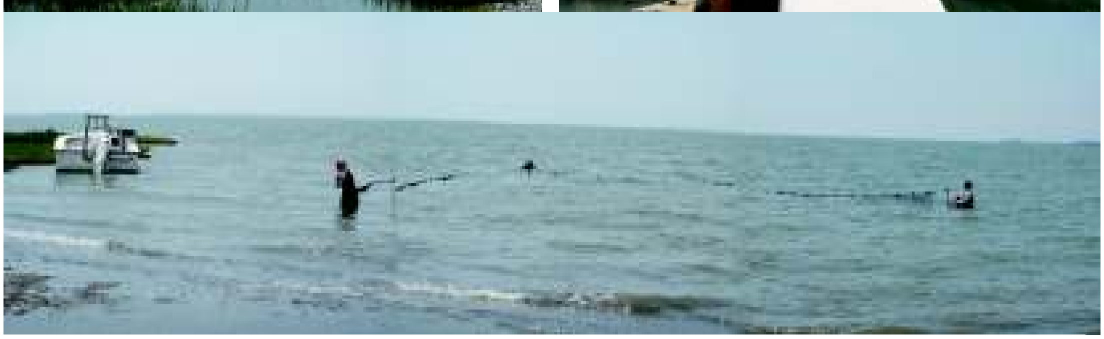
Investigation of Maryland's Coastal Bays and Atlantic Ocean Finfish Stocks

2007 – 2011 Final Report





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Preface

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

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

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

- using a standardized datasheet;
- collecting GPS coordinates at each sample;
- collecting bottom water quality;
- 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 jellyfishes;
- 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 2008, all data from the Trawl, Beach Seine, and Drop Net Surveys were incorporated into a centralized database using .Net technology on an SQL server. The new database was developed by MDNR Information Technology Services staff over a period of two years. Previously, these data were housed in Dbase, MS Excel, or MS Access. During 2009, all data imported into the new CBFI database from 1989 to the present were verified and cleaned using the original field sheets or related transcribed copies from that time. Since 2009, data from 1972, 1985-1988 have also been verified. Species codes were eliminated and common names plus the ITIS scientific name were used to ensure correct species identification.

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.

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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, mollusks, sponges, and macroalgae are common. This report includes data from 1989 – 2011, the final year of the 5-year grant segment.

Over 130 adult and juvenile species of fishes, 26 molluscs, and 11 macroalgae have been collected since 1972. This survey was designed to meet the following three objectives:

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

Methods:

Study Area

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

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

The Coastal Bays are separated from the Atlantic Ocean to the east by Fenwick Island (Ocean City) and Assateague Island. Ocean City, Maryland is a heavily developed commercial area and the center of a $2 billion dollar tourism industry catering to approximately 12 million visitors annually (CCMP 2005). Assateague Island is owned by the State of Maryland and the National Park Service (NPS). These entities operate one state (Assateague State Park) and two national parks (Assateague Island National Seashore and

Chincoteague National Wildlife Refuge). These properties have campgrounds, small buildings, dunes, beach front with some Off Road Vehicle (ORV) access, and marshes.

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

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

Data Collection

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

Gears

Trawl

Trawl sampling was conducted at 20 fixed sites throughout Maryland's Coastal Bays on a monthly basis from April through October (Table 1, Figure 1). Sampling gear complications due to an over-abundance of macroalgae necessitated moving trawl site T006 and T001 slightly (around one hundred meters) in order to complete the trawls. With the exception of June and September, samples were taken beginning the third week of the month. Occasionally, weather or mechanical issues required sampling to continue into the next 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 2.8 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.

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, Figure 1). Occasionally, weather or mechanical issues required sampling to continue into the next month.

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. A 15.24 m (50 foot) version of the previously described net was used at site S019 due to it is restricted sampling area. However, some sites necessitated varying this routine to fit the available area and depth. GPS coordinates were taken at the start and stop points as well as an estimated percent of net open.

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

Salinity, water temperature, and DO were taken with a Yellow Springs Instrument (YSI) YSI Pro2030 at two depths, 30 cm (1 foot) below the surface and 30 cm (1 foot) from the bottom, at each trawl site. The YSI cord was marked in 1 ft intervals and the probe had a weight attached to it. The weight was used to keep the probe at the proper depth and as vertical as possible. Chemical data were only taken 30 cm below the surface for each seine site due to the shallow depth (<1.1 m). The YSI was calibrated each week, and the unit was turned on at the beginning of each day and left on from that time until the last site readings were taken.

Water turbidity was measured with a secchi disk. Secchi readings were taken on the shaded side of the boat without the user wearing sunglasses. The secchi disk was lowered into the water until it could not be seen. It was then raised until the black and white pattern could just be seen. The biologist marked the position on the string with their fingers and measured the length of the string to the end of the disk. Both beginning and ending depths for each trawl were read on a depth finder and recorded. At seine sites, depth was estimated by the biologists pulling the seine. Wind speed measurements were acquired using a La Crosse handheld anemometer with digital readout. Measurements were taken facing into the wind. Tidal states were estimated checking the published tide tables for the sampled areas. Difficulties determining tide resulted from inlet influences in Ocean City, MD and Chincoteague, VA and wind driven tidal influences.

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

applicable) of each species were measured and the remainder counted. On occasion, invertebrate species counts were estimated.

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

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

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

Data Analysis

Statistical analyses were conducted on species that historically are most abundant in the trawl and beach seine catch data. Additional species were added to the analyses dependant on their recreational importance and biological significance as forage for adult game fish and indicators of water quality. Species rarely encountered and 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 (1989-2011). That method was adopted by the Atlantic States Marine Fisheries Commission (ASMFC) Striped Bass Technical Committee as the preferred index of relative abundance to model stock status. The mean was calculated using catch per area covered for trawl and catch per haul for seine. The GM was calculated from the $\log_e(x+1)$ transformation of the catch data and presented with 95% Confidence Intervals (CIs; Ricker 1975). The GM and CIs were calculated as the antilog [$\log_e$-mean(x+1)] and antilog [$\log_e$-mean(x+1) $\pm$ standard error * (t value: α=0.05, n-1)], respectively. A geometric grand mean was calculated for the time series (1989-2011) and used as a point estimate for comparison to the annual (2011) 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 the period 1989-2011. A subsequent multiple pairwise comparison of means test (Duncan's Multiple Range Test) was performed to determine differences among sites in 2011. Those results are reported for each species in this chapter. The site or group of sites most abundant were classified as primary sites. Secondary sites were second most abundant. Preferred sites were compared between the preferred sites at the beginning of this report period (2007) and the preferred sites reported in 2011 to examine if there has been a shift in sites used by individual species or groups of species. Those results are discussed later in this chapter.

To summarize macroalgae presence in the CBFI, the number of samples with light, moderate and heavy macroalgae volume was identified. For trawls, ≤5 liters of macroalgae was considered a light load. Loads >5 and ≤69 liters of macroalgae were considered moderate, and loads <69 liters were considered heavy. For seines, ≤5 liters of macroalgae was also considered a light load. Loads >5 and ≤25 liters were considered moderate, and loads >25 liters were considered heavy.

To investigate changes in macroalgae volume over time, analysis of variance (ANOVA) was used to compare total mean macroalgae volume from 2006-2011 by year and month. Duncan's Multiple Range Tests were used to identify years or months with significant differences in macroalgae abundance. Separate trends for red and green macroalgae were also examined using the same process. Significance was determined at p=0.05.

Because red and green macroalgae accounted for at least 97% of total macroalgae captured in trawls and seines from 2006-2011, only red and green macroalgae were included when considering data over this time period. In the rare instances when macroalgae volume was not recorded, those data were not included in analyses.

Results and Discussion:
Finfish were the most abundant taxa captured in the survey. Specifically, they accounted for 28,898 fish caught trawling (8,232 fish) and beach seining (20,666 fish; Table 4) in 2011**.** Collected fishes represented 70 species which is a normal representation of species in a year. This is similar to what was found from 2007 to 2011.

Below average indices were produced in 2011 for Black Sea Bass, Spot, and Summer Flounder in the trawl and seine. Atlantic Croaker, Bay Anchovy, and Weakfish were both average for trawl and below average for seine, which is not unusual as these species are rarely caught in the seine. Nearly all other species of recreational and commercial interest had average indices of abundance.

Crustaceans were the second most abundant taxa captured in this survey. Specifically, they accounted for 18,827 specimens caught trawling (15,332 crustaceans) and beach seining (3,495 crustaceans; Table 6); estimates of these counts are included in the total numbers reported here. Seventeen crustacean species were identified, which is similar to the numbers of crustaceans found between 2007 and 2011.

The third most abundant taxa captured in the survey were molluscs. Specifically, they accounted for 1,958 specimens caught trawling (1,510 molluscs) and beach seining (448 molluscs; Table 6). Molluscs were represented by 20 different species.

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

The numbers of fish and crustaceans species as well as the numbers of individuals found by year have remained relatively stable through the past five years. The number of molluscs and other species has varied a little more than the fish. Mollusc individual numbers are greatly influenced by blue mussels which are sometimes caught in large clumps which affect the overall numbers caught.

Species Results: American Eel (*Anguilla rostrata*)
American Eel were captured in five of 140 trawls (3.6%) and in five of 38 beach seines (13.2%). A total of 39 American Eel were collected in trawl (18 fish) and seine (21 fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). American Eel ranked 30th out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 1.0 fish/hectare and 0.6 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The indices for the 2011 trawl and seine were both equal to the grand mean (Figures 2 and 3). For the past five years American Eel have had stable abundance with no variance from the grand mean. Since 1989, the trawl relative abundance estimates rarely (three years) varied from the grand mean, and the seine relative abundance estimates also rarely (four years) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl site T006 had the highest level of abundance (CPUE) and this location was classified as a primary site (Figure 1, Table 9). Secondary trawl sites included T012 and T015. Beach seine sites S001, S007, and S013 were determined to be primary locations and all remaining beach seine sites were classified as secondary sites (Figure 1, Table 10).

Discussion
The abundance index for trawl and seine were both equivalent to the grand mean (1989-2011). 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 more frequently caught in the trawls at site T006 and were widely dispersed in the seines. T006 is in Turville Creek where MDNR Fisheries Service's Eel Project does an annual elver survey further up the creek from our sampling site. The elver sampling site is located at a fish ladder and prodigious numbers of elvers are captured at this site every year. We attribute the large numbers of elvers being captured at this site to a moderately sized freshwater source close to the ocean inlet. The elvers are probably drawn to this area in search of fresh water in which to grow to adulthood. The two trawl sites where American Eels are listed as secondary preference are also far into creeks and not open water. The large distribution of preferred and secondary 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 2011 recreational American Eel regulations were comprised of a 25 fish creel and a 6 inch minimum size limit (Table 11). Commercial restrictions included a six inch minimum size (Table 12). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Croaker (*Micropogonias undulatus*)
Atlantic Croakers were captured in 26 of 140 trawls (18.6%) and in zero of 38 beach seines (0%). A total of 450 juvenile Atlantic Croakers were collected in trawls conducted on Maryland's Coastal Bays in 2011 (Table 4). Atlantic Croakers ranked 6th out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 25.6 fish/hectare and 0 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The 2011 trawl index was equal to the grand mean and the seine index was below the grand mean (Figures 4 and 5). Over the past five years Atlantic Croakers have had four years of average abundance, and one year of below average abundance in the trawl portion of the survey. Atlantic Croakers have had below average abundance for the past five years in the seine portion of the survey. Since 1989, the trawl relative abundance estimates frequently (12 years) varied from the grand mean, although 2011 was in the middle of the range of historical values therefore was a more typical year for abundance.

Duncan's Multiple Range Test indicated that trawl site T001, T002, T004, T005, T012, and T014 had the highest level of abundance (CPUE) and these locations were classified as a primary sites (Figure 1, Table 9). Secondary trawl sites included T003 and T011. Seine sites are not included in this discussion because Atlantic Croaker are seldom caught in beach seines.

Discussion
The abundance index for trawl was equal to the grand mean. 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 (Murdy *et al* 1997).

Juvenile Atlantic Croakers were more frequently caught in deeper water (trawl). Therefore, trawl indices better represent a more accurate picture of changes in relative abundance when compared to beach seine indices. Atlantic Croaker juveniles were most abundant later in the season in 2011.

Primary and secondary trawl and sites for Atlantic Croakers were located in the relatively protected areas of Assawoman Bay, the St. Martins River, and Newport Bay. Juvenile Atlantic Croakers seem to prefer the deeper sheltered coves and creeks, and share a similar pattern of distribution to Spot and Summer Flounder. Atlantic Croaker is a known prey item for Summer Flounder, and may explain the co-occurrence of these species (Latour, 2008).

Management
Atlantic Croakers are managed by the State of Maryland in cooperation with Atlantic States Marine Fisheries Commission (ASMFC). Maryland's 2011 recreational Atlantic Croaker regulations were comprised of a 25 fish creel and a 9 inch minimum size limit (Table 11). Commercial restrictions included a 9 inch minimum size and a season of March 16 through December 31 (Table 12). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Menhaden (*Brevoortia tyrannus*)
Atlantic Menhaden were captured in 11 of 140 trawls (7.9%) and in 14 of 38 beach seines (36.8%). A total of 15,826 Atlantic Menhaden were collected in trawl (62 fish) and beach seine (15,764 fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Atlantic Menhaden ranked first out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 3.5 fish/hectare and 414.8 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CI of the GM indices of relative abundance were compared. The 2011 trawl and seine data were equal to the standardized grand mean (Figures 6 and 7). Atlantic Menhaden have had below average abundance once in the past five years in trawl and average abundance the other four years. In seines Atlantic Menhaden have been average four of the past five years and below average the other year. Since 1989, the trawl and beach seine relative abundance estimates occasionally (nine years each) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl site T005 had the highest level of abundance (CPUE) and was classified as a primary site (Figure 1, Table 9). The secondary trawl site is T006. Beach seine site S019 was determined to be a primary location and S001, S002, S003, S005, S006, S007, S010, S011, S012, S013, S015, and S017 were classified as secondary sites (Figure 1, Table 10).

Discussion
The abundance index for trawl and seine were equal to the grand mean. Atlantic Menhaden were caught more often in near shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices. Significant changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and/or overfishing.

The primary and secondary trawl sites were in protected areas at the head of Turville Creek and the St. Martins River as well as the southern bays. Turville Creek is known to have high nutrient levels and may attract the prey sources of menhaden (Maryland Department of the Environment, 2001). The beach seine primary site for Atlantic Menhaden was located at the drainage ditch seine site on Trappe Creek (S019). Site S019 is likely to have high chlorophyll concentrations, a desirable characteristic for a filter feeder (Wazniak *et al*, 2004). It also had a lower salinity than any other site. Secondary seine sites displayed a geographically wide dispersion indicating preference for shallow water 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 2011. There are no harvest limits for Atlantic Menhaden in the waters of the Atlantic Ocean or Maryland's Coastal Bays; however, a Chesapeake Bay-wide commercial harvest cap of 109,020 metric-tons was implemented in 2006 (Table 12; ASMFC 2006). Monitoring will continue in the CBFI Trawl and Beach Seine Survey. Significant changes to costal management will occur over the next two to three years.

Species Results: Atlantic Silverside (*Menidia menidia*)

Atlantic Silversides were captured in 15 of 140 (10.7%) trawls and in 36 of 38 beach seines (94.7%). A total of 1,938 Atlantic Silversides were collected in trawl (107 fish) and beach seine (1,831 fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Atlantic Silversides ranked 3rd out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 6.1 fish/hectare and 48.2 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CI of the GM indices of relative abundance were compared. The 2011 trawl and seine indices were both equal to the grand mean (Figures 8 and 9). Atlantic Silversides have had average abundance the past five years for trawl and below average abundance for two of the last five years for seine collections.

Duncan's Multiple Range Test indicated that trawl site T006 and T019 had the highest level of abundance (CPUE) and that locations were classified as a primary site (Figure 1, Table 9). Secondary trawl sites included T002, T005 and T008, T009, T010, T013, T015, and T018. Beach seine site S005, S006, S009, and S010, were determined to be primary locations and S001, S003, S004, S007, S008, and S017 were classified as secondary sites (Figure 1, Table 10). Since 1989, the trawl relative abundance estimates never varied from the grand mean and beach seine abundance estimates seldom (four years) varied from the grand mean.

Discussion

The abundance index for trawl and seine were both equal to the grand mean. Significant changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in species composition and habitat type.

Atlantic Silversides were caught more frequently in near-shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices.

Primary and secondary trawl and beach seine sites for 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 of primary and secondary trawl and seine sites were their proximity to land and inlets. They do not seem to prefer large expanses of exposed open water. Atlantic Silversides are know 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 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 83 of 140 trawls (59.3%) and in 18 of 38 beach seines (47.4%). A total of 5,024 bay anchovies were collected in trawl (4,617 fish) and (407 fish) beach seine samples collected in Maryland's Coastal Bays in 2011 (Table 4). Bay anchovies ranked 2nd out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 263.0 fish/hectare and 10.7 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the standardized time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The 2011 trawl index was below the grand mean and the seine index was equal to the grand mean (Figures 10 and 11). Bay Anchovy have had below average abundance two of the past five years, and above average abundance one year of the past five for trawl, and above average abundance for two of the past five years for seine samples. Since 1989, the relative abundance estimates seldom (five years trawl, four years beach seine) varied from the grand means.

Duncan's Multiple Range Test indicated that trawl site T001, T002, T003, T004, T005, T011, T012, T014, T016 and T018 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 1, Table 9). T013 was classified as a secondary trawl site. Beach seine sites S003, S011, S012, S015, S016, and S017 were determined to be primary locations and S006, and S013 were classified as secondary sites (Figure 1, Table 10).

Discussion
The abundance index for trawl was below the grand mean and the seine index was equal to the grand mean. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in species composition and habitat type.

Bay anchovies 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.

Primary and secondary trawl and beach seine sites for bay anchovies were located in Assawoman Bay, Isle of Wight Bay (tributaries), Newport Bay, and Chincoteague Bay. All sites were located on the west side of those coastal bays. The west side is generally marsh land with muddy bottoms. Primary and secondary sites were absent from Sinepuxent Bay and Isle of Wight, which may indicate a preference for slower moving water. Bay anchovies were frequently found in Chincoteague Bay. Bay Anchovies are known to be a preferred forage species for larger game fish and have been found co-occurring with Spot, Summer Flounder, and Weakfish 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 19 of 140 trawls (13.6%) and one of 38 seines (2.6%). A total of 28 juvenile Black Sea Bass were collected in trawl (27 fish) and beach seine (one fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Black Sea Bass were ranked 34th out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 1.5 fish/hectare and <0.1 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The 2011 trawl and beach seine indices were both lower than the standardized grand means (Figures 12 and 13). Black Sea Bass have had below average abundance two of the past five years and above average abundance twice for trawl. Black Sea Bass have had below average abundance two of the past five years, and above average abundance once for seine. Since 1989, the relative abundance estimates frequently (13 years trawl, nine years beach seine) varied from the grand means.

Duncan's Multiple Range Test indicated that trawl site T009 had the highest level of abundance (CPUE) and this location was classified as a primary site (Figure 1, Table 9). Secondary trawl sites included T001, T003, T004, T007, T008, T012, T016, and T020.

Beach seine sites S002. S005, S006, and S010 were determined to be primary locations and S003, S017, and S018 were classified as secondary sites (Figure 1, Table 10).

Discussion

The 2011 trawl and beach seine indices were both lower than the standardized grand means. 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.

Black Sea Bass were caught most often in open-water (trawl) locations in all bays reflecting a wide range of preferred habitats. 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. However, because Black Sea Bass do prefer reef habitat, trawls and seines are not ideal gears to sample Black Sea Bass.

Primary and secondary trawl and beach seine sites for Black Sea Bass, (1989-2011) were located in Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, and Chincoteague Bay. Trawl and seine sites of primary and secondary preference were locations with or near structure such as channels, drop offs, rip rap, or crab pots. 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 2007 and 2008 recreational Black Sea Bass regulations were comprised of a 25 fish creel and a 12 inch minimum size limit with an open season from January 1 to through December 31. Maryland's 2009 recreational Black Sea Bass regulations were comprised of a 25 fish creel and a 12.5 inch minimum size limit with an open season from January 1 through December 31. Maryland's 2010 and 2011 recreational Black Sea Bass regulations were comprised of a 25 fish creel and a 12.5 inch minimum size limit with an open season from May 22 to October 11 and November 1 through December 31 (Table 11). Commercial restrictions included an 11 inch minimum size and required a landing permit with an associated individual fishing quota issued by the State (Table 12). 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 three of 140 trawls (2.1%) and in 16 of 38 beach seines (42.1%). A total of 45 juvenile Bluefish were collected in trawl (three fish) and beach seine (42 fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Bluefish ranked 28th out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.2 fish/hectare and 1.1 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The 2011 trawl and beach seine indices were both equal to the grand means (Figures 14 and 15, respectively). Bluefish have had average abundance all of the past five years for trawl and seine except for 2009 when the abundance was below average for both trawl and seine. Since 1989, the relative abundance estimates occasionally (five years trawl, six years beach seine) varied from the grand means.

Duncan's Multiple Range Test indicated that trawl site T003, T004, T005, had the highest level of abundance (CPUE) and those locations were classified as a primary sites (Figure 1, Table 9). T002 was a secondary trawl site. Beach seine sites S001, S003, S005, and S006 were determined to be primary locations and S002 and S010 were classified as secondary sites (Figure 1, Table 10).

Discussion

The 2011 trawl and beach seine indices were both equal to the grand means. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type.

Bluefish were caught more frequently in near shore (beach seine) locations. Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices.

Primary and secondary trawl and beach seine sites for Bluefish were located in Assawoman Bay, Isle of Wight Bay, and Sinepuxent Bay. Primary and secondary sites were all located north of the Ocean City Inlet with the exception of site S010 which is just south of the inlet. 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 2011 recreational Bluefish regulations were comprised of a 10 fish creel and an 8 inch minimum size limit (Table 11). Commercial restrictions included an eight inch minimum size and no seasonal closures (Table 12). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Spot (*Leiostomus xanthurus*)

Spot were collected in 32 of 140 trawls (22.9%) and 20 of 38 seines (52.6%). A total of 315 Spot were collected in trawl (74 fish) and beach seine (241 fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Spot ranked 9th out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 4.2 fish/hectare and 6.3 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The 2011 trawl index and the beach seine index were both below the grand mean (Figures 16 and 17). Spot have had below average abundance two of the past five years and above average abundance in one of the past five years for trawl. Spot have had below average abundance two of the past five years and above average abundance in one of the past five years for seine. Both trawl and seine indices were above average in 2008. Since 1989, the relative abundance estimates frequently (17 years trawl, 12 years beach seine) varied from the grand means, indicating variability in abundance over the time period.

Duncan's Multiple Range Test indicated that trawl sites T001, T002, T005, T011, and T012 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 1, Table 9). Secondary trawl sites included: T003, T004, T014, T015, T018, and T019. Beach seine sites S007, S012, S013, and S019 were determined to be primary locations and S001, S002, S003, S005, S006, S008, S010, S011, S015, and S017 were classified as secondary sites (Figure 1, Table 10).

Discussion

The 2011 trawl index and the beach seine index were both below the grand mean. 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 caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance.

