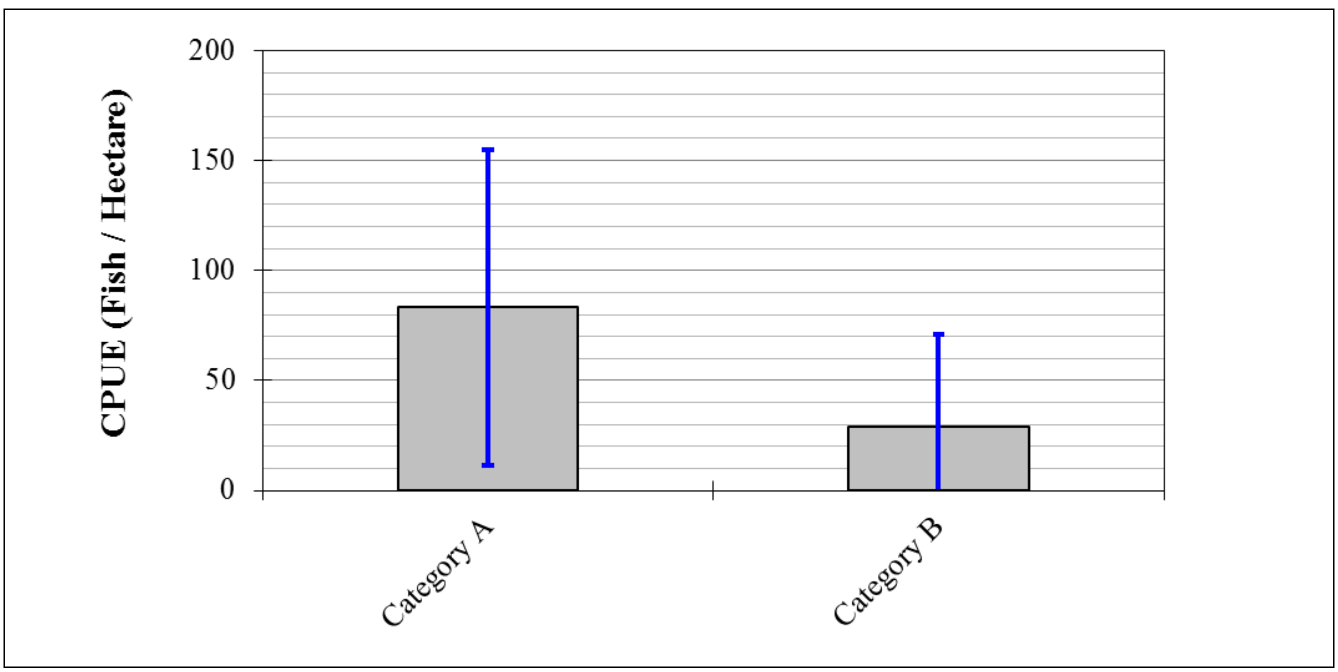

Figure 5. Sinepuxent Bay SAV Habitat Survey relative tautog abundance (CPUE; fish/ha) with 95% confidence intervals (September, 2015). Category A (50-75% SAV coverage) and Category B (≤ 25% SAV coverage).

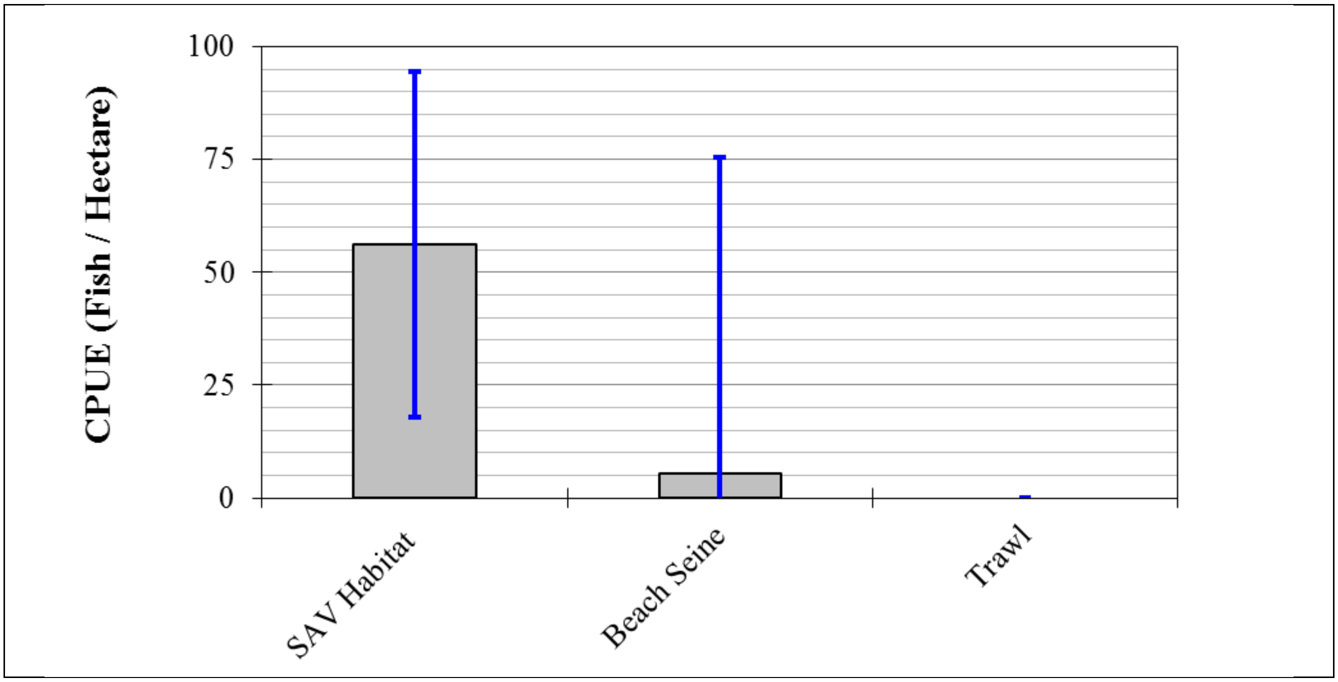

Figure 6. Sinepuxent Bay SAV Habitat Survey relative tautog abundance compared to the CBFI Beach Seine and Trawl Survey fish abundance (CPUE; fish/ha) with 95% confidence intervals (September, 2015).