Primary and secondary trawl and beach seine sites for Spot were located in Assawoman Bay, Isle of Wight Bay (tributaries), Sinepuxent Bay, Newport Bay, and Chincoteague Bay. Spot were widely dispersed in the Coastal Bays as exhibited by a large number of primary and secondary preference sites. 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 72 of 140 trawls (51.0%) and 14 of 38 seines (36.8%). A total of 234 Summer Flounder collected in trawl (212 fish) and beach seine (22 fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Summer Flounder ranked 11th out of 70 species in overall finfish abundance. The trawl and beach seine CPUEs were 12.1 fish/hectare and 0.6 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The 2011 trawl index and the beach seine index were both below the grand mean (Figures 18 and 19, respectively). Summer Flounder have had above average abundances in three of the past five years, and below average abundance for one of the past five years for trawl. Summer Flounder have had below average abundance for two of the past five years for seine. Since 1989, the trawl relative abundance estimates frequently (13 years) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl site T012 had the highest level of abundance (CPUE) and that location was classified as a primary site (Figure 1, Table 9). Secondary trawl sites included: T001, T002, T003, T004, T005, T006, T007, T011, T014, T015, T018, and T019. Beach seine site S012 was the only primary location and S001, S002, S003, S005, S006, S010, S013, S015, and S017 were classified as secondary sites (Figure 1, Table 10).

Discussion

The 2011 trawl index and the beach seine index were both below the grand mean. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in forage species composition and habitat type.

Summer Flounder were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data.

Primary and secondary trawl and beach seine sites were located in Assawoman Bay, tributaries of Isle of Wight Bay, Newport Bay, and Chincoteague Bay. Site T012, the only primary trawl site, was characterized by a muddy bottom, a deep hole, and undeveloped marsh. It is located at the head of Newport Bay and consistently produces the most juvenile Summer Flounder. Primary seine site, S012, was close site T012 in Chincoteague Bay. There were many secondary trawl and seine sites which illustrated the quality of the coastal bays as habitat for Summer Flounder. Lack of preferred sites in Sinepuxent Bay is probably due to the higher current associated with the trawl sites in the bay.

Management

Summer Flounder are managed by the State of Maryland in cooperation with ASMFC and the MAFMC. Maryland's 2011 recreational Summer Flounder regulations were comprised of a 3 fish creel and 18.0 inch minimum size limit. The open season was April 16th through November 30th (Table 11). Commercial restrictions included a 14 inch minimum size for all gears with the exception of hook-and-line which had regulations consistent with recreational measures (Table 12). Permitted fishermen in the Atlantic Ocean and Coastal Bays can harvest 5,000 pounds per day while non-permitted fishermen can land 100 or 50 pounds per day in the Atlantic/Coastal Bays and Chesapeake Bay, respectively. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Tautog (*Tautoga onitis)*
Tautogs were captured in zero of 140 trawls (0%) and in zero of 38 beach seines (0) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Tautogs were not ranked out of 70 species in overall finfish abundance.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The indices for the 2011 trawl and seine were both below the grand mean (Figures 20 and 21). The past five years, Tautog has varied without trend from the grand mean.

Duncan's Multiple Range Test indicated no trawl sites had the highest level of abundance (CPUE) and were classified as a primary or secondary site (Figure 1, Table 9). Beach seine sites S002, S005, S006 and S010 were determined to be primary locations and seine sites S001, S003, S004, S007, and S011 were classified as secondary sites (Figure 1, Table 10).

Discussion
The abundance indices for trawl and seine were both below the grand mean (1989-2011). Sporadic catches indicate that this survey may not be an effective means for determining Tautog juvenile abundance. Juvenile Tautogs prefer submerged aquatic vegetation (SAV), and adult Tautogs prefer structured habitat. The gear used in the CBFI survey, and our survey locations, are not suited to those habitats. However, our survey does indicate a site preference for seine sites in the northern bays, and may be the preferred habitat for Tautog in the Maryland Coastal Bays.

Management
Tautogs are managed by the State of Maryland in cooperation with Atlantic States Marine Fisheries Commission (ASMFC). Maryland's 2011 recreational Tautog regulations were comprised of a 4 fish creel and a 14 inch minimum size limit 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 11). Commercial restrictions are consistent with recreational regulations (Table 12).

In 2011, an update stock assessment was performed that indicated fishing was occurring above the target fishing mortality. The model used for stock assessment was largely based on recreational harvests and does not account for recent increases in Tautog habitat along the Mid-Atlantic. However, there are no biological surveys currently being conducted in our region targeting Tautog.

Species Results: Weakfish (*Cynoscion regalis*)
Weakfish were collected in 36 of 140 trawls (25.70%) and zero of 38 seines (0%). A total of 730 juvenile Weakfish were collected in trawl (730 fish) and beach seine (zero fish) samples conducted on Maryland's Coastal Bays in 2011 (Table 4). Weakfish ranked fifth out of 70

species in overall finfish abundance. The trawl and beach seine CPUEs were 41.6 fish/hectare and 0 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2011 time series grand mean. The point estimate of the time series grand mean was used as an indicator of central tendency of abundance, against which the 95% CIs of the GM indices of relative abundance were compared. The 2011 trawl index was equal to the grand mean and the beach seine index was less than the grand mean (Figures 22 and 23, respectively). Weakfish have had below average abundance for two of the past five years for trawl and below average abundance for three of the past five years for seine. Since 1989, the relative abundance trawl estimates occasionally (seven years) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl sites T001, T002, T003, T004 and T012 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 1, Table 9). The secondary trawl site of greatest abundance was T005. Beach seine sites S003, S015, and S017 were determined to be primary sites and S001, S002, S004, S005, S006, S007, S008, S009, S010, S011, S013, S014, S016, S018 and S019 were classified as secondary sites (Figure 1, Table 10).

Discussion
The 2011 seine index was below the grand mean; changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type. Weakfish were considered depleted but not overfished. The recent declines appear to be due to natural mortality (NEFC 2009).

Weakfish were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data.

Primary and secondary trawl for Weakfish were located in Assawoman Bay and the St. Martins River. Primary and secondary sites were absent from Sinepuxent Bay, which may indicate a preference for slower moving water. Weakfish also showed less preference for sites in Chincoteague Bay.

Management
Weakfish are managed by the State of Maryland in cooperation with ASMFC. Maryland's 2011 recreational Weakfish regulations were comprised of a one fish creel and a 13 inch minimum size limit (Table 11). Commercial regulations in 2011 restricted fisherman to a 12 inch minimum size and included an array of season closures dependant upon the type of gear used and body of water being fished (Table 12). The commercial fishery is managed as a bycatch fishery with a 100 pounds catch limit on the Atlantic coast and a 50 pound limit on the Chesapeake Bay. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Additional Discussion on Habitat Preference by Bay

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

All trawl and seine sites had at least one species that preferred its habitat (primary or secondary classification) in the northern bays (Tables 9 and 10). Several sites distinguished themselves as being primary and secondary sites for a majority of the species examined. Sites T001, T002, T003, T004, T005, S002, S003, S005, and S006 had the greatest diversity of species that preferred these sites (Tables 9 and 10). Many species including Atlantic Croaker, Bay Anchovy, Atlantic Menhaden, Bluefish, Spot, Summer Flounder, and Weakfish showed an affinity to the northern bays (Tables 9 and 10). The combination of the habitat type, forage, tidal current, salinities, and dissolved oxygen make this area desirable for juvenile finfish production.

Sinepuxent Bay

A greater diversity of species preferred the beach seine sites in Sinepuxent compared to the trawl sites (Tables 9 and 10). Seine sites ranged from two to nine species with a primary or secondary designation while trawl sites ranged from zero to two species. Seine site S010 had the greatest species diversity with primary or secondary classifications (nine). It is located in a shallow, muddy, protected cove which is an ideal habitat for juvenile finfish (Atlantic Menhaden, Atlantic Silversides, Black Sea Bass, Summer Flounder, Spot, and Bluefish).

Newport Bay and Chincoteague Bay

Six out of ten trawl sites, and six out of eight seine sites had at least one species with a primary classification in these bays (Tables 9 and 10). Trawl sites ranged from three to nine species with a primary or secondary designation while seine sites had a range of two to nine species. Seine site S017 had the greatest diversity of species that preferred this site (nine), and was a primary or secondary site for every species listed except Bluefish. It is located in a shallow, muddy, protected cove which is an ideal habitat for juvenile finfish (Atlantic Croaker, Atlantic Menhaden, Atlantic Silversides, Bay Anchovy, Black Sea Bass, Spot, Summer Flounder, and Weakfish).

Trawl site T012 in Newport Bay had five species with a primary classification for this site. It is in a narrow channel between two areas of marsh and has always been noted as a popular destination for juvenile Summer Flounder.

Chincoteague Bay had only one species (Bay Anchovy) with primary classification for both trawl and seine (Tables 9 and 10). Spot and Bay Anchovy appear to be the species that most preferred use of Chincoteague Bay as it had the most preferred trawl and seine sites combined. Chincoteague Bay is the furthest from the Ocean City inlet, and many species are not likely to travel that far south from the inlet where there is flushing and a diversity of food sources.

Discussion of preferred site changes from 2007 through 2011

Three changes in preferred sites are most prevalent in the trawl data comparison between 2007 and 2011. Trawl site T006 was dropped as a preferred site for several species including Atlantic Croaker, Bay Anchovy, Black Sea Bass, Bluefish, and Spot. This site has been plagued by large amounts of macroalgae in the trawl samples which may have affected the abundance of these species in this area. The second change was that several species added two or more preferred sites in Chincoteague Bay between 2007 and 2011 including Bay Anchovy, Spot, and Summer Flounder. One other noteworthy change was that Atlantic Silversides added four new preferred sites: three in Sinepuxent Bay and one in Chincoteague Bay.

The seine data did not show as much change between 2007 and 2011 in preferred sites. Atlantic Menhaden added two new preferred sites: one in Assawoman Bay and one in Newport Bay. Atlantic Croaker and Weakfish both added several preferred sites, but this is more likely an artifact of the analysis and the fact that they are seldom, if at all, caught in the seine samples. The even distribution of zero catches makes all sites equally preferred or in this case equally 'not preferred'.

Macroalgae

Results

In the final year of the 5-year segment of the CBFI Trawl and Beach Seine Survey, four of the five taxonomic macroalgae divisions were represented in the catch: red, green, brown and yellow-green (Table 8). However, trawl and seine surveys were both primarily composed of red macroalgae, particularly *Agardhiella* and *Gracilaria* (Figures 24 and 25). Green macroalgae were the second most abundant macroalgae captured by both gear types. The dominant genus of green macroalgae in the trawls was *Ulva* (Figure 24), while *Chaetomorpha*, *Enteromorpha* and *Codium* dominated seines (Figure 25). Using the dominant genera of macroalgae from 2011 to look at the time series 2006 – 2011, *Gracilaria* and *Agardhiella* have dominated the northern bays whereas the southern bays have been diverse in their algal characterizations (Figure 26). For seines, the red algae genera dominate all regions but green algae genera are present in high levels in both Assawoman and Chincoteague Bays (Figure 27).

Of the 140 trawls in 2011, 62.9% (88 sites) had light loads of macroalgae, 27.1% (38 sites) had moderate loads, and 10% (14 sites) had heavy loads (Figure 28). Sites with at least one heavy load of macroalgae in 2011 were T001, T002, T003, T011, T015 and T017. For the 2011 trawl survey, 68.8% of all *Agardhiella* and 79.5% of all *Gracilaria* was captured in Assawoman Bay. Sites T002, T001 and T011 had the most macroalgae, respectively, in the 2011 trawl survey (Figure 29). T006 was moved slightly southwest which resulted in a 22 percent reduction in macroalgae collection based upon historical averages (Figure 30). Of the 38 seines, 68.4% (26 sites) had light loads of macroalgae, 18.4% (7 sites) had moderate loads, and 13.1% (5 sites) had heavy loads (Figure 31). Sites with at least one heavy load of macroalgae in 2011 were S001, S007, S010 and S012. In the 2011 beach seine survey, sites S007, S012 and S001 had the most macroalgae, respectively (Figure 32).

Looking at red and green macroalgae trawl and seine data from 2006 through 2011, macroalgae were most abundant in northern regions, specifically Assawoman Bay and Isle of Wight Bay (Figures 33 and 34). Sites T002, T006 and T001 provided the highest percentages of total abundance of macroalgae over this time, respectively (Figure 35).

Macroalgae in seines were most abundant in Isle of Wight Bay, the St. Martins River and Assawoman Bay (Figures 36 and 37). The three sites with the highest percent of total volume of macroalgae were sites S007, S006 and S001, respectively (Figure 38).

When considering all red and green macroalgae data from trawls, biomass significantly increased in 2008, but remained statistically the same from 2008 through 2011 ($p=0.0439$, Figure 39). There was no significant difference in mean macroalgae volume by month for trawl data for the time period 2006-2011 ($p>0.05$, Figure 40). However, there was significantly less mean macroalgae volume in September and October in the final year of the 5-year segment (Figure 41). From 2006 – 2011, 2010 is the only year that differs significantly in mean macroalgae volume by year for seine data ($p=0.0367$, Figure 42). There was no significant difference in mean macroalgae volume by month for seine data from 2006-2011 ($p>0.05$, Figure 43) or for seine data from 2011 ($p>0.05$, Figure 44). From 2006 – 2011 there has been a significant drop off in green algae production after July ($p=0.0017$, Figure 45).

Discussion

Shifts in macroalgae composition can occur as different genera of macroalgae compete for dominance according to changing physical (water flow, water temperature, turbidity) or biological conditions (e.g. competition with other species). No major shift in macroalgae composition has been observed in Maryland's Coastal Bays since quantification of macroalgae began in 2006. Trawls were primarily composed of red macroalgae; specifically, *Agardhiella* was the most abundant red macroalgae for all years except 2008 and 2011, when *Gracilaria* was dominant. Seines were also primarily composed of red macroalgae, with the exception of 2008 when the seine survey was primarily composed of green macroalgae. This composition of macroalgae is similar to the composition observed by other studies in Maryland and Delaware Coastal Bays in the late nineties (Goshorn et al. 2001, Tyler 2010). In fact, harmful algal blooms of *Gracilaria* were identified in Turville Creek from 1999-2001 (Dennison et al. 2009). In Delaware's coastal bays, a shift from *Agardhiella*, *Gracilaria* and *Ulva* to *Ceramium* was observed in 2008 (Tyler 2010), but no such shift has been observed in Maryland's Coastal Bays.

In the final year of the 5-year segment, most trawls and seines had light loads of macroalgae. The sites with heavy loads were primarily located in the northern regions. The northern regions (Assawoman Bay, Isle of Wight Bay and the St. Martin River) had the highest macroalgae abundances from 2006 through 2011. These northern regions are considered to be more impacted due to commercial and recreational development, including harbors and marinas and a wastewater treatment facility. However in 2011, Assawoman Bay more than doubled its volume of observed macroalgae, while Isle of Wight Bay decreased significantly. Isle of Wight Bay decreased in volume of observed macroalgae potentially due to a shift in location of T006. In addition to the change in volume of observed macroalgae, T006 is no longer a preferred site for five species (Atlantic Croaker, Bay Anchovy, Black Sea Bass, Bluefish and Spot) of fish. These species of fish, or their forage, may depend on the macroalgae for habitat. This could explain the decrease in macroalgae presence correlating with the decrease in fish abundance at the updated location of T006.

The southern regions (Sinepuxent Bay, Chincoteague Bay and Newport Bay) are surrounded by less development and are therefore considered more pristine. However, in the late nineties, Chincoteague and Sinepuxent Bays were among the regions identified as having the highest abundances of macroalgae (Goshorn et al. 2001), and *Chaetomorpha* was extremely dense in Chincoteague Bay from 1999-2001 (Dennison et al. 2009). While this study did not observe the greatest abundances of macroalgae in Chincoteague or Sinepuxent Bays, two sites in Sinepuxent Bay did have heavy loads of macroalgae in 2011 (S010, S012), as did a site in Newport Bay (T011), and two sites in Chincoteague Bay (T015, T017). This survey did not detect unusually large amounts of *Chaetomorpha* in Chincoteague Bay; however, *Chaetomorpha* is still primarily observed in the southern bays, specifically in Chincoteague Bay.

Increases in abundance can be indicative of eutrophication. Temperature is also a limiting factor in macroalgal growth; extreme heat as well as winter temperatures can kill off macroalgae. The algal growth in Maryland's Coastal Bays tend to peak in the early summer months and declines as the temperatures begin to cool. The decrease in macroalgae mean volume seen in the later months of the survey may be attributed to temperature fluctuations.

An increase in macroalgae in the trawl survey was observed in 2008, but abundance has remained constant since then. Macroalgae had a spike in mean volume in 2010 for the beach seine survey, but returned to historic levels in 2011. Previous work in Maryland's Coastal Bays found that macroalgae volume did not differ by season; however, different taxonomic groups were dominant during different seasons (Dennison et al. 2009). Results from the present study agree with this finding; no difference in macroalgae abundance was observed by month, but green macroalgae were present in greater abundances from April through July. This observation is consistent with the sharp declines in *Ulva* (green macroalgae) between June and August in a previous study in Indian River and Rehoboth Bays (Timmons and Price 1996).

Future Goals

Macroalgae are a part of a healthy estuarine ecosystem, and variations in abundance, distribution or composition of macroalgae can be related to natural environmental changes. Macroalgae abundance and composition could play an important role in fish and invertebrate composition and diversity. Several species of fishes (blennies, gobies, sticklebacks, pipefishes and Tautog) have been observed using macroalgae as refuge (Olla *et al.* 1979, Stoner and Livingston 1980, Gore *et al.* 1981, Wilson *et al*. 1990, Sogard and Able 1991, Raposa and Oviatt 2000). Macroalgae also provide habitat and foraging opportunities for several species of decapods (Wilson *et al*. 1990, Sogard and Able 1991). However, macroalgae are not considered an essential habitat for fish because it is variable and ephemeral (Sogard and Able 1991). *Ulva* also produces exudates which can be toxic to Winter Flounder and many invertebrates (Sogard and Able 1991).

An increase in macroalgae abundance or change in composition may be indicative of eutrophication. The conflicting studies on the advantages and disadvantages of macroalgae for nekton warrant further research. Therefore, continued monitoring is necessary to establish long term macroalgae trends in Maryland's Coastal Bays. Future analyses could also consider:

- trends between fish catch and/or species diversity with macroalgae abundance;
- trends in finfish species composition between macroalgae and SAV beds; and
- relationships between macroalgae abundance, distribution and composition and water quality parameters and/or nutrient levels.

Water Quality and Physical Characteristics Results

Temperature

Analysis of the 2011 CBFI Trawl Survey, the last year in the five year grant segment, water quality data beginning in April showed increasing average water temperature through July for Assawoman Bay, St. Martin's River and Chincoteague Bay. All values in Tables 13 and 14 are rounded to one place after the decimal. Water temperature reached its zenith for Sinepuxent and Newport Bays in June. Average temperature remained steady for Newport, dropping only 0.3 degrees in July before again assuming the same temperature for August as in June. After dropping 0.4 degrees for September it then plummeted. Sinepuxent Bay experienced a slight dip in average water temperature for July followed by one last spike in August. Isle of Wight Bay witnessed the highest recorded temperature for that system in August at 28.3 C (Figure 46 and Table 13). There was a 2.3 degree difference between Sinepuxent Bay with the lowest seasonal average water temperature at 21.2 C and Newport Bay, which returned an overall average of 23.4 C. When the temperatures of all bays were combined across the seven months comprising the survey for each of the past five sampling seasons, the resultant measure is referred to as the overall temperature average per year. The highest overall temperature average occurred in 2011 (22.4 C) and the lowest occurred in 2007 (21.4 C).

The June 2011 seine sites temperature range was 4.1 C (23.6 C to 27.7 C; Table 14). Three months later in September of 2011, the range was more expansive at 8 C (19.6 C to 27.6 C). In 2011, the temperature range changed by 3.9 C from June to September. For 2010, the temperature range changed by 5.1 C from June to September as evidenced by this set of values: 20.9 C to 24.9 C.

The overall temperature average for all the bays in 2011 (including the St. Martin's River) during June was 25.5 C which was slightly warmer than two of the previous four June sampling rounds. The years 2010 (27.8 C) and 2008 (26.5 C) were higher. For September, this overall average dropped to just 24.4 C. The overall average for September (24.4 C) was slightly warmer than four of the past sampling seasons.

The warmest regions judging by overall average temperature during the course of this five year period were Chincoteague Bay (22.6 C), St. Martin's River (22.3 C) and Newport Bay (22.3 C). Overall average temperatures for Assawoman, Isle of Wight and Sinepuxent Bays were 21.6 C, 21.5 C, and 20.8 C. Temperature fluctuation has not been immense among these bodies of water. Sinepuxent had the least change over the years in temperature with 0.9 C. This was closely followed by Chincoteague at 1.1 C. Assawoman, St. Martins, Isle of Wight and Newport experienced the most temperature change over the years with a difference of 1.5 C, 1.7 C, 1.9 C and 2.0 C. The highest water temperatures for the past five years were recorded in 2007 at T018 during the month of September with both the top and bottom measurements of 35 C.

Dissolved Oxygen

As expected, dissolved oxygen (DO) levels generally decreased as water temperatures increased. During the month of April 2011, the YSI was inoperable when trawl sites were visited in Sinepuxent, Chincoteague and Newport (Table 13). In Assawoman, DO decreased from April to June, leveled off through July, and began to rise through the fall. St. Martins River had its lowest DO in July after which this measurement increased in August. After a slight dip in September, the DO increased. In Isle of Wight Bay, average DO decreased through May and then experienced a slight increase for June. The lowest DO was observed for this bay in July and then it increased through October, despite a small decline in September. DO levels for Sinepuxent were fairly level until dipping in August. This measurement increased in September and then dropped slightly for October. For Newport Bay, DO declined from May to June and then increased slightly for July. Following a plunge to an average DO of 5.9 mg/L in August through September, DO was much higher in October at 8.0 mg/L. Chincoteague Bay experienced very few oscillations in DO going from 6.6 mg/L in May to 6.1 mg/L in August. September returned the lowest value for this bay at 5.6 mg/L. DO was much higher in October (Figures 48-53, Table 13). The range of DO across the water systems was 1.7 mg/L to 9.4 mg/L. The DO of 1.7 mg/L was taken on August 16, 2011 at site T005 near bottom.

For 2011, the overall DO average for all bays combined was 6.7mg/L which was notably different than the same measure for 2010 (6.4 mg/L). This metric does not vary much for the past four seasons with 2009 returning the highest overall average DO of 6.8 mg/L and the lowest occurring in both 2008 and 2007 at 6.6 mg/L (trawls).

All bays were very close together in terms of dissolved oxygen measurements. The overall average for five years per bay shows DOs ranging from 6.7 mg/L for Assawoman, Sinepuxent and Isle of Wight bays down to 6.5 mg/L for both Newport Bay and the St. Martin's river. Looking at surface DO over these past five years, Newport and Chincoteague Bay always had a site with the lowest DO at the surface beginning at 4.49 mg/L in July of 2007 (T012, Newport) and ending with 3.66 mg/L for August of 2011 (T015, Chincoteague). Sites T012 and T015 had the lowest surface DO levels for two seasons each. T019 made this list for one season only (2009) with a DO of 3.43 mg/L. Out of the previous five seasons, there were two occasions when site T015 has had the lowest bottom DO ranging from 2.73 mg/L in 2007 to 2.41 mg/L in 2010. Site T005 returned the lowest bottom DOs for 2008 (2.43 mg/L) and 2011 (1.66 mg/L). Site T006 had the lowest bottom DO for 2009 at 1.18 mg/L. The highest levels for DO over five years were recorded in April 2009 at site T006 with 15.8 mg/L at the surface to 16.3 mg/L at bottom. From 2007 to 2011, the lowest DO for seine sites each season has always been measured at S019. The lowest DO (1.25 mg/L) was recorded in June of 2007. This season it was higher at 3.16 mg/L. With the exception of this season, the lowest seine DO observations at this site were beheld in June. The highest DO reading for all seine sites (10.7 mg/L) was recorded in June of 2010 at site S008.