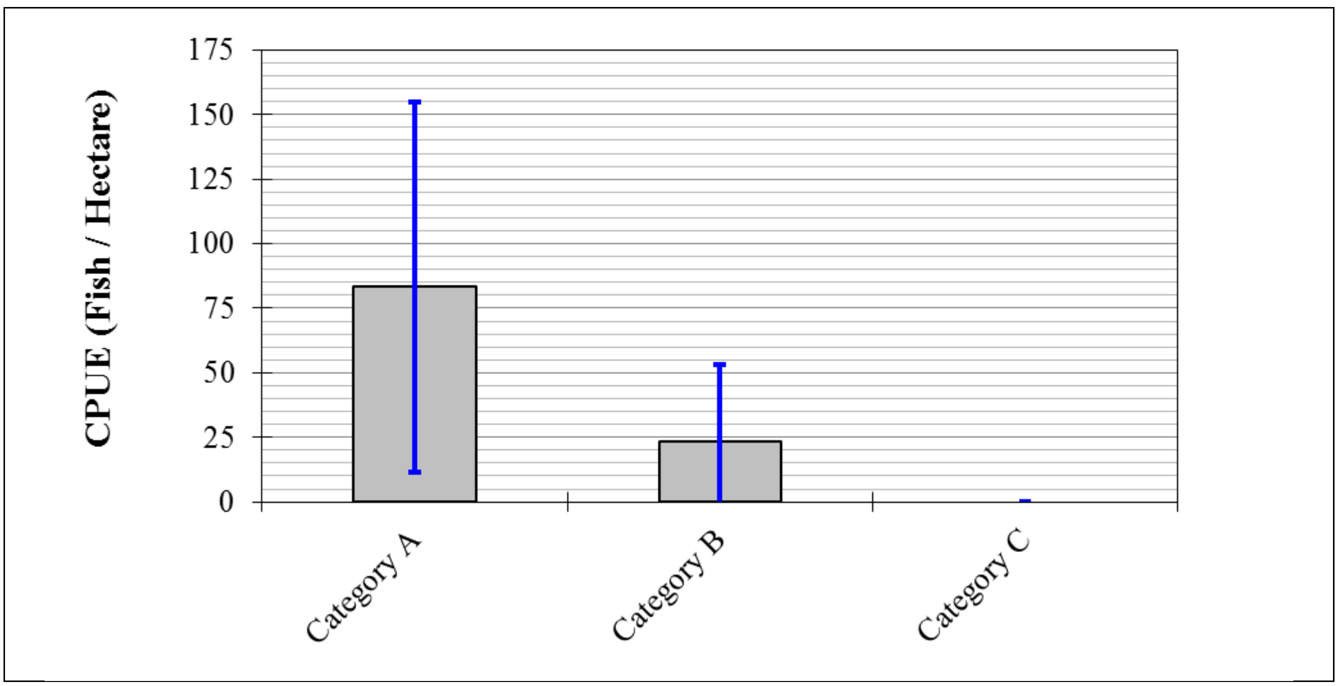

Figure 7. Sinepuxent Bay SAV Habitat Seine, Beach Seine and Trawl Survey (combined) relative tautog abundance (CPUE; fish/ha) by SAV Categories with 95% confidence intervals (September, 2015). Category A (50-75% SAV coverage), Category B (≤ 25% SAV coverage) and Category C (No SAV).

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 from 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
Commercial sampling trips were conducted on June 24, July 6, August 17 and October 25. When targeting horseshoe crabs, trawls usually occurred at night in order to increase the legal size catch.

Gear and Location
Sampling was conducted on commercial trawlers targeting horseshoe crabs. The net used for the trawls from June to October was a standard summer flounder bottom trawl net with a 15.2 cm net body mesh. A 14.1 cm codend was used for all these trawls with the exception of August where the codend was 15.2 cm. Head rope lengths ranged from 18.3 m up to 20.7 m for the June to October trawls. Foot rope lengths were 24.4 m throughout sampling trips.

Sites were determined by the fishing vessel captains on a trip by trip basis depending on the target species. Trips targeting horseshoe crabs were one to three miles from shore.

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 deduced using an anemometer. Time and depth was recorded at haul back. 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. Blue 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. Width was also

measured on whelks at the widest part of the shell. 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 determined using two methods. The primary method was utilized when targeting horseshoe crabs for biomedical research, whereas the fishermen counted and sexed each and every horseshoe crab per haul. These enumerations were used to calculate the proportion each sub-sample represented to the total catch. When the primary method was not available, subsample proportion estimations were conducted by a visual inspection.

Data analysis

Statistical analyses were conducted on all species. Size, sex and abundance estimates by selected species were extrapolated from the subsampling regime proportional catch calculations.

Results:

Trawl time varied, with time ranging between 17 and 73 minutes. Water temperature ranged from a high of 24.6 C in September to a low of 16.9 C in October. Depth over the course of the surveys ranged from 8.9 m to 20.7 m (Table 1).

The target species for all trips was the horseshoe crab. Numbers of species collected ranged from 6 to 14 per trip (Table 2). Gear configurations were similar with slight variation in mesh and head rope width (Table 3). Predominant species encountered from all the trawls were horseshoe crabs, summer flounder, clearnose skate *(Raja eglanteria),* southern kingfish (*Menticirrhus americanus*), nine-spined spider crab *(Libinia emarginata),* and knobbed whelk (*Busycon carica*; Table 4).

From June to October, prosomal widths were collected for 272 horseshoe crabs (Figure 1). Prosomal width ranged from 91 mm to 330 mm. There were 119 females with a mean prosomal width of 191 mm and mode of 180 mm. Prosomal widths for females ranged from 91 mm to 300 mm. The rest were males (153) with a mean prosomal width of 184 mm and mode of 200 mm. Male prosomal widths ranged from 108 mm to 235 mm. The ratio of male to female horseshoe crabs was 1.3:1 (Table 5).

From all trips combined, a total of 34 summer flounder were measured. Lengths ranged in size from 210 mm to 590 mm (Figure 2). The mean was 414.2 mm and the mode was 420 mm. Most of the measured summer flounder were legal, ≥14 inches (Table 6). The proportion of summer flounder less than 355.6 mm (14 inches) and 406.4 mm (16 inches) was examined over time since 2005 in order to identify potential recruitment pulses in the near shore population (Table 6). The results varied without trend over the 2005-2015 time series. The average percent less than 355.6 mm was 17.1% and the average percent less than 406.4 mm was 23.6%.

Thirty five knobbed whelks were measured (Figure 3). The mean length for knobbed whelks was 186 mm and the mode was 190 mm. Widths ranged from 80 mm to 180 mm. The average and mode for width was 105 mm and 100 mm, respectively.

Discussion:
Fishermen have decreased the number of tows in recent years because of an increased abundance of the target species, horseshoe crabs. The increased abundance of horseshoe crabs reduces the number of tows needed to reach the daily possession limit which reduces the utility of the data for some species such as summer flounder.

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 it supplies rare information that characterizes the horseshoe crab fishery. From 90 mm to 160 mm, females outnumber males with 45 animals compared to 25 animals. Males dominated the 170 to 220 mm range. For 230 mm and above, females were more represented. It is often assumed the population contains more males than females as this is what is observed on the spawning beaches. These data indicate that males were slightly more abundant (57.5% / 42.5%) than females in the commercial catch, and it is likely that male horseshoe crabs remain on the spawning beaches longer than the females. Adult prosomal width ranges from 177.8 mm (7 inches) to 304.8 mm (12 inches; MDNR 2016). The majority of both male and female animals were adults. The histogram presents a maturing population of both sexes with more adults than juveniles.

Summer flounder bycatch less than 16 inches (TL) has varied between 10.1% and 43.9% since 2011. The strong 2007-2008 year classes (Chapter 1; Figure 26) were apparent in the 2011 bycatch landings. Summer flounder less than 14 inches (TL) representing age 1 to age 3 fish has ranged from 1.3 to 21.4% of the catch since 2011. The strong 2009 year class was not apparent in the bycatch landings in 2012. However, moderate year classes of 2012 and 2013 were represented in 2013-2015 bycatch landings, which showed a marked increase in younger fish encountered when compared to 2012. The size structure of these data may have been influenced by the targeted species fishing location, which was closer to shore (1-3 miles) than preferred. Large summer flounder are encountered more frequently greater than 10-miles offshore. Poor recruitment of summer flounder was observed in 2014 and 2015, and this situation may influence summer flounder abundance in the future. However, the majority of fish measured in 2015 had reached the length capable of spawning. Summer flounder obtain sexual maturity upon reaching lengths of 355.6 mm (14 inches) for females and 304.8 mm (12 inches) for males (Manooch 1984). Most were above the 355.6 mm minimum size limit allowed by commercial fishing nets, pots, traps, trotlines, or seines. Moreover, the majority of fish were above the minimum size (406.4 mm) for commercial and recreational hook and line (Figure 2).

There were more knobbed whelk (35) encountered in 2015 compared to 2014 (27). The majority were over the minimum size of 152.4 mm (Figure 3). Castagna and Kraeuter (1994) studied knobbed whelks raised under lab conditions from egg cases collected in Virginia. These animals reached maturity at nine years old and all were males. At 12.4 years, the first egg case was laid (embryos were absent from the case) by a 172 mm long individual with a width of 95 mm. After a decade of growing in the lab, the average size was 144 mm. At 14 years, the average shell length had become 168.7 mm. Research concerning knobbed whelks harvested off Georgia by Power et al (2009) found that female whelks achieved maturity at six years old with a length of 100 mm while males became mature much younger (4 years) with lengths of 85-90 mm. Based on these two studies, it might be concluded that there were no young animals present in the sample. Castagna and Kraeuter (1994) postulated that harvesting based upon size might select for females. However, with males obtaining maturity at smaller sizes in Georgia, this might not necessarily be the case.