Salinity

Trawling results showed salinity for every bay, excluding Newport where salinity peaked in July, was at its highest in June. Except for the St. Martin River, which had steady levels in salinity through May, all bays experienced a rise in salinity from April (Table 13 and Figure 54). Salinity recorded in the bays varied from 17.1-34.6 ppt. through the year. The St. Martin's River had the lowest average salinity (24.6 ppt) and Chincoteague Bay (29.7 ppt) yielded the highest. The overall salinity average for 2011 was 27.1 ppt. which was the fifth-highest value for that calculation compared with the previous six seasons. During seining, average salinity was always lower in September compared to June at each site. Salinity range was 0.1(S019) to 34.7 ppt.

Considering salinity over the past five seasons, it has varied by 4.4 ppt from the highest overall average of 29.7 ppt (Sinepuxent) down to 25.3 ppt (St. Martin's). Chincoteague had the next highest average salinity at 29.4 ppt, followed by Isle of Wight (27.2 ppt), Assawoman (27.1 ppt) and Newport bays (26.5 ppt). In 2007 site T020 returned the highest salinity readings of 36 ppt for both surface and bottom measurements that were recorded over this five year period. That same season, site S018 also returned the highest salinity for seine sites witnessed over the past five years at 35.7 ppt.

Secchi

Results of Secchi analysis showed variations for turbidity levels from April to October for all systems (Figure 55 and Table 13). For Assawoman Bay, visibility actually increased from April to May, then declined. Turbidity was at its worst for this bay in July with an average visibility of 61.0 cm. In the St. Martins River, turbidity began very low with an average visibility of 95.0 cm and as turbidity increased, average visibility fell to its lowest point (44.0 cm) in July. For Isle of Wight Bay, visibility decreased from April to May, then remained relatively stable from June to August when the amount of suspended particles in the water column reached its maximum of 55.0 cm. From September onward, visibility began to rise in this bay. Sinepuxent Bay experienced a slight increase in visibility from April to May and then turbidity increased, with water clarity reaching its lowest point in June. The level of suspended material in the water column decreased with the arrival of July and turbidity leveled off through August. For the remainder of the sampling season, visibility for this bay declined slightly. Newport Bay experienced an increase in visibility from April to May, after which light penetration fell through July. From August onward, visibility began to rise. Turbidity for Chincoteague Bay worsened from April until the poorest light penetration was reached in July. Visibility increased from August to the end of sampling.

This season the number of times the Secchi disk reached the bottom was examined. During trawling, the disk was reported as encountering the bottom three times out of 140 samples. On two occasions during the day of October 18, the water clarity was such that the instrument bottomed with measurements of 137.16 cm and 91.44 cm. Both areas are reasonably close to one another in Chincoteague Bay (T018 and T019). A few days later on October 21, the disk reached mud at 106.68 cm in Turville Creek.

The number of occurrences (16) with water clarity sufficient enough to view the disk as it encountered substrate was much greater for the seine component of our survey (Figure 57).

This would be expected as depths must be sufficiently shallow to permit wading. The same trend was observed in 2010 where the Secchi reached bottom eleven instances while in 27 cases visibility did not extend to the bottom (Figures 58 and 59).

When Secchi depth was averaged by bay over five years results show Newport Bay as having the most turbid water with an average secchi depth of 55.0 cm observed. Assawoman Bay is the clearest overall with a five year average of 104.2 cm. Out of this five year period, the highest average secchi depth by year (all bays combined) was returned for 2008 (91.8 cm) followed closely by 2009 at 89.5 cm. The most turbid water was observed during 2007 with an average Secchi depth of 72.4 cm. However, it is important to note that secchi depths were not stratified by Bay depths and to more accurately compare secchi depths between bays, more in-depth analyses would need to be completed.

Discussion

Differences in temperature, dissolved oxygen, salinity and turbidity are influenced by the flushing times of these systems. For example, the lower water temperatures observed in Sinepuxent Bay were likely a result of an increased flushing rate based on its close proximity to the Ocean City Inlet (Atlantic Ocean). Lung (1994) presented data from two summers indicating flushing times of 21.1 to 21.3 days for Assawoman Bay and 8.0 to 15.8 days for the St. Martin's River. Flushing rates of the Isle of Wight Bay were reported to be 9.3 to 9.6 days. It was predicted by Prichard (1960) that Chincoteague Bay required 62 days to replace 99 percent of its water. Flushing rates for both Sinepuxent 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 would be relatively fast (more like Isle of Wight) while the flushing rate in Newport Bay would be much longer (more like Chincoteague Bay).

Dissolved oxygen concentrations will be discussed at greater length due its greater impact on fisheries resources. Some of the dissolved oxygen concentrations give rise to the concern that hypoxia is occurring in the Coastal Bays during the summer months. In a report by the Committee on Environmental Natural Resources (2000), hypoxia exists when dissolved oxygen levels can no longer support the majority of life with the DO level for this condition usually set below 2 mg/L. One quarter of the Virginian Provence (the mouth of the Chesapeake Bay north to Cape Cod) suffers exposure to DO concentrations of ≤ 5 mg/L according to Strobel et al. (1995). In this area, hypoxia generally is associated with warmer water and dissolved oxygen can experience a decline between May through October in the southern reaches of the Provence. When temperatures decrease, mixing of top and bottom water levels is permitted, eliminating the hypoxic regions that grew during the summer. The Environmental Protection Agency (EPA) has conducted research to establish DO standards necessary for protection of saltwater organisms in this region. If estuarine organisms in a certain area are exposed constantly to DO levels above 4.8 mg/L (chronic protective value for growth), they are likely not to suffer adverse effects. If a location experiences oxygen levels below 2.3 mg/L, life there is threatened (EPA, 2000).

While some low levels of oxygen were observed, the majority of DO averages for the bays stayed above the 4.8 mg/L level this season (Figure 47 and Table 13). No DO levels for Assawoman Bay ever fell below 4.8 mg/L. Only once did the average for bottom DO fall below 4.8 mg/L for the St. Martin's River's during the sampling months. This occurred in August when a value of 1.66 mg/L (bottom) was returned for site T005 and was the lowest DO for all trawl sites. Isle of Wight Bay had bottom readings of 4.00 mg/L and 4.76 mg/L in July, dragging the bottom average DO to a dismal 4.4 mg/L. Sinepuxent always had average surface and bottom DOs above 4.8, but site T008 provided a surface measure of 4.73mg/L in August. In Newport Bay, the average DO never went below 4.8 mg/L for either surface or bottom, but site T012 returned a value of 4.56 mg/L in August when bottom measurements were collected. Chincoteague Bay managed to return surface and bottom average DOs above the chronic protective value, however, in August Site T015 returned readings of 3.00 mg/L and 3.67 mg/L for bottom and surface DO, respectively. Bottom DO was 3.25 mg/L in September at this same site. Ayers Creek (S019) had the lowest recorded DO (3.16 mg/L on 9/20) for the seine sites (Table 14). The lower DO may be a result of poor flushing as this site is extremely narrow and far up a tributary to Newport Bay.

Research concerning low DO impact on various species was conducted in western Long Island Sound (Howell et al, 1994). Species abundance and diversity suffered noticeable reductions in relation to bottom DO. When bottom DO ranged from 2.9 to 2.0 mg/L, the occurrence of Windowpane Flounder, Butterfish, and Winter Flounder was reduced significantly. As DO decreased, overall total catch per tow and the total species number also decreased. Butterfish, Bluefish, and squid were found to be greatly affected by low DO (hypoxia). Sites where DO is above 3 mg/L can support more fish and other species compared to areas where bottom DO is below this value.

Research has shown that relationships between predator and quarry can also be impacted by reduced DO. Blue Crabs (*Callinectes sapidus*) can leave areas when dissolved oxygen levels reach 3.0 to 4.0 mg/L (moderate hypoxia) thus affording the clam *Mya arenaria* some protection when the major predator is absent. Moderate hypoxia seemed to hold no influence over how deep the clams buried or the degree of siphon protrusion. *M. arenaria* will not only increase the protrusion of its siphon during exposure to extreme hypoxia ($\leq$ 1.5 mg/L), but will also burry to shallower depths in sediment. If this low DO event is reversed quickly, the crabs can migrate back to this region, finding the clams more exposed and vulnerable to predation (Taylor and Eggleston, 2000). This DO information may prove useful to explain changes in abundance of these species as they are encountered in this project.

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Table 1. MDNR Coastal Bays Fisheries Investigation Trawl Site Descriptions.

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

Table 2. MDNR Coastal Bays Fisheries Investigation Beach Seine Site Descriptions.

Site Number	Bay	Site Description	Latitude	Longitude
S001	Assawoman Bay	Cove behind Ocean City Sewage Treatment Plant, 62nd St.	38 23.273	75 04.380
S002	Assawoman Bay	Bayside of marsh at Devil's Island, 95th St.	38 24.749	75 04.264
S003	Assawoman Bay	Small cove, E. side, small sand beach; Sandspit, bayside of Goose Pond	38 24.824	75 06.044
S004	Isle of Wight Bay	N. side, Skimmer Island (AKA NW side, Ocean City Flats)	38 20.259	75 05.299
S005	Isle of Wight Bay	Beach on sandspit N. of Cape Isle of Wight (AKA in cove on marsh spit, E. and S. of mouth of Turville Creek)	38 21.928	75 07.017
S006	Isle of Wight Bay	Beach on W. side of Isle of Wight, St. Martins River (AKA Marshy Cove, W. side of Isle of Wight, N. of Rt. 90 Bridge)	38 23.708	75 06.855
S007	Isle of Wight Bay	Beach, 50th St. (next to Seacrets)	38 22.557	75 04.301
S008	Sinepuxent Bay	Sandy beach, NE side, Assateague Is. Bridge at Nat'l. Seashore	38 14.554	75 08.581
S009	Sinepuxent Bay	Sand beach1/2 mile S. of Inlet on Assateague Island,	38 19.132	75 06.174
S010	Sinepuxent Bay	Grays Cove, in small cove on N. side of Assateague Pointe development's fishing pier	38 17.367	75 07.977
S011	Chincoteague Bay	Cove, 800 yds NW. of Island Pt.	38 13.227	75 12.054
S012	Chincoteague Bay	Beach N. of Handy's Hammock (AKA N. side, mouth of Waterworks Cr.)	38 12.579	75 14.921
S013	Chincoteague Bay	Cove at the mouth of Scarboro Cr.	38 09.340	75 16.426
S014	Chincoteague Bay	SE of the entrance to Inlet Slew	38 08.617	75 11.105
S015	Chincoteague Bay	Narrow sand beach, S. of Figgs Ldg.	38 07.000	75 17.578
S016	Chincoteague Bay	Cove, E. end, Great Bay Marsh (AKA Big Bay Marsh)	38 04.482	75 17.597
S017	Chincoteague Bay	Beach, S. of Riley Cove in Purnell Bay	38 02.162	75 22.190
S018	Chincoteague Bay	Cedar Is., S. side, off Assateague Is.	38 02.038	75 16.619
S019	Chincoteague Bay	Land site - Ayers Cr. At Sinepuxent Rd.	38 18.774	75 09.414

Table 3. Measurement types for fishes and invertebrates captured during the 2011 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, 2011. 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*	15,826	62	15,764	3.5	414.8
Bay Anchovy	*Anchoa mitchilli*	5,024	4,617	407	263.0	10.7
Atlantic Silverside	*Menidia menidia*	1,938	107	1,831	6.1	48.2
Silver Perch	*Bairdiella chrysoura*	1,344	541	803	30.8	21.1
Weakfish	*Cynoscion regalis*	730	730	0	41.6	0
Atlantic Croaker	*Micropogonias undulatus*	450	450	0	25.6	0
Golden Shiner	*Notemigonus crysoleucas*	395	0	395	0	10.4
Naked Goby	*Gobiosoma bosc*	344	341	3	19.4	0.1
Spot	*Leiostomus xanthurus*	315	74	241	4.2	6.3
Winter Flounder	*Pseudopleuronectes americanus*	265	42	223	2.4	5.9
Summer Flounder	*Paralichthys dentatus*	234	212	22	12.1	0.6
Smallmouth Flounder	*Etropus microstomus*	228	220	8	12.5	0.2
Hogchoker	*Trinectes maculatus*	154	137	17	7.8	0.4
Oyster Toadfish	*Opsanus tau*	109	57	52	3.2	1.4
Northern Pipefish	*Syngnathus fuscus*	108	84	24	4.8	0.6
Striped Killifish	*Fundulus majalis*	105	0	105	0	2.8
Mummichog	*Fundulus heteroclitus*	89	8	81	0.5	2.1
Northern Puffer	*Sphoeroides maculatus*	86	69	17	3.9	0.4
Pinfish	*Lagodon rhomboides*	85	3	82	0.2	2.2
Northern Searobin	*Prionotus carolinus*	77	75	2	4.3	0.1
Spotfin Mojarra	*Eucinostomus argenteus*	72	4	68	0.2	1.8
Banded Killifish	*Fundulus diaphanus*	72	1	71	0.1	1.9
Atlantic Needlefish	*Strongylura marina*	64	0	64	0	1.7
Dusky Pipefish	*Syngnathus floridae*	57	53	4	3.0	0.1
Fourspine Stickleback	*Apeltes quadracus*	55	16	39	0.9	1.0
Atlantic Herring	*Clupea harengus harengus*	54	54	0	3.1	0
White Mullet	*Mugil curema*	50	2	48	0.1	1.3
Bluefish	*Pomatomus saltatrix*	45	3	42	0.2	1.1
Striped Mullet	*Mugil cephalus*	40	0	40	0	1.1
American Eel	*Anguilla rostrata*	39	18	21	1.0	0.6
Striped Anchovy	*Anchoa hepsetus*	34	18	16	1.0	0.4
Rainwater Killifish	*Lucania parva*	33	4	29	0.2	0.8
Spotted Hake	*Urophycis regia*	29	29	0	1.7	0

Table 4. List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2011. 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
Black Sea Bass	*Centropristis striata*	28	27	1	1.5	<0.1
Bluegill	*Lepomis macrochirus*	28	0	28	0	0.7
Northern Kingfish	*Menticirrhus saxatilis*	25	21	4	1.2	0.1
Striped Burrfish	*Chilomycterus schoepfii*	25	11	14	0.6	0.4
Southern Kingfish	*Menticirrhus americanus*	23	21	2	1.2	0.1
Green Goby	*Microgobius thalassinus*	22	20	2	1.1	0.1
Striped Cusk-Eel	*Ophidion marginatum*	21	21	0	1.2	0
Striped Blenny	*Chasmodes bosquianus*	20	5	15	0.3	0.4
Gizzard Shad	*Dorosoma cepedianum*	17	10	7	0.6	0.2
Black Drum	*Pogonias cromis*	16	0	16	0	0.4
Rough Silverside	*Membras martinica*	15	0	15	0	0.4
Spotted Seatrout	*Cynoscion nebulosus*	15	0	15	0	0.4
Windowpane Flounder	*Scophthalmus aquosus*	14	14	0	0.8	0
Striped Searobin	*Prionotus evolans*	13	13	0	0.7	0
Butterfish	*Peprilus triacanthus*	9	9	0	0.5	0
Sheepshead	*Archosargus probatocephalus*	8	0	8	0	0.2
Lined Seahorse	*Hippocampus erectus*	7	6	1	0.3	<0.1
Southern Stingray	*Dasyatis americana*	6	3	3	0.2	0.1
Halfbeak	*Hyporhamphus unifasciatus*	4	0	4	0	0.1
Unknown Juvenile Fish	*Unknown Juvenile Fish*	4	4	0	0.2	0
Northern Sennet	*Sphyraena borealis*	3	0	3	0	0.1
Smooth Butterfly Ray	*Gymnura micrura*	3	3	0	0.2	0
Pigfish	*Orthopristis chrysoptera*	3	1	2	0.1	0.1
Striped Bass	*Morone saxatilis*	3	1	2	0.1	0.1
Feather Blenny	*Hypsoblennius hentz*	2	2	0	0.1	0
Pumpkinseed	*Lepomis gibbosus*	2	0	2	0	0.1
Blueback Herring	*Alosa aestivalis*	2	0	2	0	0.1
Sandbar Shark	*Carcharhinus plumbeus*	1	1	0	0.1	0
Smooth Dogfish	*Mustelus canis*	1	1	0	0.1	0
Clearnose Skate	*Raja eglanteria*	1	1	0	0.1	0
Lookdown	*Selene vomer*	1	1	0	0.1	0
Pipefishes	*Gasterosteiformes*	1	1	0	0.1	0

Table 4 (con't). List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2011. 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**
Inshore Lizardfish	*Synodus foetens*	1	1	0	0.1	0
Skilletfish	*Gobiesox strumosus*	1	1	0	0.1	0
Short Bigeye	*Pristigenys alta*	1	1	0	0.1	0
Scup	*Stenotomus chrysops*	1	1	0	0.1	0
Conger Eel	*Conger oceanicus*	1	0	1	0	<0.1
	Total Finfish	**28,898**	**8,232**	**20,666**		

Table 5. List of crustaceans collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2011. 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
Crustacean Species**								
Blue Crab	*Callinectes sapidus*	11,292	9,430	1,862	0		537.1	49.0
Sand Shrimp	*Crangon septemspinosa*	4,994	20	9	4,855	110	277.6	3.1
Grass Shrimp	*Palaemonetes spp.*	2,093	12	19	620	1,442	36.0	38.4
Say Mud Crab	*Dyspanopeus sayi*	182	173	9			9.9	0.2
Long-Clawed Hermit Crab	*Pagurus longicarpus*	81	57	24			3.2	0.6
Barnacle Infraclass	*Cirripedia*	25	25				1.4	
Lady Crab	*Ovalipes ocellatus*	54	44	10			2.5	0.3
Brown Shrimp	*Farfantepenaeus aztecus*	41	32	9			1.8	0.2
Iridescent Swimming Crab	*Portunis gibbesii*	38	38	0			2.2	
Atlantic Rock Crab	*Cancer irroratus*	7	7	0			0.4	
Flat-Clawed Hermit Crab	*Pagurus pollicaris*	7	6	1			0.3	<0.1
Mantis Shrimp	*Squilla empusa*	5	5	0			0.3	
Nine-Spined Spider Crab	*Libinia emarginata*	4	4	0			0.2	
White Shrimp	*Litopenaeus setiferus*	1	1	0			0.1	0.1
Lesser Blue Crab	*Callinectes similis*	1	1	0			0.1	
Unknown Crustacean	*Unknown crustacean*	1	1	0			0.1	
Hermit Crab	*Pagurus*	1	1	0			0.1	
	Total Crustaceans	**18,827**	**9,857**	**1,943**	**5,475**	**1,552**		

** CPUE was calculated only for number collected (T and S) but not for estimated counts, specific volumes, or estimated volumes.

Table 6. List of crustaceans and molluscs collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2011. 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)	Est. Cnt (T)	Est. Cnt (S)	Total Spec. Vol. (S)	CPUE Vol.	CPUE (T) #/Hect.	CPUE (S) #/Haul
Mollusc Species**										
Convex Slipper Shell	*Crepidula convexa*	907	377		130	400			28.9	10.5
Blue Mussel	*Mytilus edulis*	502	2		500				28.6	
Atlantic Brief Squid	*Lolliguncula brevis*	242	240	2					13.7	0.1
Solitary Glassy Bubble Snail	*Haminoea solitaria*	170			170				9.7	
Eastern Mud Snail	*Nassarius obsoletus*	45	5	40					0.3	1.1
Common Atlantic Slipper Shell	*Crepidula fornicata*	26	26						1.5	
Eastern White Slippersnail	*Crepidula plana*	16	16						0.9	
Bruised Nassa	*Nassarius vibex*	12	9	3					0.5	0.1
Lemon Drop Nudibranch	*Doriopsilla pharpa*	11	11						0.6	
Dwarf Surfclam	*Mulinia lateralis*	8	8						0.5	
Thick-Lipped Oyster Drill	*Eupleura caudata*	5	4	1					0.2	<0.1
Common Jingle Shell	*Anomia simplex*	4	4						0.2	
Atlantic Surfclam	*Spisula solidissima*	2	2						0.1	
Northern Quahog	*Mercenaria mercenaria*	2	2						0.1	
Atlantic Oyster Drill	*Urosalpinx cinerea*	1	1						0.1	
Blood Ark	*Anadara ovalis*	1	1						0.1	
Channeled Whelk	*Busycotypus canaliculatus*	1	1						0.1	
Striped Nudibranch	*Cratena pilata*	1	1						0.1	
Ribbed Mussel	*Geukensia demissa*	1		1						<0.1
Stout Tagelus	*Tagelus plebeius*	1		1						<0.1
Squid Family–Egg Mass	*Loliginidae*						0.2	<0.1		
	Total Molluscs	**1,958**	**710**	**48**	**800**	**400**	**0.2**			

** CPUE was calculated only for number collected (T and S) but not for estimated counts, specific volumes, or estimated volumes.

Table 7. List of other species collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2011. 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*	2,077	42		2,035		0.8				118.3		<0.1	
Sea Walnut	*Mnemiopsis leidyi*	924	1		923						52.6			
Comb Jelly	*Ctenophora sp.*	350			350		210.1		32.5		19.9		13.8	
Sea Nettle	*Chrysaora quinquecirrha*	192	17		175		23.8		44		10.9		3.9	
Hairy Sea Cucumber	*Sclerodactyla briareus*	121	121								6.9			
Forbes Asterias Star	*Asterias forbesi*	24	24								1.4			
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	20	8	12							0.5	0.3		
Horseshoe Crab	*Limulus polyphemus*	16	16								0.9			
Moon Jelly	*Aurelia aurita*	6	6								0.3			
Rubbery Bryozoan	*Alcyonidium sp.*	3	3				144.9				0.2		8.3	
Thyonella gemmata	*Thyonella gemmata*	1	1								0.1			
Halichondria Sponge	*Halichondria*	2	2				194.1	7.0			0.1		11.1	0.2
Lions Mane	*Cyanea capillata*	1	1								0.1			
Sea Anemone Order	*Actiniaria*	1	1								0.1			

Table 7 (con't). List of other species collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2011. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	Scientific Name	Total No. Collect	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.
Cannonball Jellyfish	*Stomolophus meleagris*	1	1								0.1			
Bryozoans	*Ectoprocta*	1	1				454.8		0.1		0.1		25.9	
Sea Pork	*Aplidium sp.*	1	1				131.2				0.1		7.5	
Fig Sponge	*Suberites ficus*						100.1						5.7	
Red Beard Sponge	*Microciona prolifera*						49.6	1.1					2.8	<0.1
Golden Star Tunicate	*Botryllus schlosseri*						29.9						1.7	
Sulphur Sponge	*Cliona celata*						12.9						0.7	
Serpulid Worms	*Hydroides dianthus*						3.12						0.1	
	Total Other	**3,741**	**246**	**12**	**3,483**		**1,355.3**	**8.1**	**76.6**					

** CPUE was calculated only for number collected (T and S) but not for estimated counts.

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, 2011. 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)	CPUE (T) #/Hect Vol.	CPUE (S) #Haul Vol.
SAV							
Eel Grass	*Zostera*	13.2	29.2			0.8	0.8
Widgeon Grass	*Ruppia*	1.9	2.6			0.1	<0.1
	Total SAV	**15.1**	**31.8**				
Macroalgae							
Brown							
Sour Weeds	*Desmarestia*	42.3	0.1			2.4	<0.1
Common Southern Kelp	*Laminaria*	11.8				0.7	
		54.1	**0.1**				
Green							
Sea Lettuce	*Ulva*	282.0	15.5	26.6		17.8	0.4
Green Hair Algae	*Chaetomorpha*	46.7	50.3			2.7	1.3
Hollow Green Weeds	*Enteromorpha*	16.8	35.2	7.1		1.4	0.9
Green Fleece	*Codium*	3.8	21.0			0.2	0.6
Green Sea fern	*Bryopsis*	0.2				<0.1	
Green Tufted Seaweed	*Cladophora*	9.2	5.3			0.5	0.1
		358.7	**127.3**	**33.7**			
Red							
Graceful Red Weed	*Gracilaria*	1696.5	50.0	1855.8		205.4	1.3
Agardh's Red Weed	*Agardhiella*	1585.2	453.9	961.4		147.2	11.9
Tubed Weeds	*Polysiphonia*	147.9	4.6	35.5		10.6	0.1
Barrel Weed	*Champia*	36.4	1.6			2.1	<0.1
Banded Weeds	*Ceramium*	19.8	15.5			1.1	0.4
Hairy Basket Weed	*Spyridia*	4.2	55.2			0.2	1.5
Hooked Red Weed	*Hypnea*	1.4				0.1	
		3491.4	**580.8**	**2852.7**			
Yellow-Green							
Water Felt	*Vaucheria*	28.0	37.9			1.6	1.0
		28.0	**37.9**				
Unknown							
Unknown	*Unknown*	31.0	3.6				
		31.0	**3.6**				
	Total Macroalgae	**3,963.2**	**749.7**	**2886.4**			

Table 9. Coastal Bays Fisheries Investigations 1989-2011 Primary and Secondary Trawl Species Site Preferences Based on Duncan's General Linear Model Procedure, sampled sites = 140/year.