References:

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Table 1. Temperature range (C), depth range and number of tows for each commercial trawl survey trip from June through October 2015 by the Maryland Department of Natural Resources.

Trip Date	Temperature (C)	Depth Range (m)	Number of Tows
June 24	22.0-22.5	10.4-11.7	2
July 6	24.6	8.9-12.2	1
August 17	24.2	9.4-12.4	1
October 25	16.9	20.4-20.7	2

Table 2. Trip date, number of species, number of animals counted and number of measurements per commercial trawl survey trip from June through October 2015 by the Maryland Department of Natural Resources. All trips targeted horseshoe crabs (*Limulus polyphemus*).

Trip Date	Number of Species	Number of Animals Counted	Number Measured
June 24	12	134	124
July 6	6	54	52
August 17	8	83	82
October 25	14	154	141

Table 3. Changes in gear for commercial trawl survey trips from June through October 2015 by the Maryland Department of Natural Resources.

Trip Date	Net Codend Mesh (cm)	Net Body Mesh (cm)	Head Rope Width (m)	Foot Rope Width (m)
June 24	14.0	15.2	18.3	24.4
July 6	14.0	15.2	18.3	24.4
August 17	15.2	15.2	18.3	24.4
October 8	14.0	14.0	20.7	24.4

Table 4. List of species collected in sub-sampled commercial offshore trawls from June through October 2015 by the Maryland Department of Natural Resources, n= 425. Species were grouped (Finfish, Crustaceans, Mollusks, and Other) and listed by order of extrapolated total number, n= 11,052. 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			
Summer Flounder	*Paralichthys dentatus*	346	34
Clearnose Skate	*Raja eglanteria*	329	11
Southern Kingfish	*Menticirrhus americanus*	202	15
Smallmouth Flounder	*Etropus microstomus*	40	1
Southern Stingray	*Dasyatis americana*	21	2
Atlantic Croaker	*Micropogonias undulatus*	17	2
Silver Hake	*Merluccius bilinearis*	17	2
Bullnose Ray	*Myliobatis freminvillii*	4	4
Spiny Butterfly Ray	*Gymnura altavela*	4	4
Spotted Hake	*Urophycis regia*	3	3
Spot	*Leiostomus xanthurus*	1	1
Atlantic Angel Shark	*Squatina dumeril*	1	1
Windowpane Flounder	*Scophthalmus aquosus*	1	1
Smooth Dogfish	*Mustelus canis*	1	1
	Total Finfish	**987**	**82**
Crustacean Species			
Portly Spider Crab	*Libinia emarginata*	410	12
Lady Crab	*Ovalipes ocellatus*	145	4
Blue Crab	*Callinectes sapidus*	135	4
Flatclaw Hermit Crab	*Pagurus pollicaris*	16	1
	Total Crustaceans	**706**	**21**
Mollusc Species			
Knobbed Whelk	*Busycon carica*	292	35
Channeled Whelk	*Busycotypus canaliculatus*	120	3
	Total Molluscs	**307**	**50**
Other Species			
Horseshoe Crab	*Limulus polyphemus*	9,052	272
	Total Other	**9,052**	**272**

Table 5. Total number of male and female horseshoe crabs (*Limulus polyphemus*) and sex ratio from sub-sampled commercial offshore trawls from 2011-2015.

Year	Number of Tows	Male	Female	Male:Female Ratio
2011	12	289	168	1.7:1
2012	16	287	247	1.2:1
2013	12	234	214	1.1:1
2014	12	279	169	1.7:1
2015	6	153	119	1.3:1

Table 6. Percent of summer flounder (*Paralichthys dentatus)* bycatch below 14 inches and 16 inches from sub-sampled commercial offshore trawls from 2011-2015.

Year	Number of Tows	% Below 14 in	% Below 16 in	# Fish per Tow (CPUE)
2011	12	14.2%	43.9%	12.9
2012	16	1.3%	10.1%	4.9
2013	12	17.1%	26.8%	3.4
2014	12	21.4%	38.9%	10.5
2015	6	17.6%	29.4%	5.7

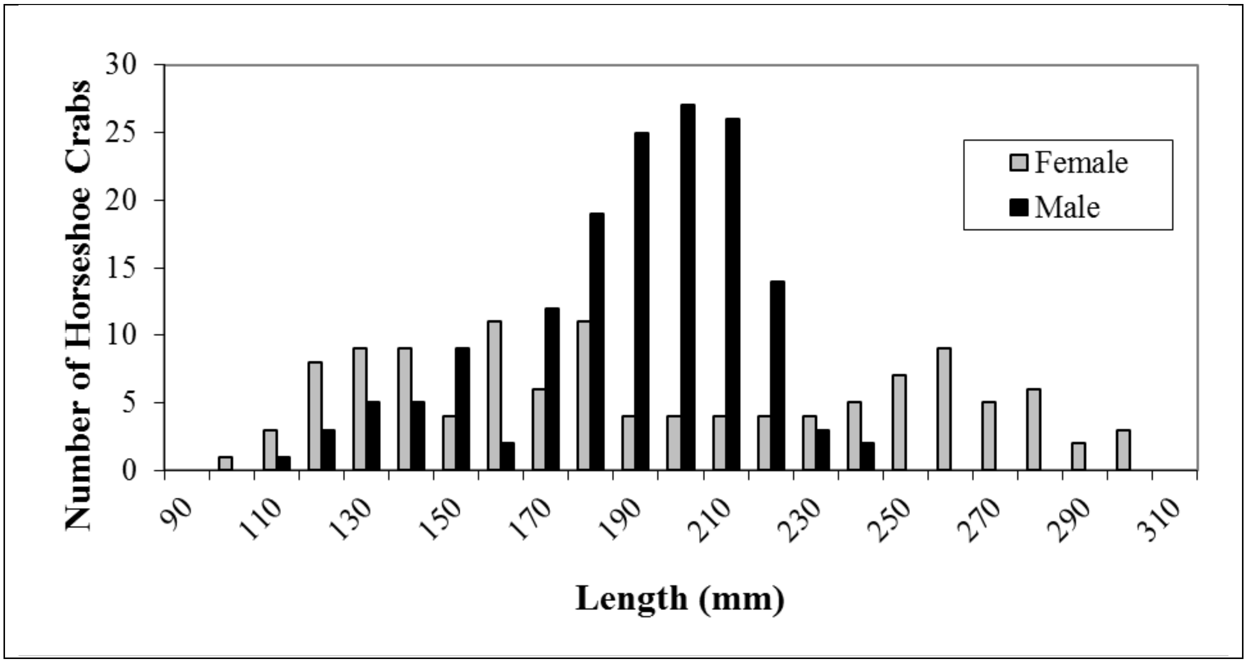

Figure 1. Horseshoe crabs (*Limulus polyphemus*) length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources from June to October, n= 272. Data were derived from four trawl trips taken at different water depths targeting horseshoe crabs.