	Assawoman Bay			**St. Martins River**		**Isle of Wight**		**Sinepuxent Bay**			**Newport Bay**		**Chincoteague Bay**							
	T001	T002	T003	T004	T005	T006	T007	T008	T009	T010	T011	T012	T013	T014	T015	T016	T017	T018	T019	T020
American Eel						1						2			2					
Atlantic Croaker	1	1	2	1	1						2	1		1						
Atlantic Menhaden					1	2														
Atlantic Silverside		2			2	1		2	2	2			2		2			2	1	
Bay Anchovy	1	1	1	1	1						1	1	2	1		1		1		
Black Sea Bass	2		2	2			2	2	1			2				2				2
Bluefish		2	1	1	1															
Spot	1	1	2	2	1						1	1		2	2			2	2	
Summer Flounder	2	2	2	2	2	2	2				2	1		2	2			2	2	
Tautog																				
Weakfish	1	1	1	1	2							1								

Table 10. Coastal Bays Fisheries Investigations 1989-2011 Primary and Secondary Seine Species Site Preferences Based on Duncan's General Linear Model Procedure, sampled sites = 38/year.

	Assawoman Bay			**Isle of Wight**		**St. Martins River**	**IOW**	**Sinepuxent Bay**			**Newport Bay**		**Chincoteague Bay**						**Drainage Ditch**
	S001	S002	S003	S004	S005	S006	S007	S008	S009	S010	S011	S012	S013	S014	S015	S016	S017	S018	S019
American Eel	1	2	2	2	2	2	1	2	2	2	2	2	1	2	2	2	2	2	2
Atlantic Croaker		2	2	2	2	1				2		1			2		2		
Atlantic Menhaden	2	2	2		2	2	2			2	2	2	2		2		2		1
Atlantic Silverside	2		2	2	1	1	2	2	1	1							2		
Bay Anchovy			1			2					1	1	2		1	1	1		
Black Sea Bass		1	2		1	1				1							2	2	
Bluefish	1	2	1		1	1				2									
Spot	2	2	2		2	2	1	2		2	2	1	1		2		2		1
Summer Flounder	2	2	2		2	2				2		1	2		2		2		
Tautog	2	1	2	2	1	1	2			1	2								
Weakfish	2	2	1	2	2	2	2	2	2	2	2		2	2	1	2	1	2	2

Table 11. Summary of Maryland Recreational Regulations for 2011.

Species	Area	Minimum Size Limit (inches)	Creel (person/day)	Season
American Eel	A	6	25	Open Year Round
Atlantic Croaker	A	9	25	Open Year Round
Black Sea Bass	A	12.5	25	May 22 thru Oct. 11 Nov. 1 thru Dec. 31
Black Drum	A	16	1 6/boat	Open Year Round
Bluefish	A	8	10	Open Year Round
Summer Flounder	A	18	3	April 16 thru November 30
Tautog	A	14	4 2	Jan 1 thru May 15 and Nov 1 thru Nov 30 May 16 thru Oct 31
Red Drum	A	18 to 27	1	Open Year Round
Speckled Trout	A	14	10	Open Year Round
Weakfish	A	13	1	Open Year Round

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

Table 12. Summary of Maryland Commercial Regulations for 2011.

Species	Area	Size (inches) gear	Commercial Season, Days, Times, & Area Restrictions	Special Conditions/Comments
American Eel	A	6	Open Year Round	25/person/day<6" If pot mesh < ½" x ½", escape panel required
Atlantic Croaker	A	9 Seine, Trotline, Pot, Trap, Net, Hook & Line	Mar 16-Dec 31	Closed Jan 1-Mar 15
Atlantic Menhaden	A	None	None	Harvest cap of 109,020 metric-tons
Black Sea Bass	A	11 Trawl, Pot, Trap Bay-No Trawl	Landing Permit Required Open Year Round	Individual IFQ issued. Individual without a landing permit: 50 lbs.
Black Drum	B		No commercial harvest in Bay	
Black Drum	C	16 Line, Net, Pot, Trap, Trotline, Seine	1,500 lbs. Open Year Round	May only land Black Drum from waters of the Atlantic Ocean, not including Coastal Bays
Bluefish	A	8 Hook & Line, Pot, Trotline, Net	Open Year Round	
Summer Flounder	C	14 Net, Pot, Trap, Trotline, Seine	Bycatch fishery closed December 10	IFQ issued Without a permit:100 lbs/day
		18 Hook & Line	April 16 thru November 30	
Summer Flounder	B	14 Net, Pot, Trap, Trotline, Seine	Bycatch fishery closed December 10	IFQ issued Without a permit: 50 lbs/day
		18 Hook & Line	April 16 thru November 30	
Tautog Jan 1 - May 15 & Nov 1 - Nov 30	A	14 Hook, Line, Net, Pot, Trap, Trotline, Seine	4	December closed
Tautog May 16 - Oct 31	A	14 Hook, Line, Net, Pot, Trap, Trotline, Seine	2	December closed

Table 12 (con't). Summary of Maryland Commercial Regulations for 2011.

Species	Area	Size (inches) gear	Commercial Season, Days, Times, & Area Restrictions	Special Conditions/Comments
Weakfish	B	12 Hook & Line	Aug. 1 thru Sep. 30 50 lbs. trip or daily limit. No bycatch allowed outside season.	The weight of the catch of the other species on board the vessel cannot be exceeded by weight of weakfish.
Weakfish	C	12 Trawl, Net, Pot, Trap, Trotline, Seine	Aug. 1 thru Sep. 30 100 lbs. trip of daily limit	The weight of the catch of the other species on board the vessel cannot be exceeded by weight of weakfish.

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

B- Includes Chesapeake Bay & all tributaries

C- Includes Atlantic Ocean & Coastal Bays

Table 13. Coastal Bays Fisheries Investigations 2011 water quality data collected during trawl sampling. Mean values are reported with the range in parentheses.

Parameter	Location	April	May	June	July	August	September	October
Assawoman Bay (Sites: T001, T002, and T003)								
Temp (°C)	Surface:	15.9	19.8	24.4	27.4	25.5	24.1	17.0
		(15.8-16.0)	(19.5-20.0)	(24.0-24.7)	(27.1-27.9)	(25.4-25.6)	(19.8-26.4)	(16.4-17.5)
	Bottom:	15.8	19.8	24.5	26.8	24.7	24.0	16.9
		(15.8-16.0)	(19.5-20.0)	(24.4-24.8)	(26.7-26.8)	(23.1-25.5)	(19.8-26.2)	(16.5-17.2)
DO (mg/L)	Surface:	8.1	6.5	5.7	6.1	6.3	6.9	8.1
		(7.9-8.2)	(6.2-6.7)	(5.2-6.4)	(5.8-6.4)	(5.3-7.1)	(6.0-7.6)	(7.9-8.2)
	Bottom:	8.0	6.4	5.6	5.3	6.8	6.7	7.8
		(7.9-8.1)	(6.2-6.7)	(5.0-6.3)	(5.0-5.5)	(5.5-8.5)	(6.0-7.6)	(7.5-7.9)
Salinity (ppt)	Surface:	25.5	27.1	29.6	28.5	26.0	23.9	23.5
		(24.4-26.9)	(26.2-28.3)	(29.0-30.1)	(28.2-28.7)	(25.2-27.3)	(23.3-24.3)	(23.0-24.2)
	Bottom:	25.3	27.3	29.6	28.6	26.1	24.1	23.8
		(23.6-27.0)	(26.8-28.3)	(29.1-30.0)	(28.3-28.7)	(25.2-27.3)	(23.3-24.6)	(23.3-24.3)
Secchi (cm)		102.3	128.7	109.3	61.0	76.0	72.0	98.7
		(62.0-125.0)	(78.0-183.0)	(54.0-188.0)	(56.0-64.0)	(65.0-94.0)	(71.0-74.0)	(65.0-118.0)
Saint Martins River (Sites: T004 and T005)								
Temp (°C)	Surface:	17.9	21.6	25.3	27.9	27.1	23.0	17.0
		(17.1-18.6)	(20.9-22.3)	(24.7-25.9)	(27.3-28.4)	(26.5-27.6)	(22.6-23.3)	(16.8-17.1)
	Bottom:	17.3	21.2	25.1	27.6	26.6	23.0	17.0
		(16.8-17.8)	(20.6-21.7)	(24.7-25.4)	(27.0-28.2)	(26.2-26.9)	(22.6-23.3)	(16.8-17.1)
DO (mg/L)	Surface:	8.6	6.3	5.8	6.0	8.1	5.8	8.0
		(8.5-8.8)	(6.1-6.5)	(5.7-5.9)	(5.7-6.3)	(7.9-8.3)	(5.4-6.3)	(7.8-8.1)
	Bottom:	7.9	6.2	5.6	5.1	4.3	5.8	7.9
		(7.6-8.2)	(5.7-6.7)	(5.2-5.9)	(5.0-5.1)	(1.7-6.8)	(5.2-6.3)	(7.8-8.0)
Salinity (ppt)	Surface:	24.4	25.1	27.4	26.9	23.2	22.5	21.7
		(22.0-26.7)	(23.2-27.0)	(25.7-29.0)	(25.3-28.4)	(21.3-25.0)	(20.1-24.9)	(20.3-23.0)
	Bottom:	25.0	24.4	27.5	27.0	24.8	22.5	21.7
		(23.3-26.7)	(21.7-27.0)	(25.9-29.0)	(25.3-28.6)	(24.1-25.5)	(20.1-24.9)	(20.3-23.0)
Secchi (cm)		95.0	92.5	55.5	44.0	59.5	62.5	99.5
		(80.0-110.0)	(85.0-100.0)	(52.0-59.0)	(38.0-50.0)	(59.0-60.0)	(61.0-64.0)	(89.0-110.0)

Table 13 (con't). Coastal Bays Fisheries Investigations 2011 water quality data collected during trawl sampling. Mean values are reported with the range in parentheses.

Parameter	Location	April	May	June	July	August	September	October
Isle Of Wight Bay (Sites: T006 and T007)								
Temp (°C)	Surface:	16.8 (13.7-19.8)	21.4 (20.5-22.2)	24.5 (22.4-26.6)	27.4 (26.9-27.8)	27.0 (25.7-28.2)	21.4 (19.8-22.9)	16.7 (16.6-16.8)
	Bottom:	16.7 (13.6-19.7)	21.4 (20.5-22.3)	24.0 (22.5-25.4)	24.8 (22.1-27.5)	27.0 (25.6-28.3)	21.4 (19.8-22.9)	16.8 (16.7-16.9)
DO (mg/L)	Surface:	8.5 (8.3-8.7)	6.3 (6.2-6.5)	7.2 (5.6-8.7)	5.9 (5.3-6.5)	7.4 (6.3-8.5)	6.7 (6.0-7.4)	8.5 (7.8-9.1)
	Bottom:	8.2 (7.7-8.6)	6.2 (5.8-6.6)	6.8 (4.9-8.6)	4.4 (4.0-4.8)	7.1 (6.1-8.1)	6.8 (6.2-7.4)	8.3 (7.8-8.9)
Salinity (ppt)	Surface:	26.3 (23.9-28.7)	27.1 (25.5-28.6)	29.5 (28.9-30.0)	27.6 (26.7-28.5)	24.3 (21.3-27.2)	24.0 (23.4-24.6)	23.4 (21.4-25.3)
	Bottom:	26.5 (24.2-28.7)	27.1 (25.4-28.7)	29.7 (29.3-30.0)	28.0 (26.8-29.1)	24.4 (21.5-27.2)	24.1 (23.5-24.6)	23.4 (21.5-25.3)
Secchi (cm)		115.0 (106.0-124.0)	85.5 (75.0-96.0)	57.0 (50.0-64.0)	59.5 (36.0-83.0)	55.0 (48.0-62.0)	74.5 (71.0-78.0)	125.3 (106.7-144.0)
Sinepuxent Bay (Sites: T008, T009, and T010)								
Temp (°C)	Surface:	14.2 (11.0-17.1)	19.4 (18.2-20.8)	26.3 (26.0-26.5)	24.2 (19.0-27.1)	25.6 (24.7-26.9)	20.8 (20.4-21.0)	17.9 (17.5-18.7)
	Bottom:	14.1 (10.9-17.1)	19.5 (18.3-20.8)	26.3 (26.0-26.5)	24.2 (18.9-27.0)	25.1 (24.1-26.6)	20.8 (20.4-21.0)	17.9 (17.5-18.7)
DO (mg/L)	Surface:	A	6.7 (6.5-7.0)	6.8 (6.0-8.2)	6.8 (6.7-7.0)	5.8 (4.7-6.6)	7.4 (6.9-8.0)	7.2 (6.8-7.6)
	Bottom:	A	7.0 (6.7-7.3)	6.6 (6.0-7.8)	6.9 (6.8-7.0)	6.0 (5.5-6.7)	7.5 (6.9-8.1)	7.0 (6.8-7.1)
Salinity (ppt)	Surface:	26.1 (25.4-26.7)	29.3 (29.3-29.3)	32.1 (31.5-33.2)	31.3 (28.9-32.8)	28.9 (27.0-30.9)	26.1 (23.9-27.3)	27.5 (27.2-27.9)
	Bottom:	26.1 (25.6-26.6)	29.3 (29.2-29.3)	32.2 (31.5-33.3)	31.4 (28.8-32.8)	29.2 (27.9-30.9)	26.2 (23.9-27.4)	27.5 (27.2-27.9)
Secchi (cm)		77.7 (58.0-102.0)	81.7 (59.0-99.0)	64.3 (60.0-68.0)	85.7 (56.0-124.0)	85.7 (72.0-104.0)	79.7 (49.0-127.0)	75.0 (64.0-84.0)

Table 13 (con't). Coastal Bays Fisheries Investigations 2011 water quality data collected during trawl sampling. Mean values are reported with the range in parentheses.

Parameter	Location	April	May	June	July	August	September	October
Newport Bay (Sites: T011 and T012)								
Temp (°C)	Surface:	17.5	20.8	26.8	26.6	27.2	26.5	17.4
		(17.1-17.8)	(20.7-20.9)	(26.6-26.9)	(26.3-26.8)	(26.8-27.6)	(26.4-26.5)	(17.1-17.6)
	Bottom:	21.2	20.8	26.7	26.3	26.3	26.2	16.7
		(17.9-24.5)	(20.7-20.9)	(26.5-26.8)	(26.2-26.4)	(26.1-26.4)	(26.0-26.3)	(16.5-16.8)
DO (mg/L)	Surface:	^{A}	6.3	6.2	6.9	6.5	6.3	8.3
			(5.8-6.9)	(6.0-6.3)	(6.8-7.1)	(6.1-7.0)	(5.6-7.0)	(7.4-9.2)
	Bottom:	^{A}	6.3	6.1	6.5	5.2	5.5	7.7
			(5.8-6.8)	(5.9-6.2)	(6.1-7.0)	(4.6-5.9)	(5.3-5.7)	(6.9-8.5)
Salinity (ppt)	Surface:	22.3	27.7	29.6	30.5	29.3	26.6	24.7
		(20.2-24.4)	(26.6-28.7)	(28.7-30.5)	(29.1-31.8)	(28.0-30.5)	(25.4-27.8)	(22.1-27.2)
	Bottom:	18.8	27.7	29.8	30.8	29.2	26.6	25.2
		(17.1-20.4)	(26.6-28.7)	(28.7-30.8)	(29.2-32.3)	(27.9-30.5)	(25.3-27.8)	(22.9-27.5)
Secchi (cm)		58.5	64.0	52.5	36.5	46.5	65.0	69.5
		(40.0-77.0)	(62.0-66.0)	(39.0-66.0)	(32.0-41.0)	(39.0-54.0)	(51.0-79.0)	(59.0-80.0)
Chincoteague Bay (Sites: T013, T014, T015, T016, T017, T018, T019 and T020)								
Temp (°C)	Surface:	17.4	20.9	25.1	28.2	26.8	26.6	19.0
		(15.4-18.7)	(20.2-21.6)	(24.0-26.0)	(26.2-29.7)	(26.1-27.4)	(25.9-27.4)	(18.5-19.8)
	Bottom:	17.4	20.7^{B}	25.0	28.1	26.3^{B}	26.3	18.7^{B}
		(15.4-18.7)	(20.1-21.7)	(24.1-25.7)	(26.0-29.7)	(26.0-26.6)	(25.8-26.8)	(18.2-19.0)
DO (mg/L)	Surface:	^{A}	6.5	6.4	6.4	6.4	5.9	8.2
			(5.7-7.2)	(5.5-7.6)	(5.2-7.2)	(3.7-7.2)	(4.6-6.8)	(7.2-9.4)
	Bottom:	^{A}	6.6^{B}	6.2	6.3	5.7^{B}	5.2	8.1^{B}
			(6.1-7.1)	(5.0-7.2)	(5.4-7.3)	(3.0-6.6)	(3.3-6.7)	(6.7-9.4)
Salinity (ppt)	Surface:	27.2	30.6	33.3	30.9	30.4	27.7	27.8
		(24.1-29.0)	(29.2-31.4)	(32.5-34.6)	(28.9-33.1)	(29.5-31.7)	(27.1-28.5)	(27.1-28.8)
	Bottom:	27.4	30.5^{B}	33.1	30.9	30.6^{B}	27.8	27.9^{B}
		(24.7-29.0)	(29.2-31.3)	(31.2-34.2)	(28.9-33.1)	(29.5-32.0)	(27.1-28.5)	(27.1-28.8)
Secchi (cm)		112	104.8	60.9	60.0	83.5	87.5	132.7
		(84.0-164.0)	(68.0-205.0)	(51.0-76.0)	(29.0-98.0)	(52.0-166.0)	(59.0-118.0)	(70.0-243.0)

Table 14. Coastal Bays Fisheries Investigations 2011 water quality data collected during seine sampling. Mean values are reported with the range in parentheses.

Parameter	Location	June	September
Assawoman Bay (Sites: S001, S002, and S003)			
Temp (°C)	Surface:	25.2 (24.1-26.1)	26.6 (25.8-27.1)
DO (mg/L)	Surface:	5.8 (4.0-6.9)	6.3 (5.9-6.5)
Salinity (ppt)	Surface:	30.0 (29.7-30.3)	25.7 (24.5-26.6)
Secchi (cm)		85.7 (56.5-106.0)	67.0 (43.0-88.0)
Saint Martins River (Sites: S006)			
Temp (°C)	Surface:	24.4[C]	20.8[C]
DO (mg/L)	Surface:	5.86[C]	7.1[C]
Salinity (ppt)	Surface:	29.6[C]	24.2[C]
Secchi (cm)		46.0[C]	57.0[C]
Isle Of Wight Bay (Sites: S004, S005, and S007)			
Temp (°C)	Surface:	24.4 (23.6-24.9)	22.4 (19.6-25.2)
DO (mg/L)	Surface:	5.4 (4.1-6.2)	6.3 (4.8-7.2)
Salinity (ppt)	Surface:	30.0 (29.7-30.5)	24.5 (22.6-26.5)
Secchi (cm)		82.7 (45.0-124.0)	71.0 (61.0-77.0)
Sinepuxent Bay (Sites: S008, S009, and S010)			
Temp (°C)	Surface:	26.4 (25.2-27.7)	20.5 (20.3-20.6)
DO (mg/L)	Surface:	5.9 (5.6-6.3)	7.5 (6.8-8.0)
Salinity (ppt)	Surface:	33.0 (32.8-33.4)	23.3 (23.2-23.5)
Secchi (cm)		66.3 (42.0-83.0)	73.7 (50.0-89.0)

Table 14 (con't). Coastal Bays Fisheries Investigations 2011 water quality data collected during seine sampling. Mean values are reported with the range in parentheses.

Parameter	Location	June	September
Newport Bay (Sites: S011 and S012)			
Temp (°C)	Surface:	27.3 (27.2-27.3)	26.9 (26.7-27.0)
DO (mg/L)	Surface:	5.8 (4.6-7.0)	6.3 (4.9-7.7)
Salinity (ppt)	Surface:	31.2 (31.1-31.2)	27.4 (26.8-28.0)
Secchi (cm)		31.5 (31.0-32.0)	53.0 (39.0-67.0)
Chincoteague Bay (Sites: S013, S014, S015, S016, S017, S018, S019)			
Temp (°C)	Surface:	25.4 (23.7-27.3)	25.9 (20.3-27.6)
DO (mg/L)	Surface:	6.2 (3.5-8.7)	5.8 (3.2-7.6)
Salinity (ppt)	Surface:	28.1 (0.1-34.7)	24.0 (6.8-28.3)
Secchi (cm)		45.3 (27.0-59.0)	68.6 (44.0-90.0)

A-Due to equipment malfunction, DO measurements were not available for some locations in April.
B-Conditions too shallow at site T019 for bottom water quality to be taken. The bottom measurements and averages are from seven sites instead of eight.
C-One site sampled.

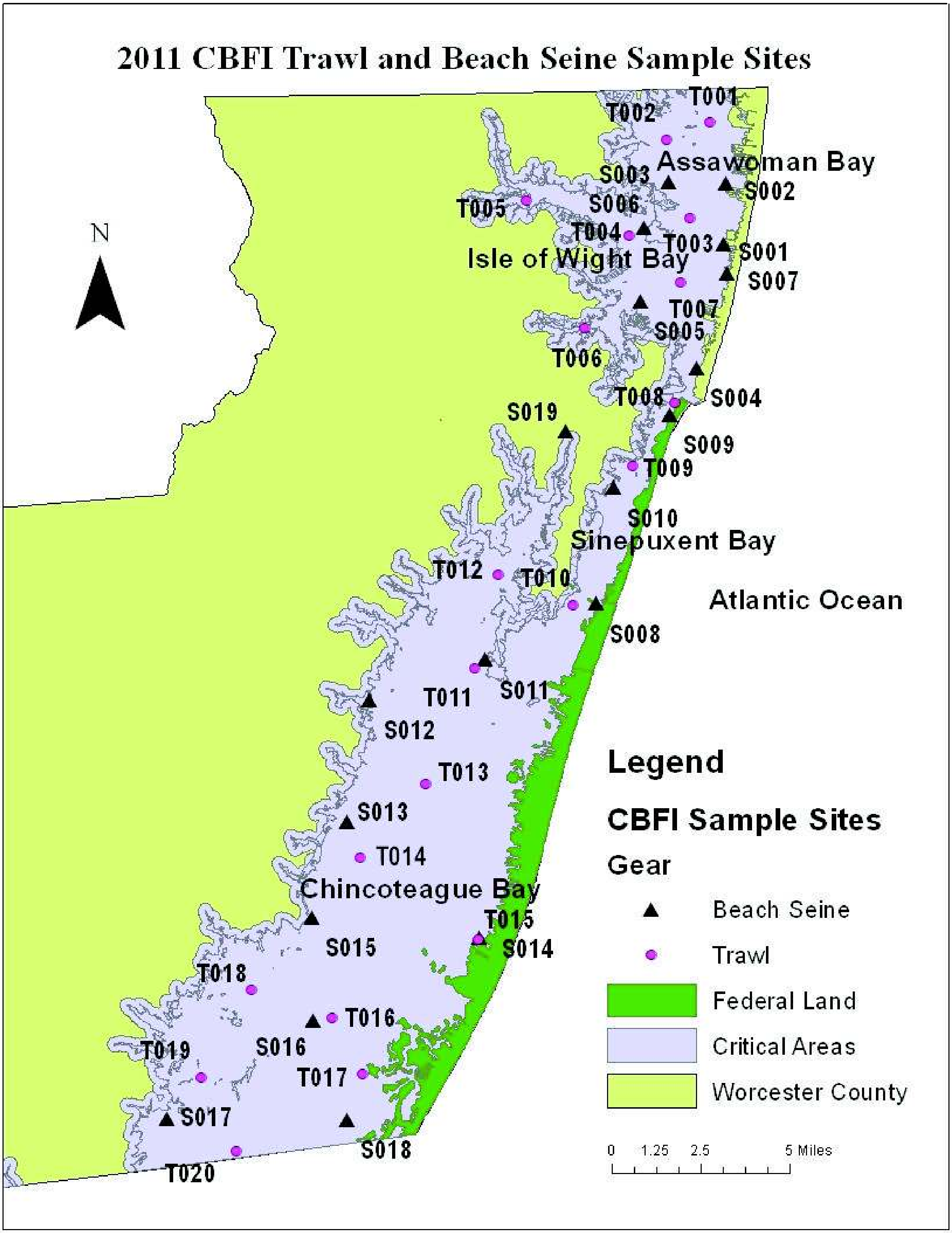

Figure 1. Site locations for the 2011 Coastal Bays Fishery Investigations Trawl and Beach Seine Survey.

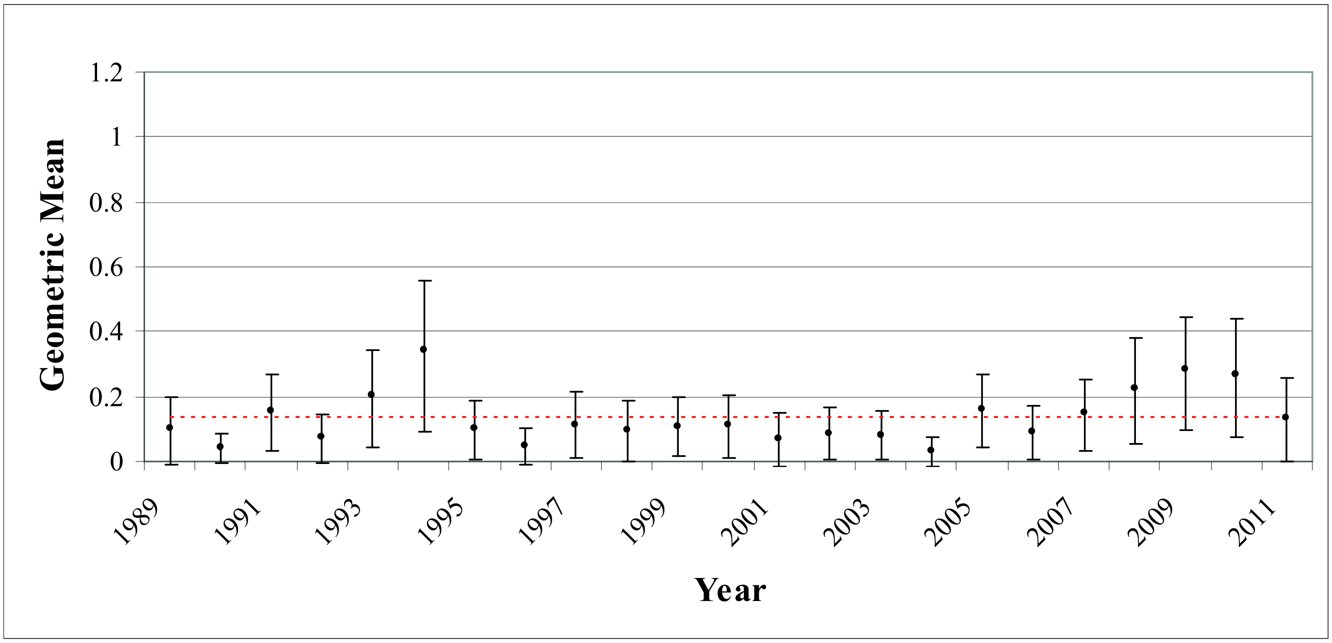

Figure 2. American Eel (*Anguilla rostrata)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

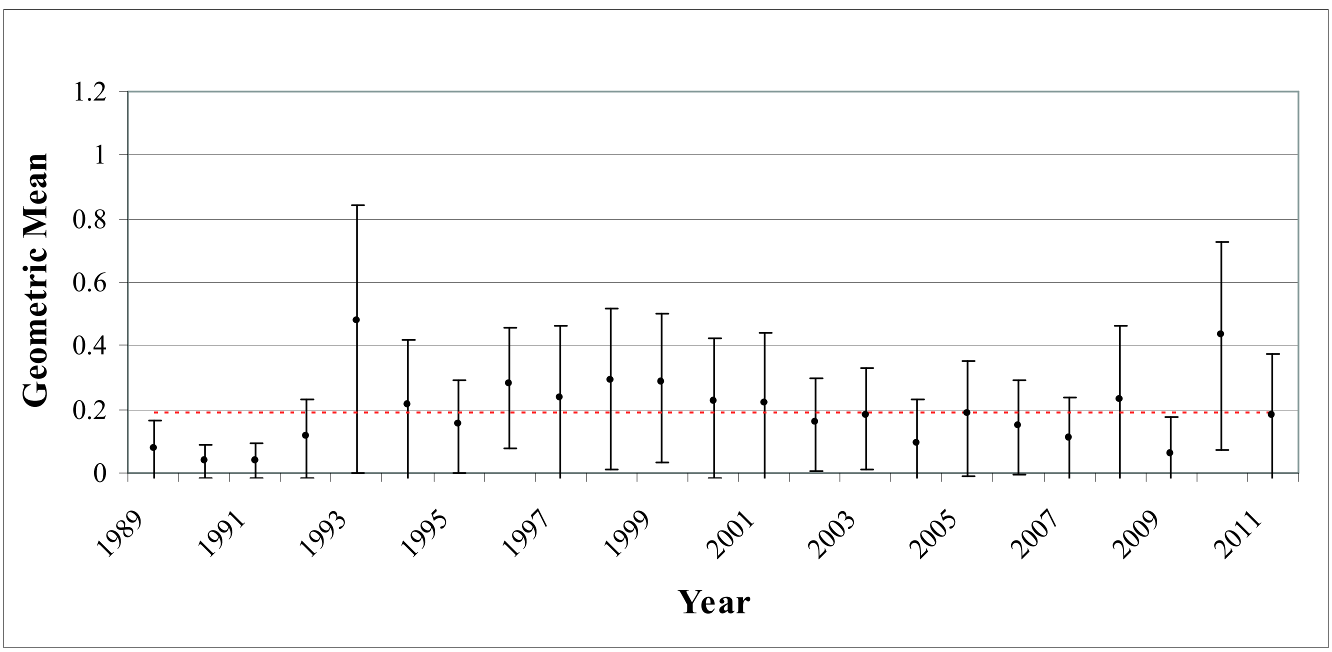

Figure 3. American Eel (*Anguilla rostrata)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

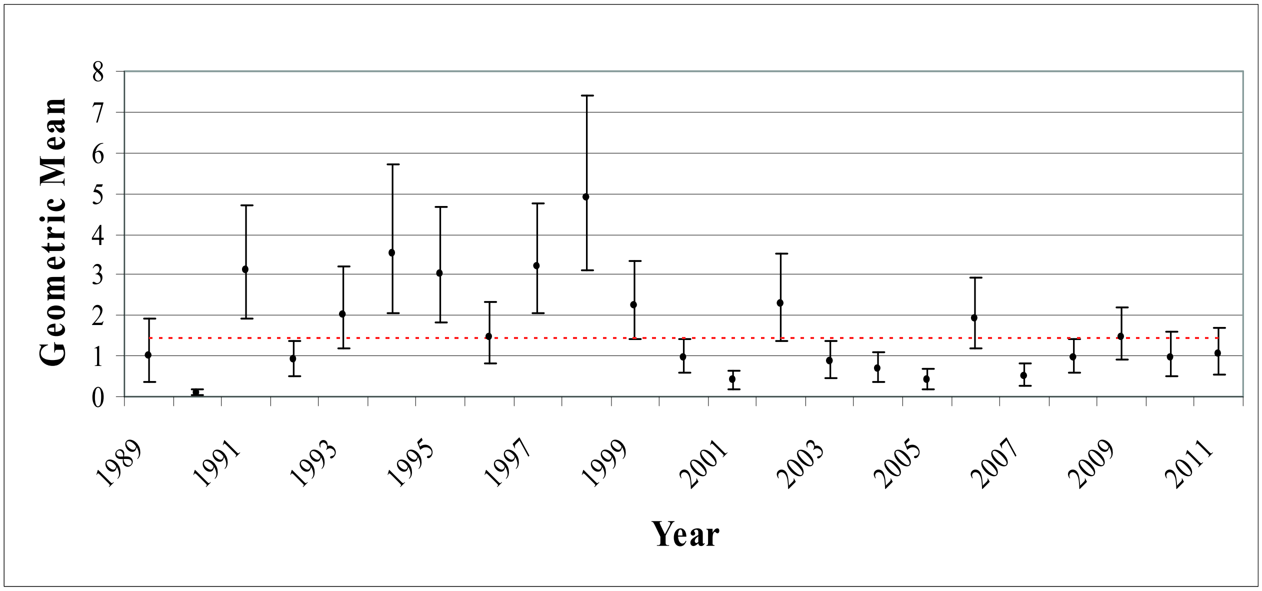

Figure 4. Atlantic Croaker (*Micropogonias undulates*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

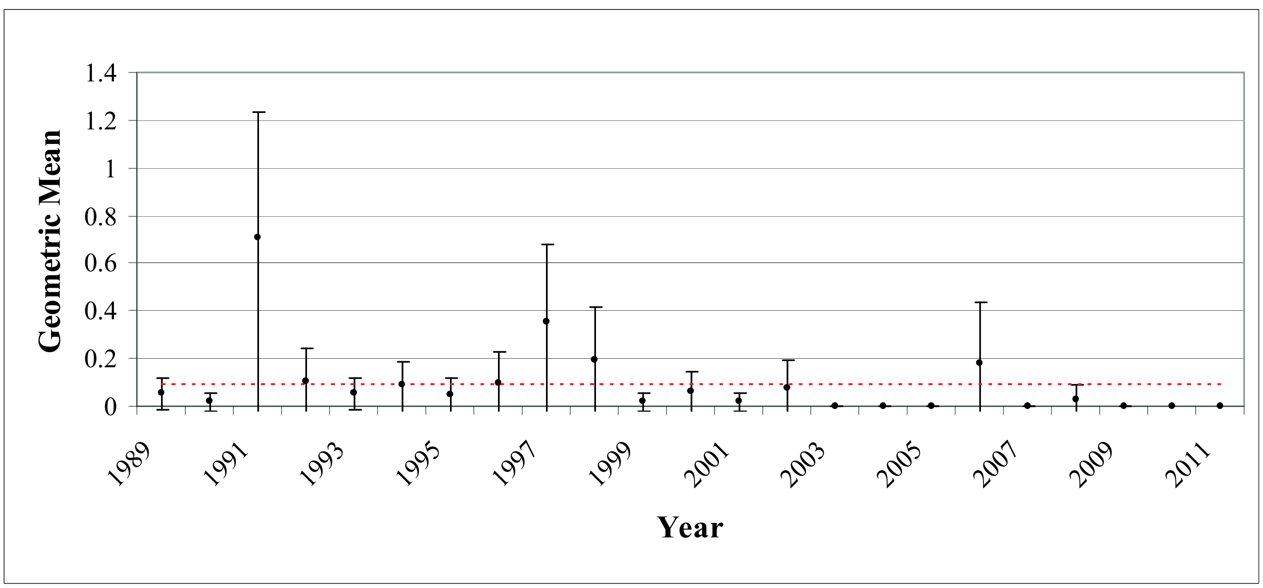

Figure 5. Atlantic Croaker (*Micropogonias undulates*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

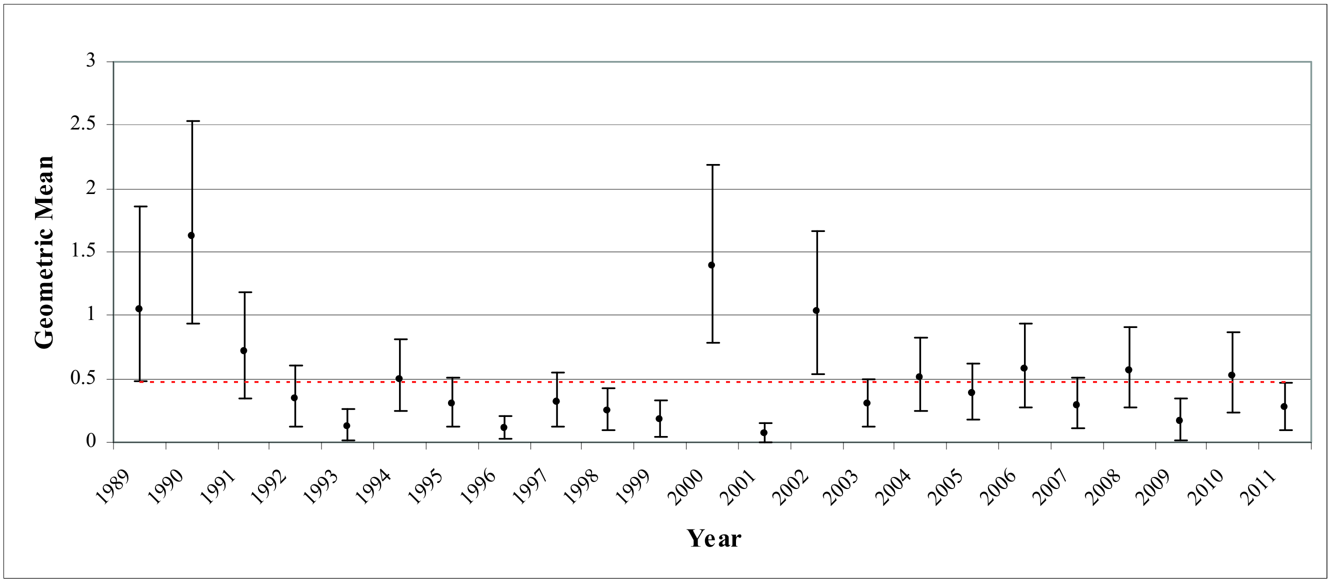

Figure 6. Atlantic Menhaden (*Brevoortia tyrannus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

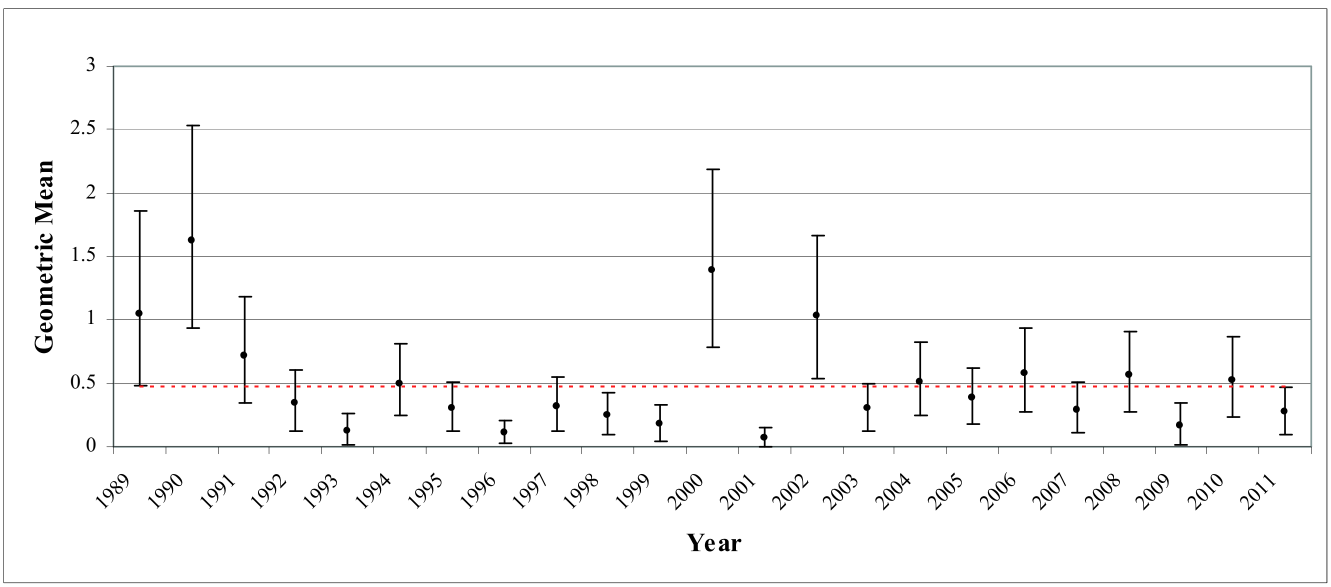

Figure 7. Atlantic Menhaden (*Brevoortia tyrannus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

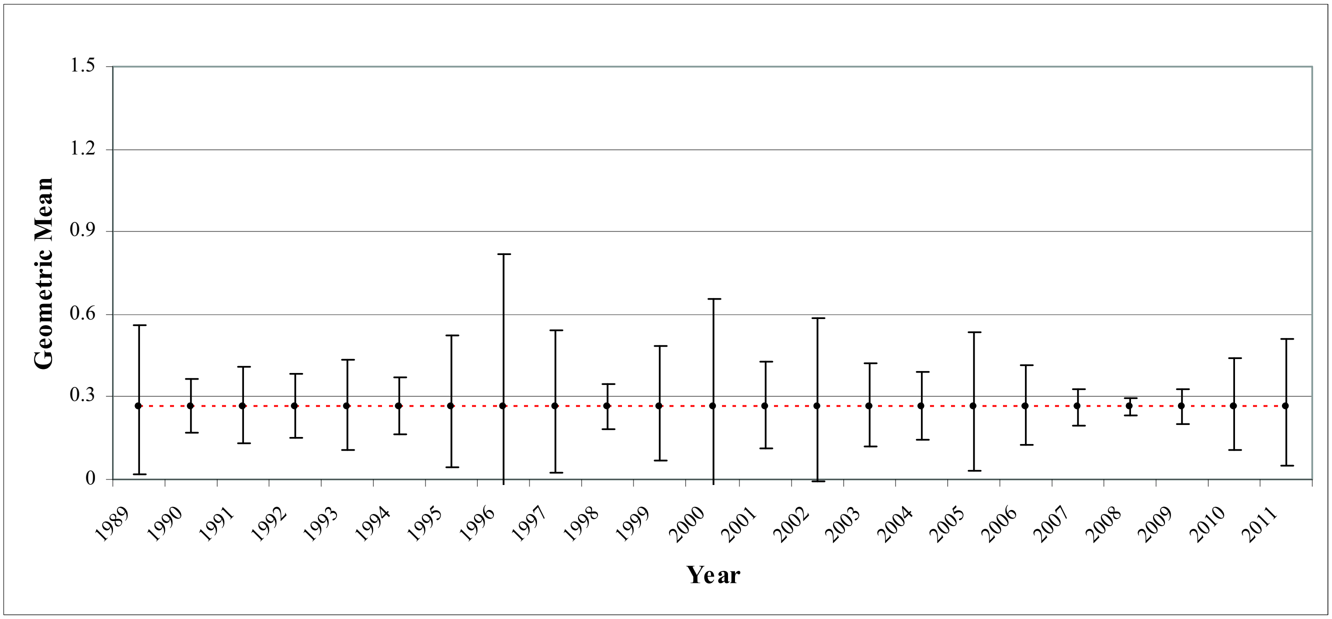

Figure 8. Atlantic Silverside (*Menidia menidia*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

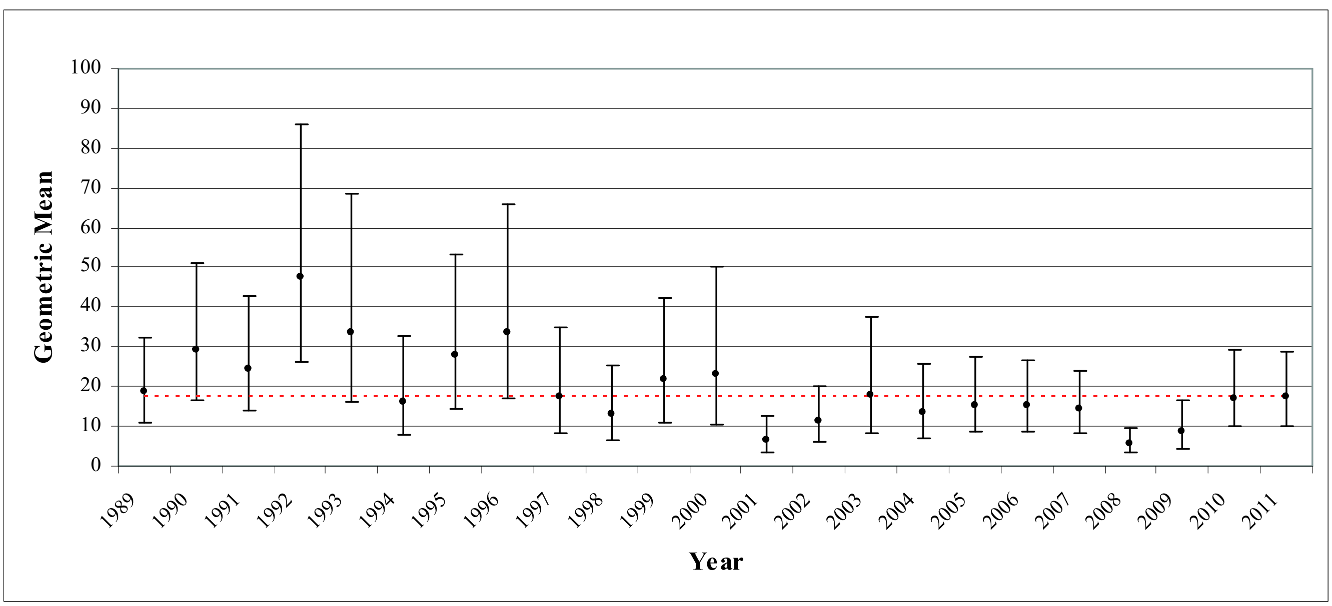

Figure 9. Atlantic Silverside (*Menidia menidia*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