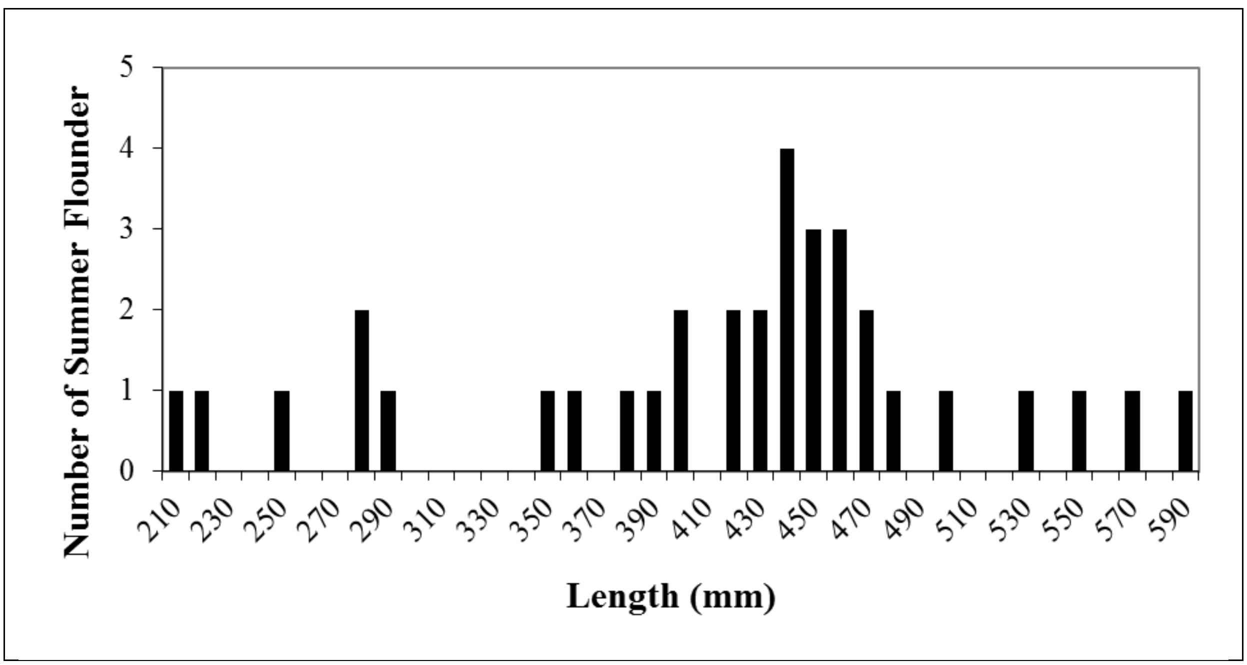

Figure 2. Summer flounder (*Paralichthys dentatus)* length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources from June and October 2015, n= 34. Data were derived from four trawl trips taken at different water depths targeting horseshoe crabs.