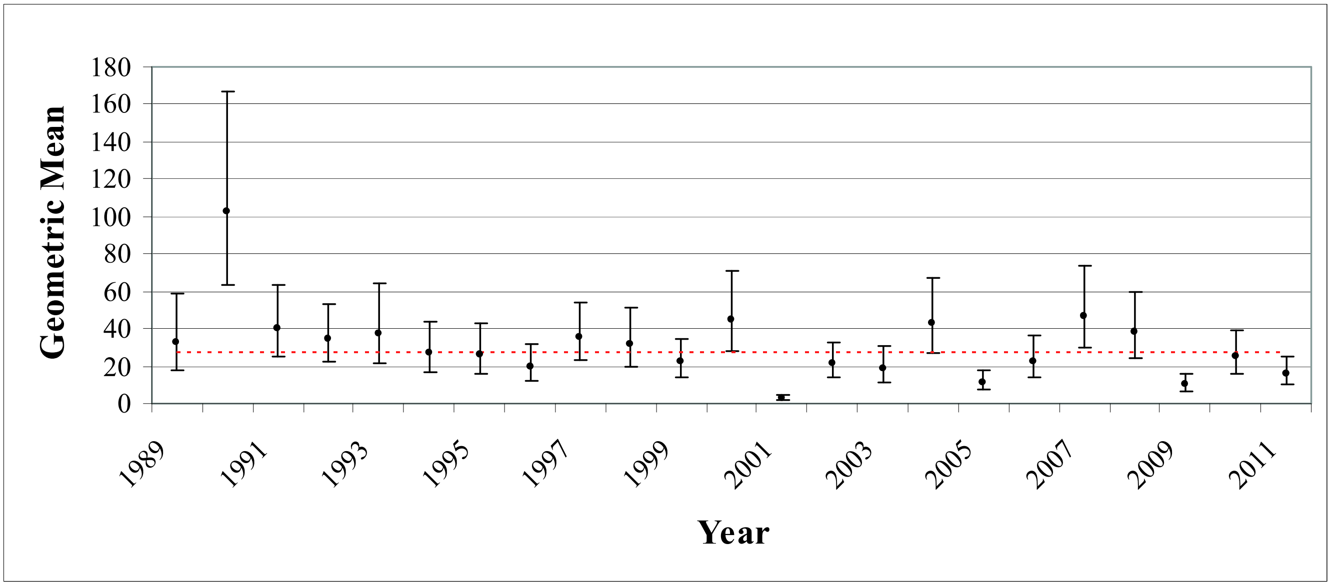

Figure10. Bay Anchovy (*Anchoa mitchilli*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

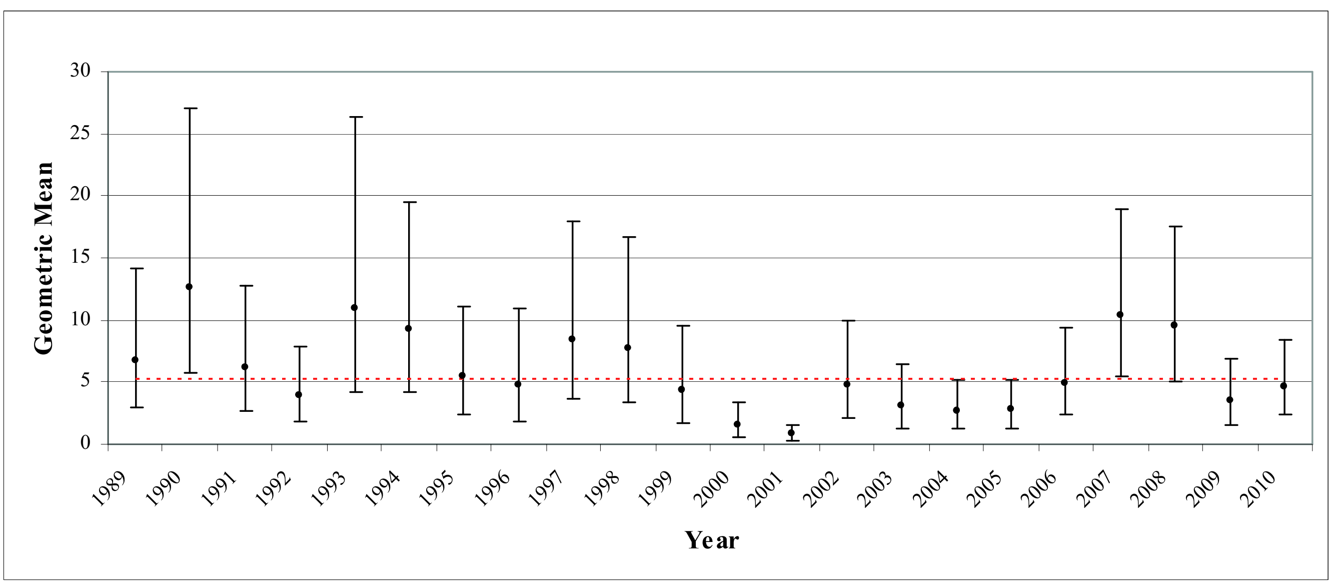

Figure 11. Bay Anchovy (*Anchoa mitchilli*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

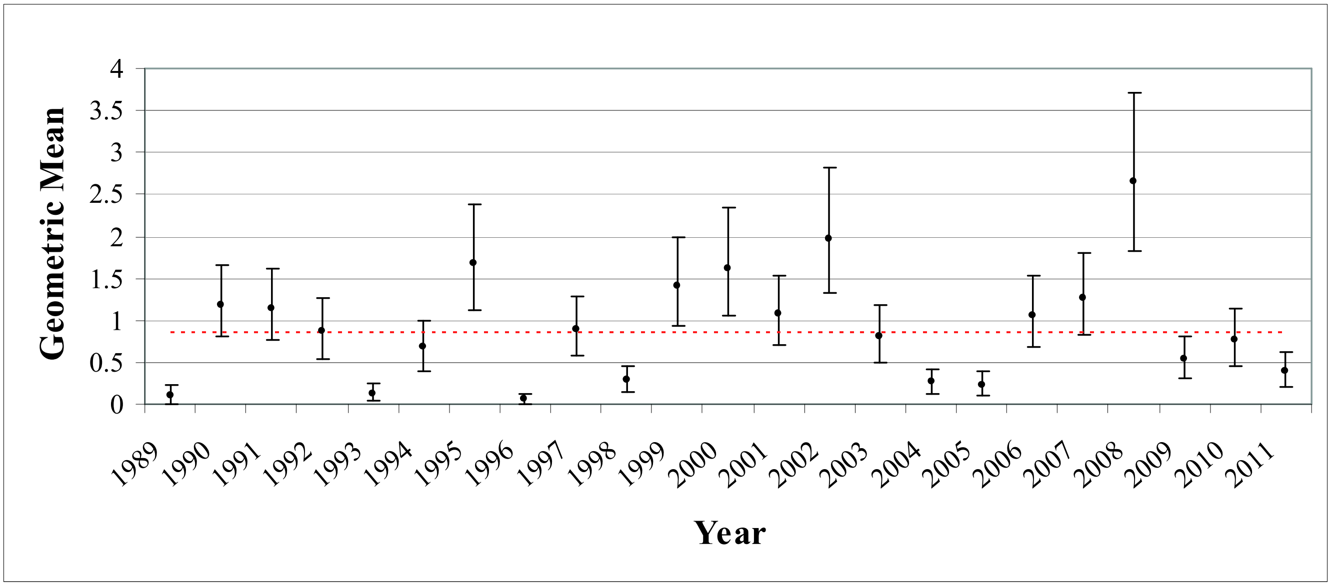

Figure 12. Black Sea Bass (*Centropristis* striata) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

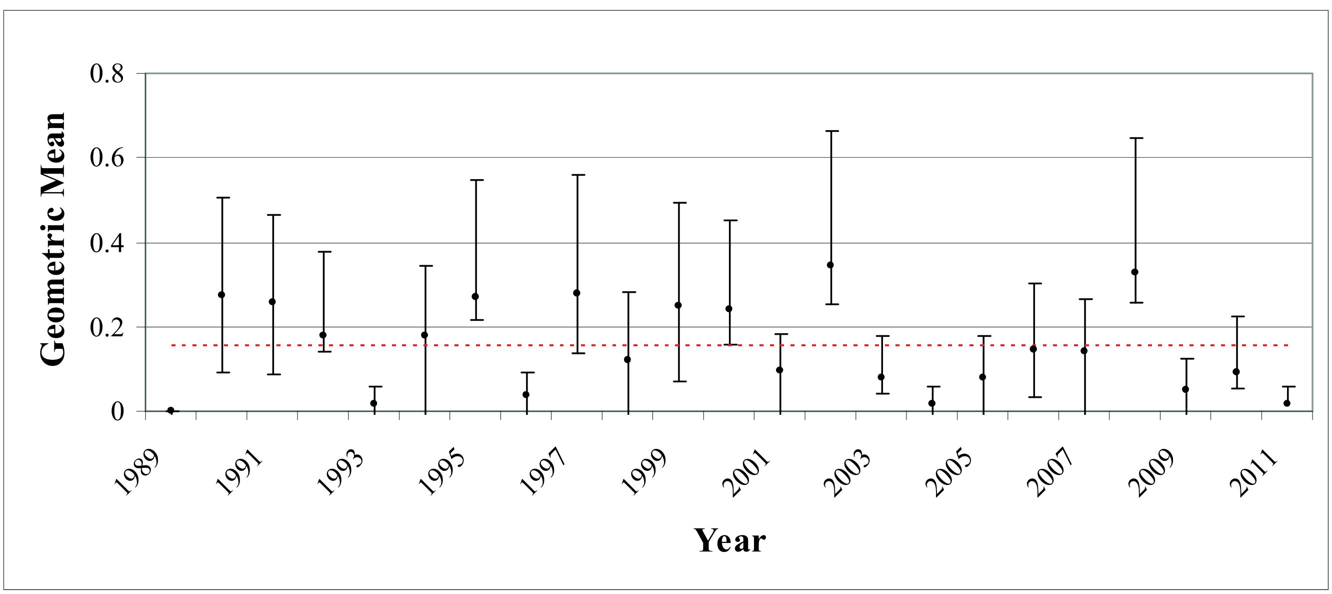

Figure 13. Black Sea Bass (*Centropristis* striata) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

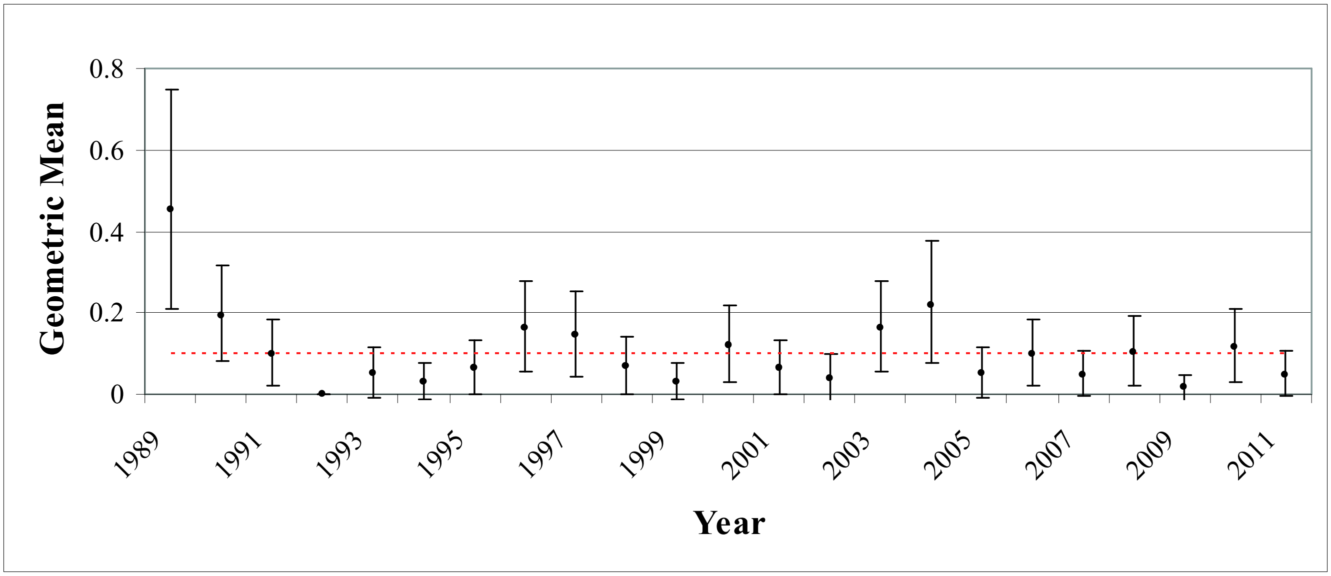

Figure 14. Bluefish (*Pomatomus saltatrix*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

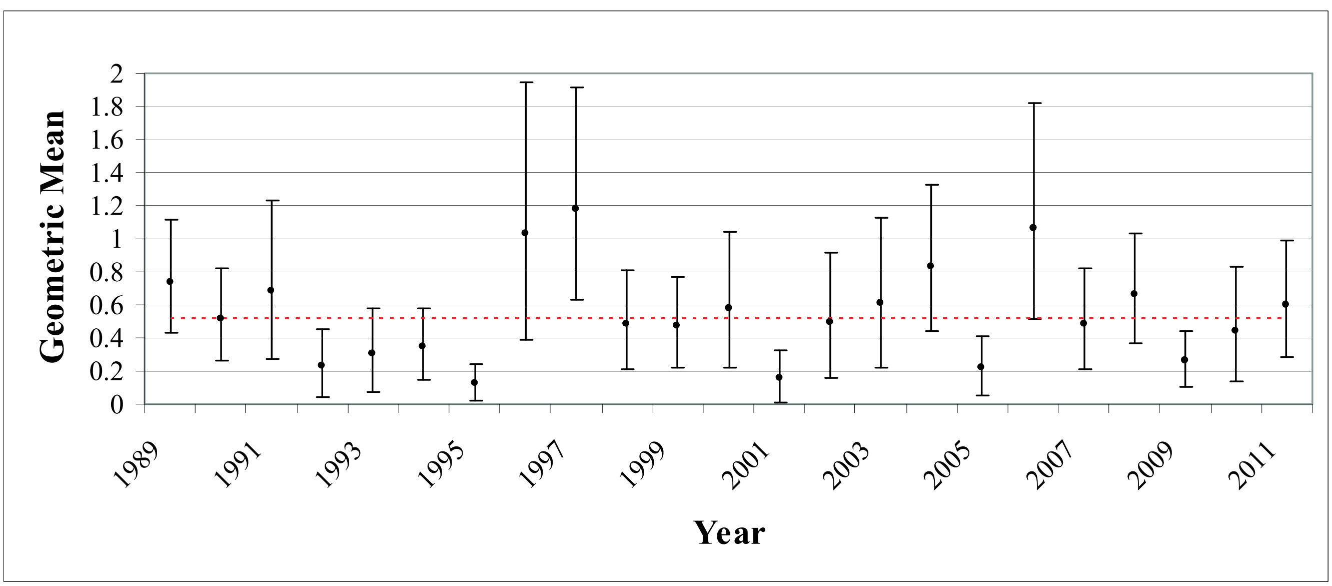

Figure 15. Bluefish (*Pomatomus saltatrix*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

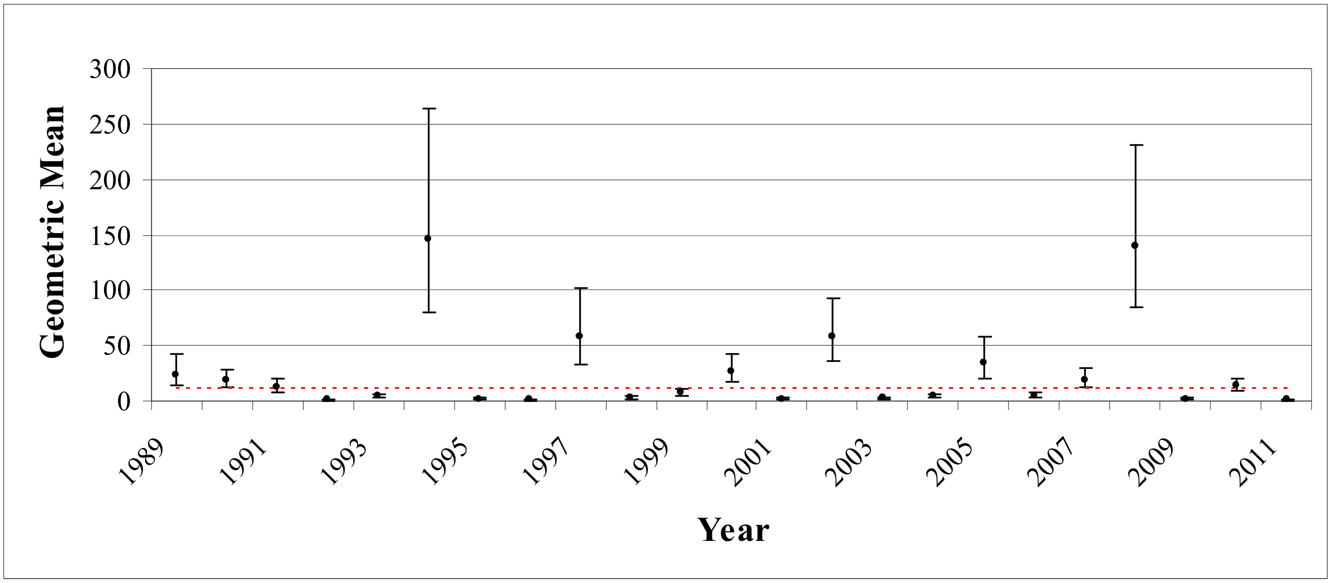

Figure 16. Spot (*Leiostomus xanthurus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

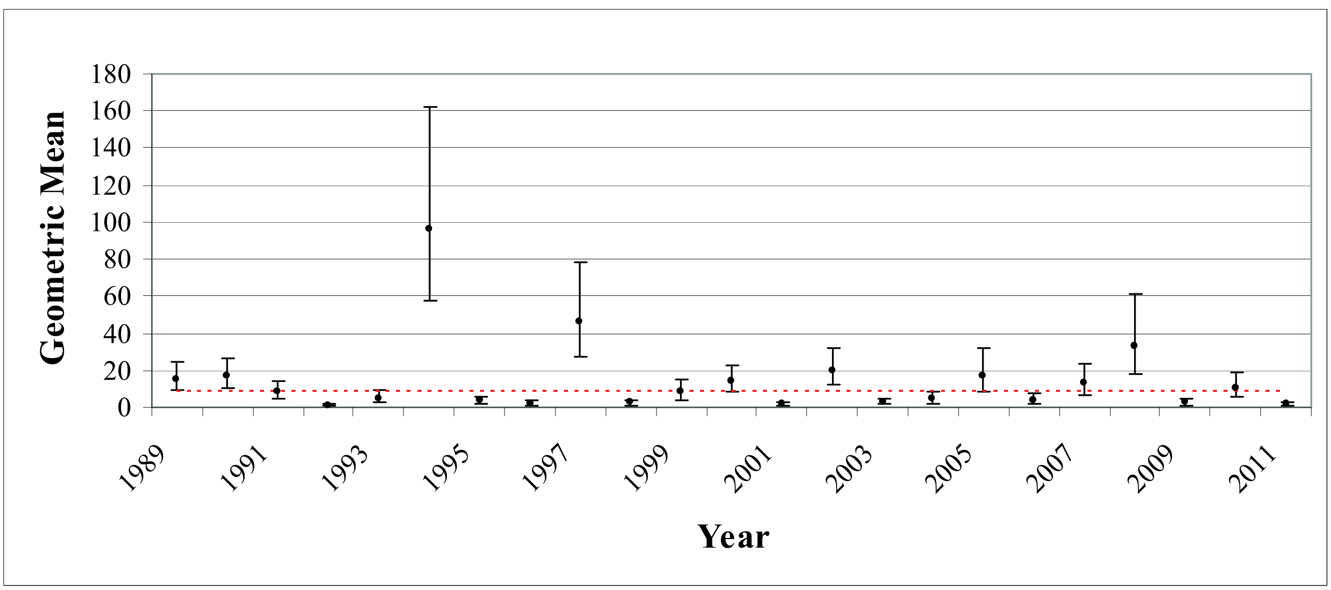

Figure 17. Spot (*Leiostomus xanthurus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

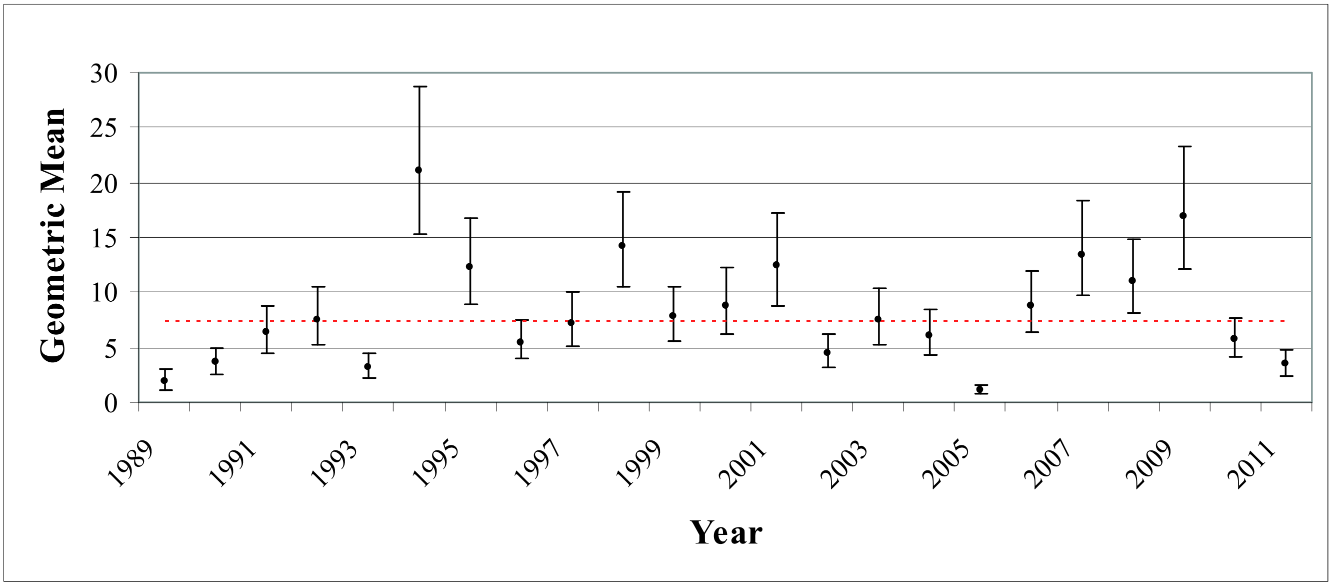

Figure 18. Summer Flounder (*Paralichthys dentatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

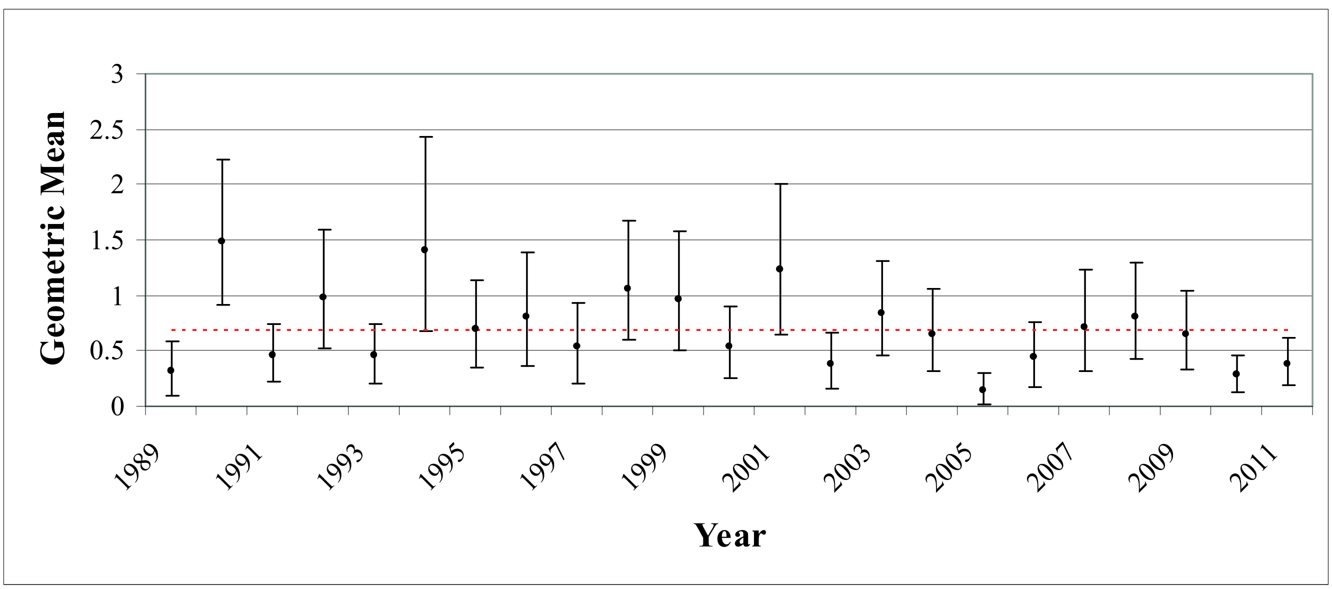

Figure 19. Summer Flounder (*Paralichthys dentatus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

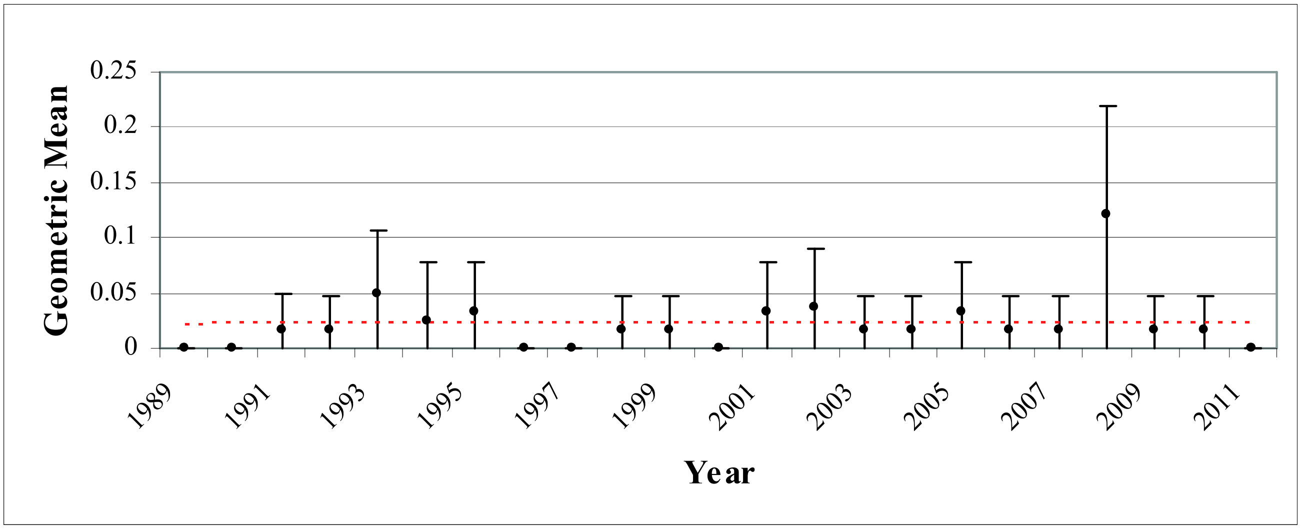

Figure 20. Tautog (*Tautoga onitis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

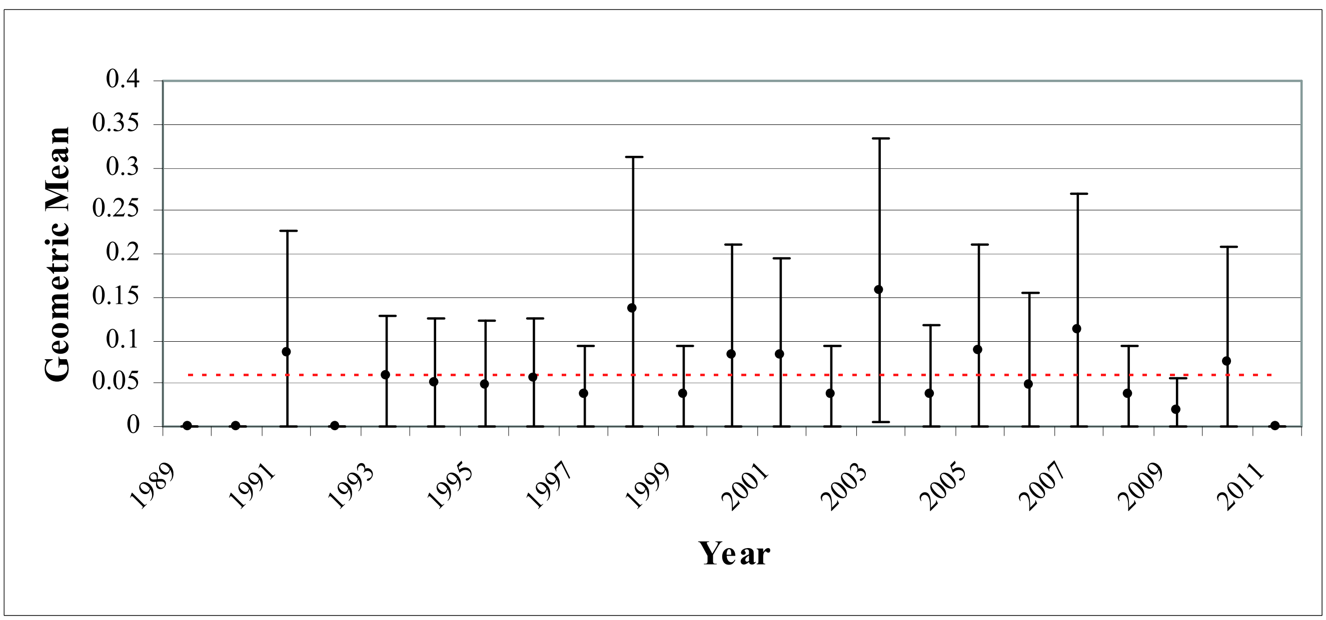

Figure 21. Tautog (*Tautoga onitis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

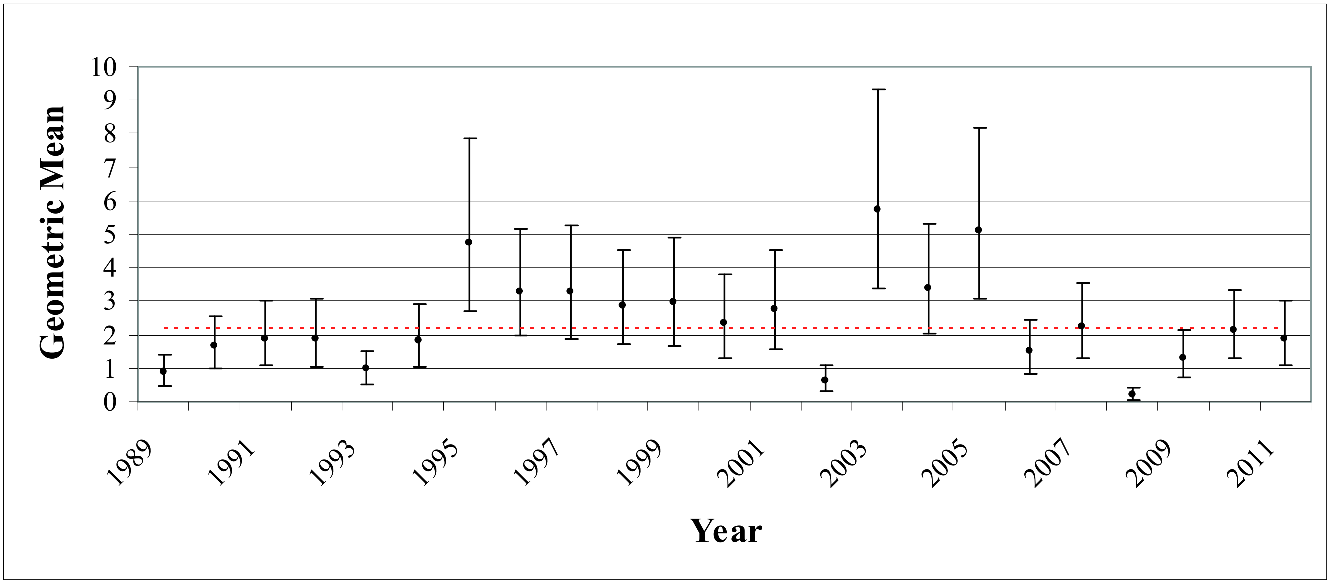

Figure 22. Weakfish (*Cynoscion regalis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

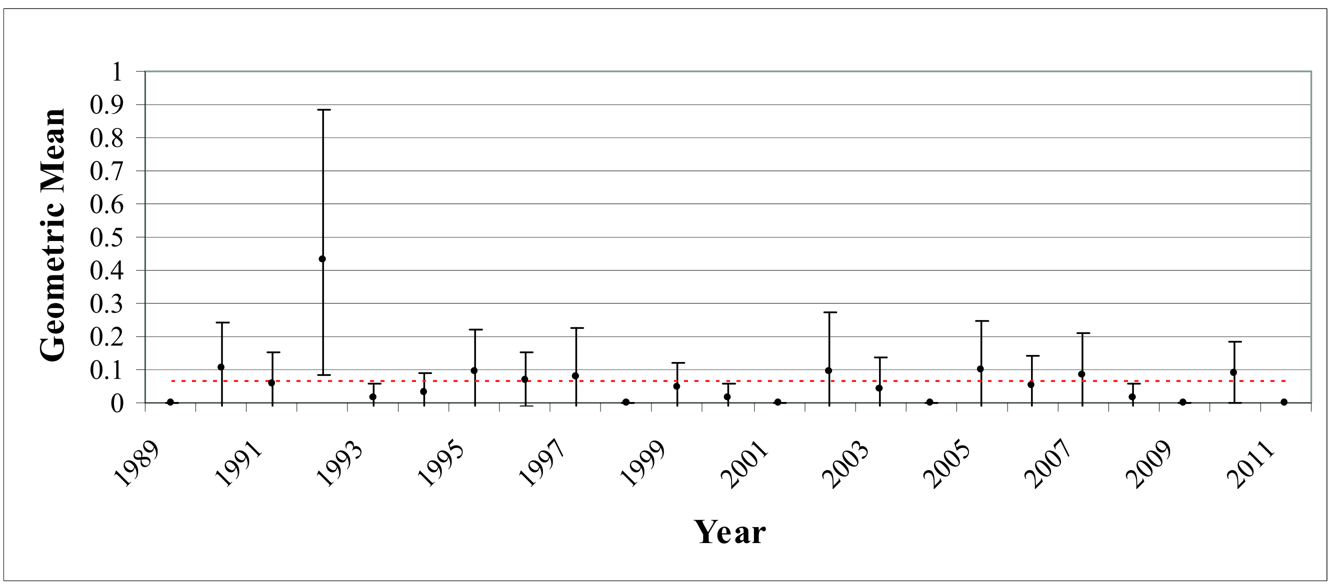

Figure 23. Weakfish (*Cynoscion regalis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2011). Dotted line represents the 1989-2011 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

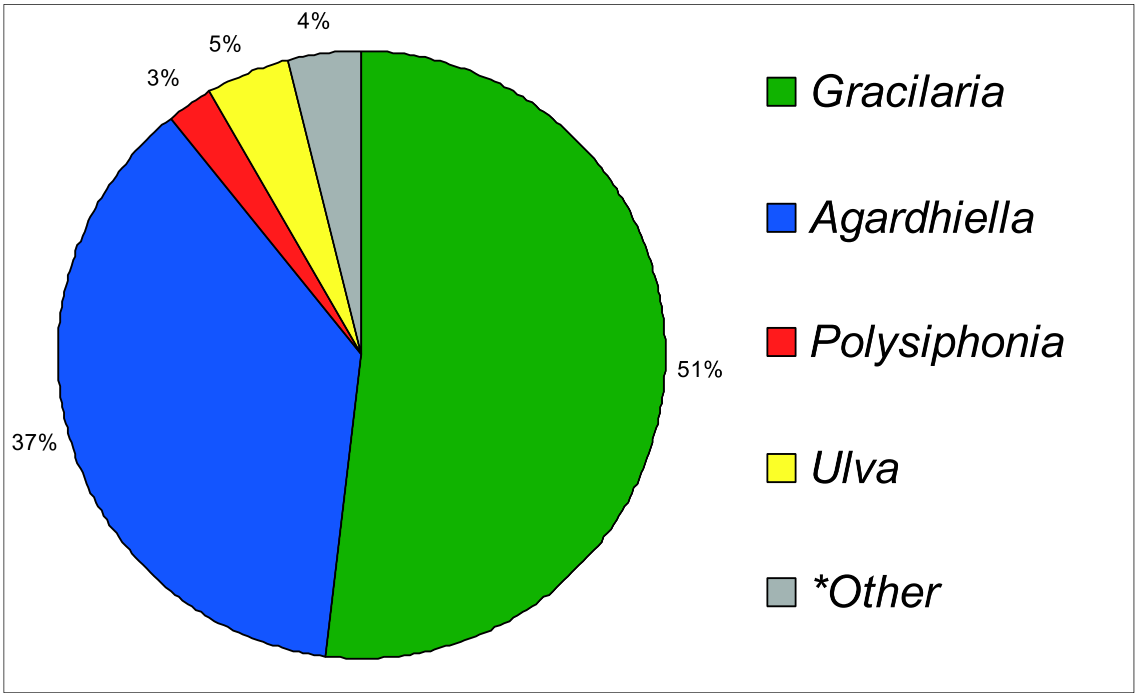

Figure 24. Percentages of total macroalgae biomass collected in 2011 Coastal Bays Fisheries Investigation Trawl Survey. *Other consisted of macroalgae genera that were less than 2% of the total volume: *Desmarestia, Laminaria, Champia, Ceramium, Spyridia, Hypnea, Chaetomorpha, Enteromorpha, Cladophora, Codium, Bryopsis, Vaucheria* and Unknown.

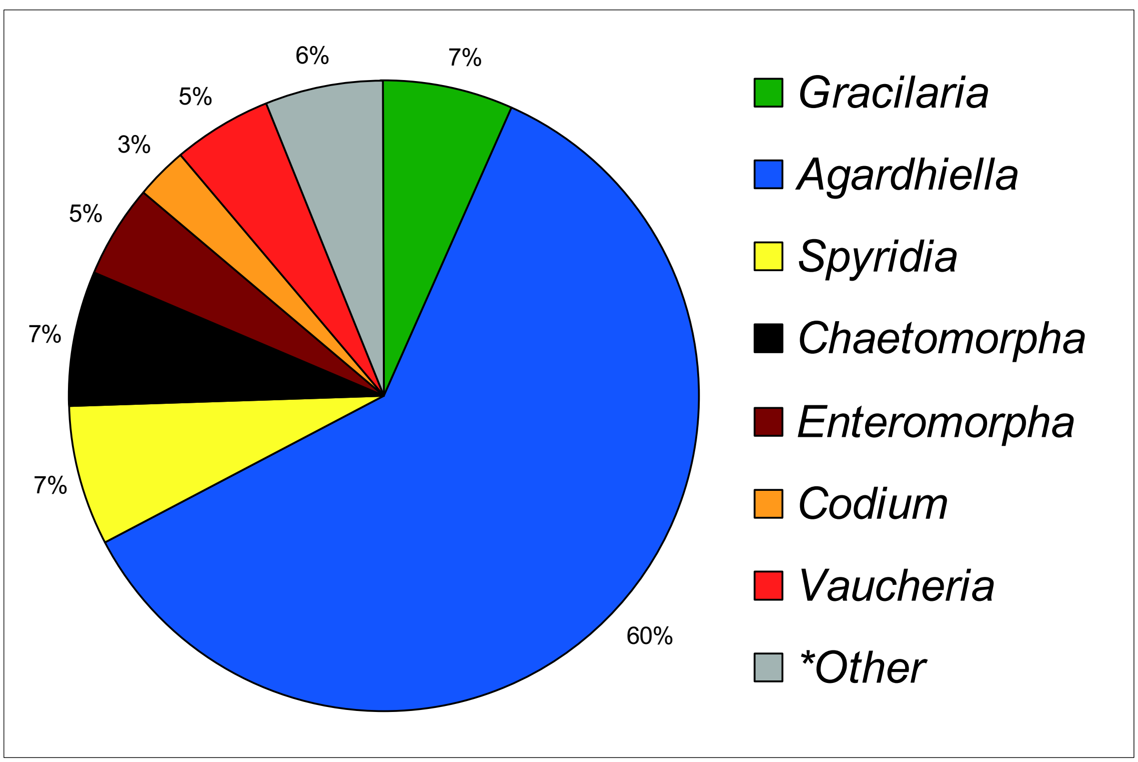

Figure 25. Percentages of total macroalgae biomass collected in 2011 Coastal Bays Fisheries Investigation Beach Seine Survey. *Other consisted of macroalgae that were 2% or less of the total volume: *Desmarestia, Polysiphonia, Champia, Ceramium, Spyridia, Ulva, Cladophora* and Unknown.

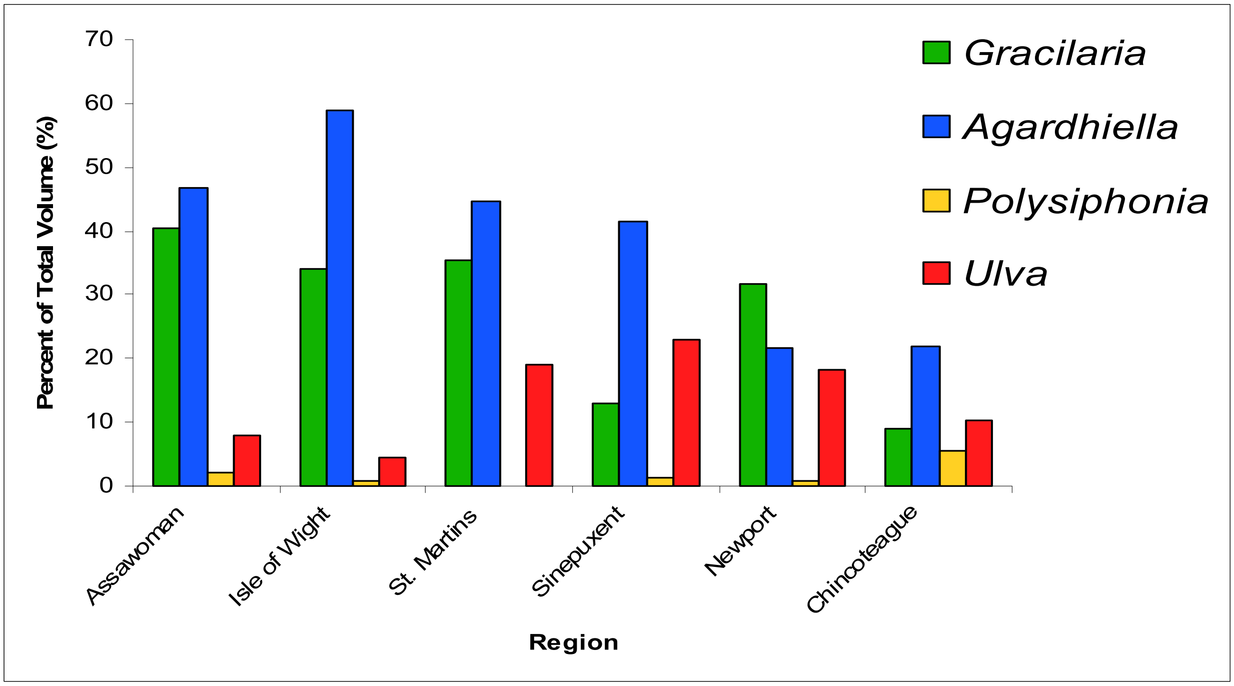

Figure 26. Percent of total volume of each dominant genus (*Agardhiella, Gracilaria, Polysiphonia and Ulva*) by region from 2006 – 2011 in the Coastal Bays Fisheries Investigation Trawl Survey. Macroalgae were present in all regions; no graphical representation indicates total volume from that region is less than 0.1%.

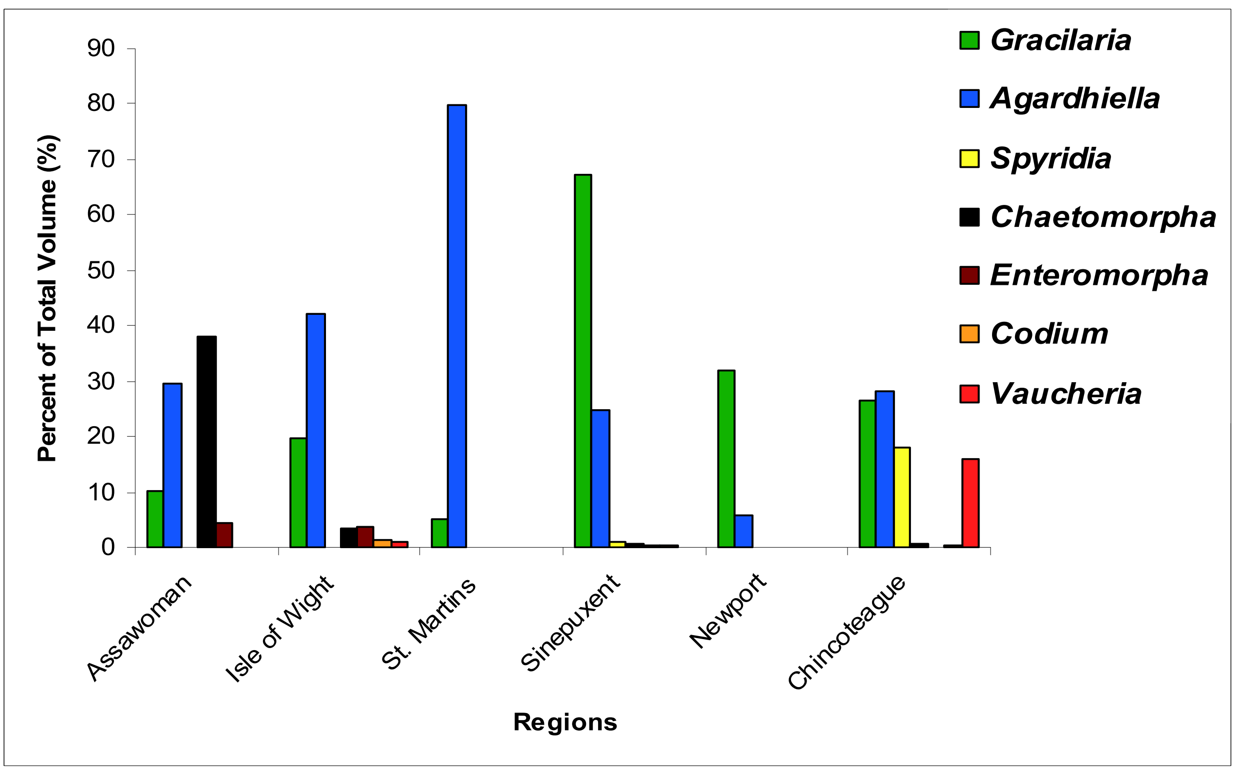

Figure 27. Percent of total volume of each dominant genus (*Gracilaria, Agardhiella, Spyridia, Chaetomorpha, Enteromorpha, Codium and Vaucheria*) by region from 2006 – 2011 in the Coastal Bays Fisheries Investigation Beach Seine Survey. Macroalgae were not present or less than 1% at sites represented with no bar.