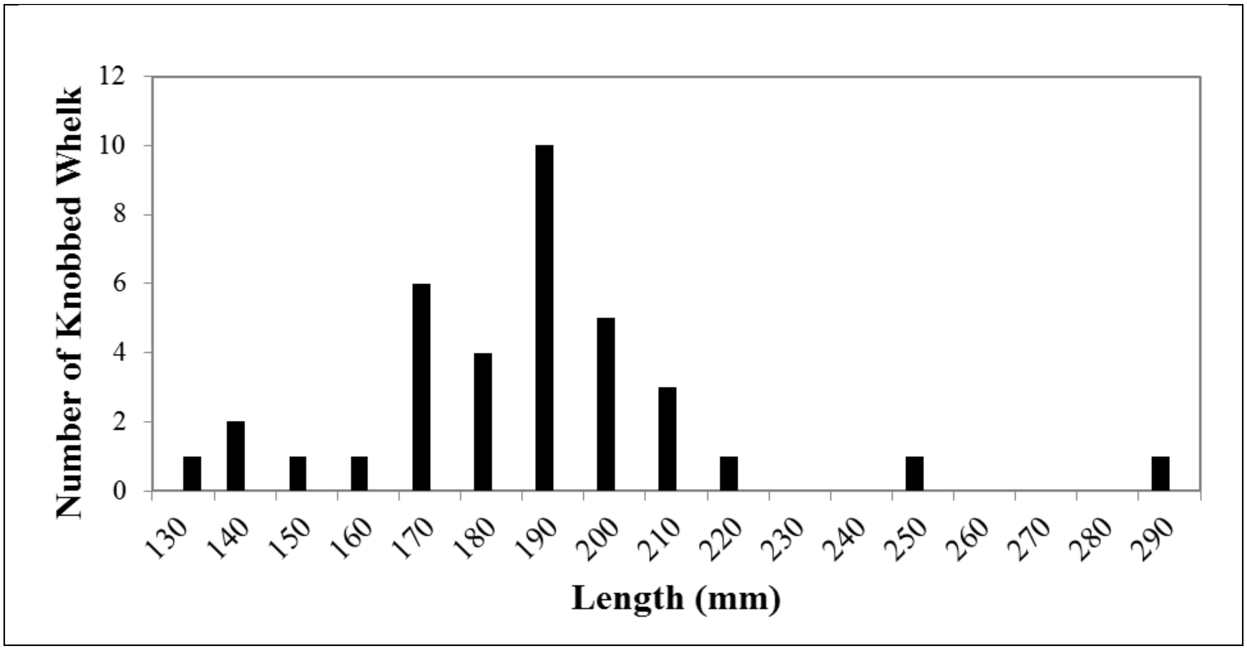

Figure 3. Knobbed whelk (*Busycon carica*) length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources from June to October, n= 35. Data were derived from four trawl trips taken at different water depths targeting horseshoe crabs.

Appendix 1. MD DNR Coastal Bays Trawl 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

Appendix 1. MD DNR Coastal Bays Trawl Data Sheet

Date _______/______/2013	Start Time (12 hr)	Collector	Set#	
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

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

Appendix 2. MD DNR Coastal Bays Beach Seine Data Sheet

Date (MM/DD/YYYY)	**Start Time (12 hr)**	**Collector**	**Set#**
______/_______/2013			
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
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_2$0
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

L Count:
Number of Fish/L:
Species:
Subsample

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.	

Appendix 2. 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

Appendix 3. 2015 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**

Species with an asterisk (*) were added in 2015.

Appendix 4 MD DNR Coastal Bays SAV Seine Data Sheet

Date (MM/DD/YYYY) ______/_______/2015	**Start Time (12 hr)**	**Collector**	**Set#**
Zone: **NB** **SB** **CB**	**Grid Number/Site Description**		
	Seine Length: 50 foot **Distance of Haul: 35 meters**	**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 Present 1 – up to 25% 2 – 26%-50% 3 – 51%-75% 4 – 76%-100%	**SAV Species Present:** **1.** **2.** **Circle Dominant Species**	**Bottom Type** **1.** **2.** **SAV not an option**	**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
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
N/A if only one type

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
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% ≡ 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
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
Credit card

List species collected for vouchers & quantities

21 L Bucket Cnt

Comments:

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

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

Appendix 4 MD DNR Coastal Bays SAV 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

Appendix 5. Maryland DNR Offshore Trawl Survey

Date	Boat	Boat length (ft)	Captain		Collector
Set	Net codend mesh	Net body mesh	Head rope width	Foot rope width	Weather

Start time	End time	Sub-sample volume 1000 liters	Water Temp (C)	* If all individuals of a species are measured instead of sub-sampled, please circle the species name and put a check mark next to the species name.
	Lat start	Depth start	Depth end	
	Lat stop			
	Long start	Sub-sample percentage of catch	Wind Dir & Speed (knots)	
	Long stop			

Draw line separating ♂ and ♀ crabs. Start females in the right column and work towards the middle. I for Immature

♂ Horseshoe crabs 0142 ♀ Horseshoe crabs

Counts

Total

Draw line separating ♂ and ♀ crabs. Start females in the right column and work towards the middle, start males on the left.

♂ Blue Crabs ♀ Blue Crabs

Counts

Place ● next to sook and another ● to indicate with eggs (ex: 60 mm sook with eggs is abbrev. 60●● and sook with no eggs 60● | Total

Spp.					Spp.					Spp.				
Counts				Total	Counts				Total	Counts				Total

Spp.					Spp.					Spp.				
Counts				Total	Counts				Total	Counts				Total

Appendix 5. Maryland DNR Offshore Trawl Survey

Spp.					Spp.					Spp.				
Counts				Total	Counts				Total	Counts				Total

Spp.					Spp.					Spp.				
Counts				Total	Counts				Total	Counts				Total

Spp.					Spp.					Spp.				
Counts				Total	Counts				Total	Counts				Total

Spp. Code & Name	Counts	Total

Comments	**Survey Checklist:** Datasheets/Protocol ID books/Keys Plastic bags/sharpie/labels Measuring boards Digital Camera Live tank/ Sample Buckets Cell Phone Lunch/$H_2 0$ Pencils/ Sharpener