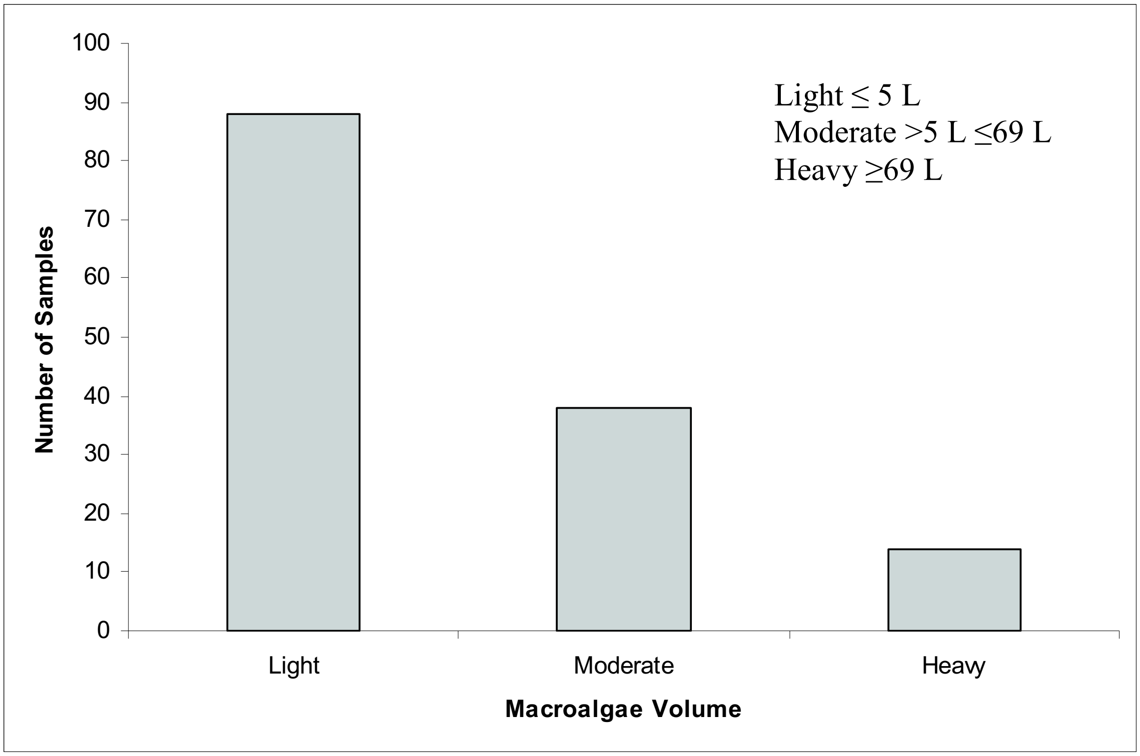

Figure 28. Macroalgae volume (L) categories of all 2011 Coastal Bays Fisheries Investigation Trawl Survey macroalgae samples (n=140).

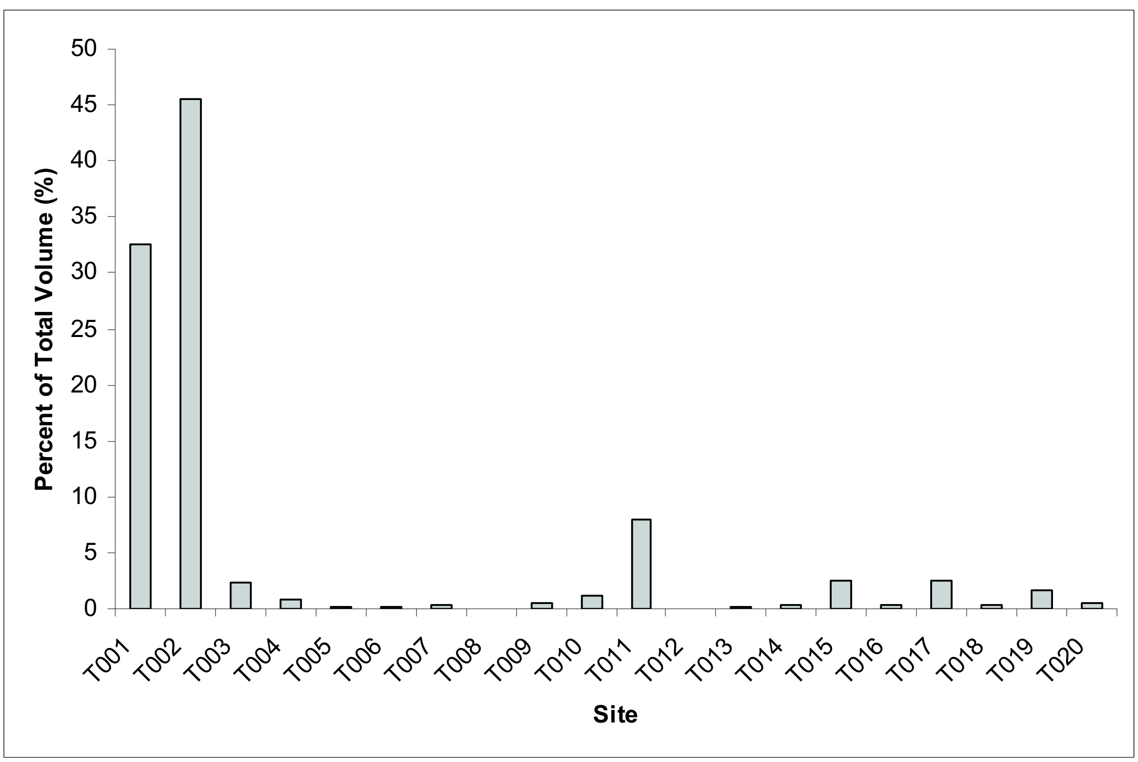

Figure 29. Percent of total volume of macroalgae by site for 2011 in the Coastal Bays Fisheries Investigation Trawl Survey. Macroalgae was present at all sites; no bar indicates total volume less than 0.1%.

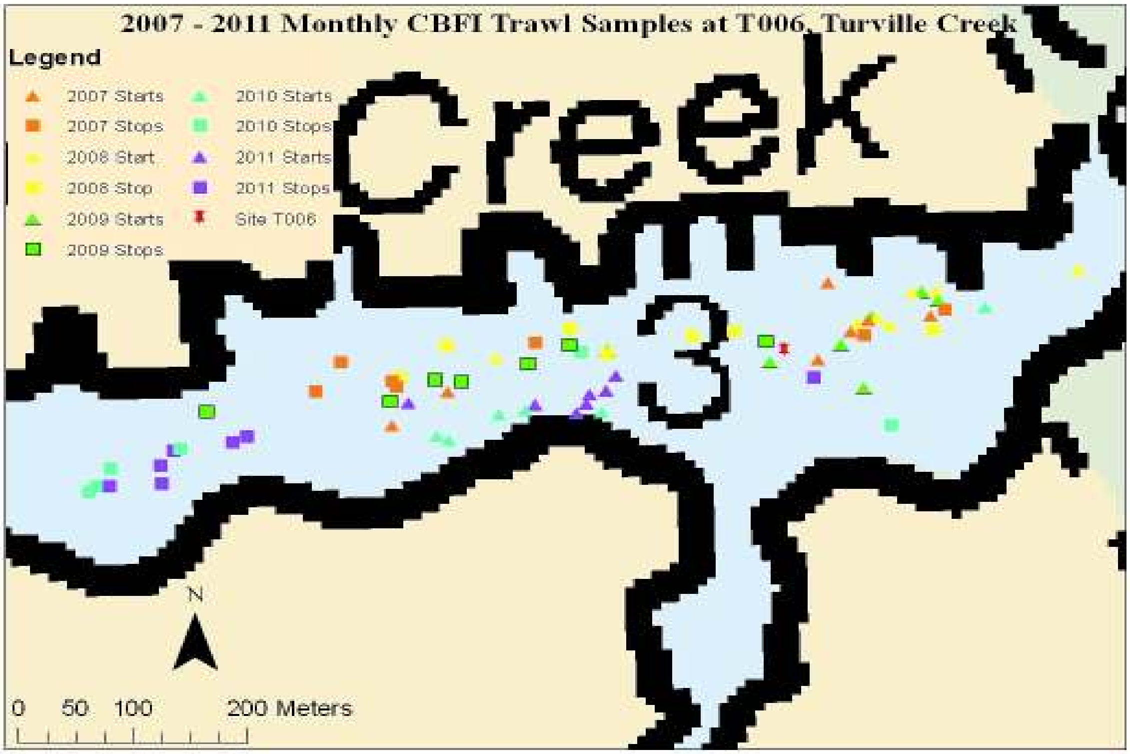

Figure 30. Map detailing the start and stop locations of all trawls at T006 from 2007-2011. Note the shift after 2009. One trawl each in 2009 and 2010 was conducted at the mouth of the St. Martin's River due to high macroalgae volumes. They are not included on this map.

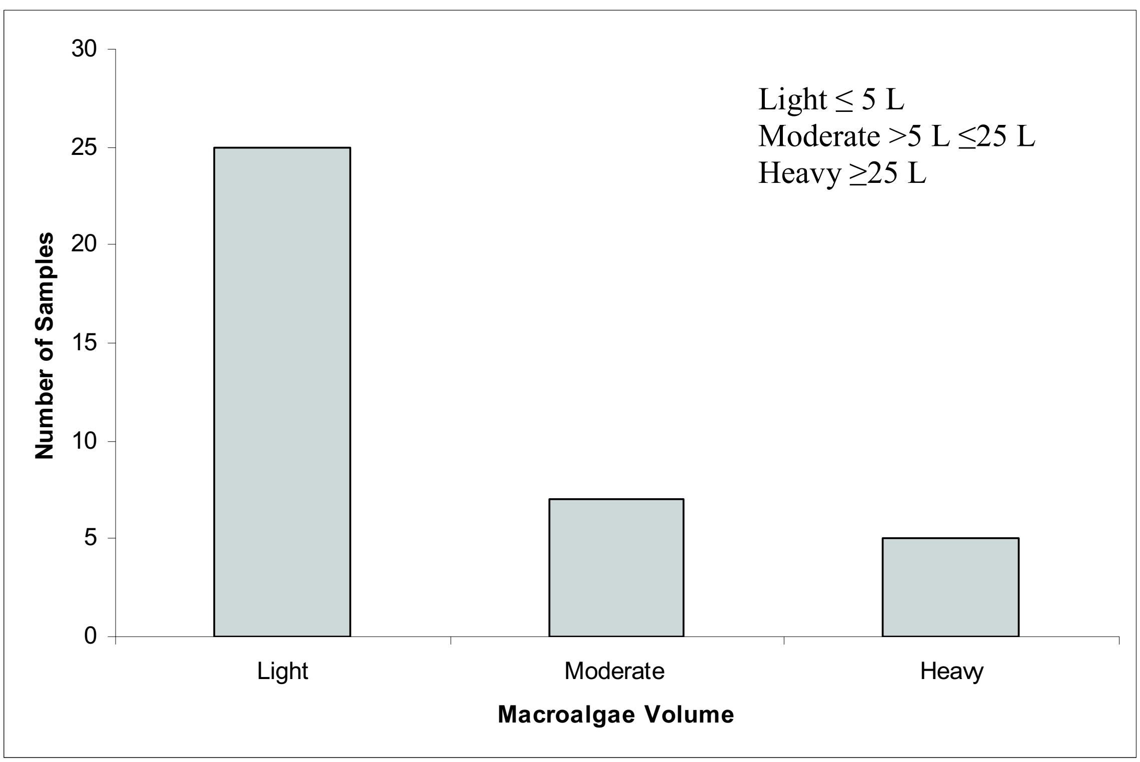

Figure 31. Macroalgae volume (L) categories of all 2011 Coastal Bays Fisheries Investigation Beach Seine Survey macroalgae samples (n=38).

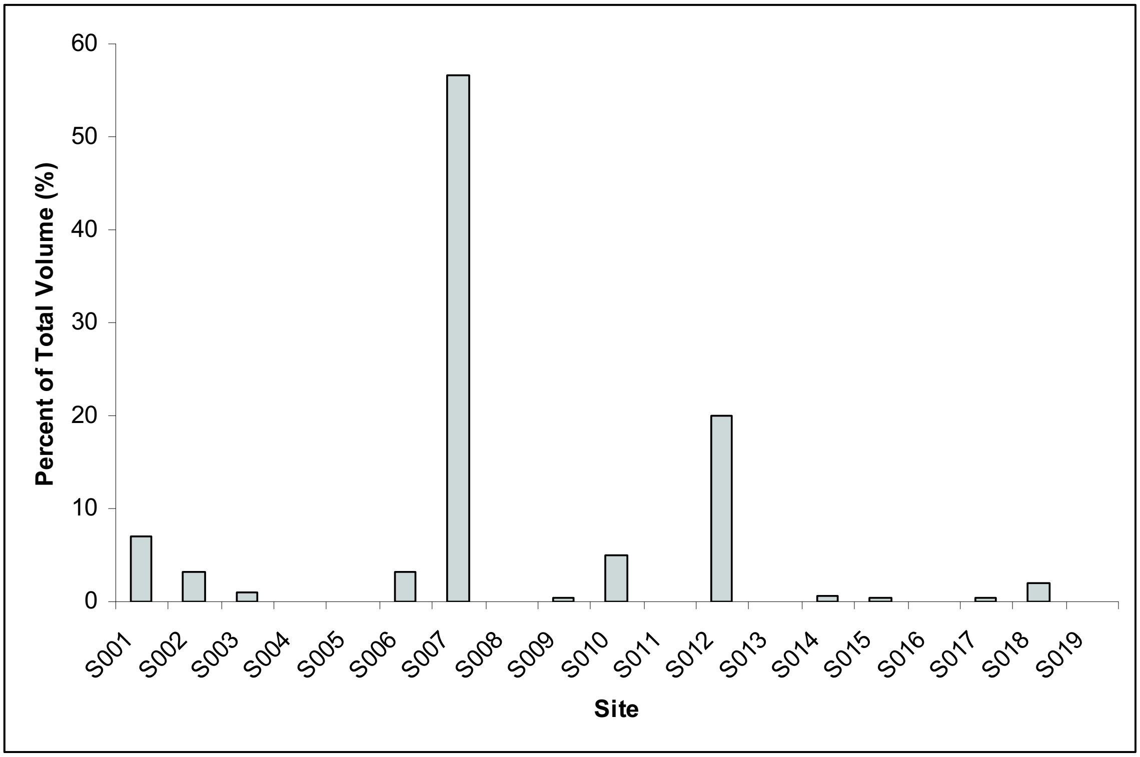

Figure 32. Percent of total macroalgae by site from 2011 in the Coastal Bays Fisheries Investigation Beach Seine Survey. Macroalgae were not present or less than 0.1% at sites represented with no bar.

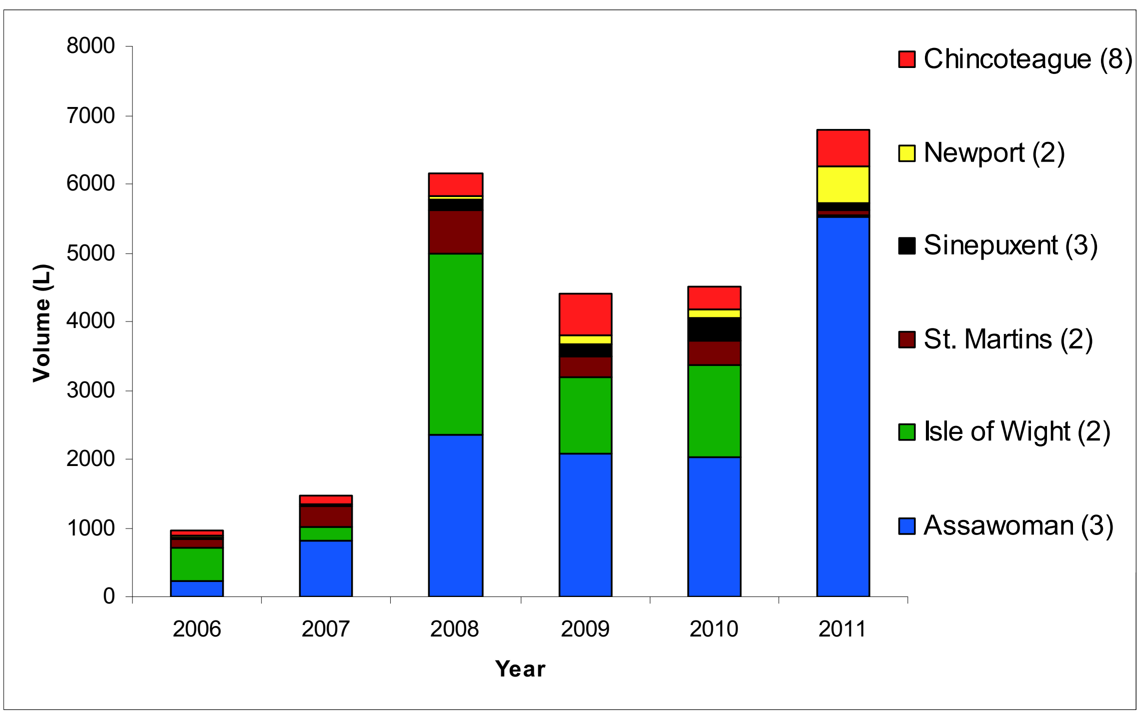

Figure 33. Total volume of (red and green) macroalgae by year and region for Coastal Bays Fisheries Investigation Trawl Survey. The number in parenthesis after the region name is the number of trawl sites in that region.

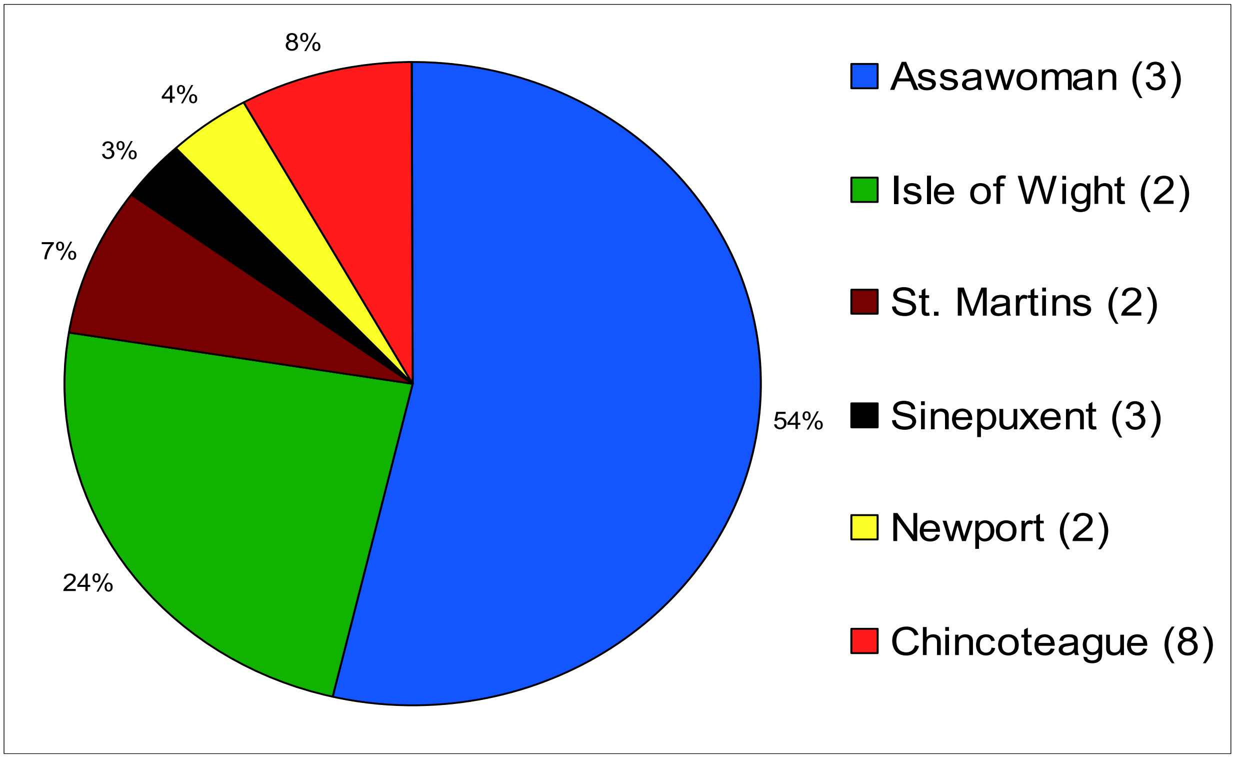

Figure 34. Percentage of total volume of macroalgae by region from 2006 – 2011 for Coastal Bays Fisheries Investigation Trawl Survey. The number in parenthesis after the region is the number of trawl sites in that region.

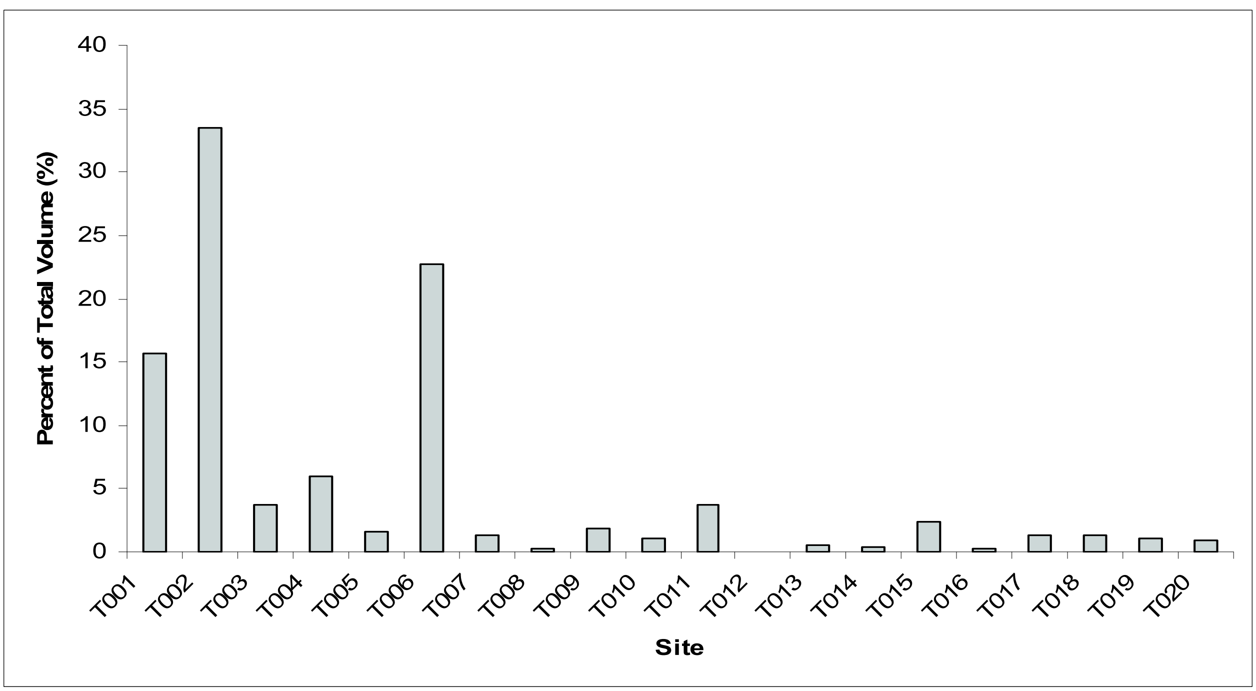

Figure 35. Percent of total volume of (red and green) macroalgae by site from 2006 – 2011 in the Coastal Bays Fisheries Investigation Trawl Survey. Macroalgae were present at all sites; no bar indicates total volume less than 0.1%.

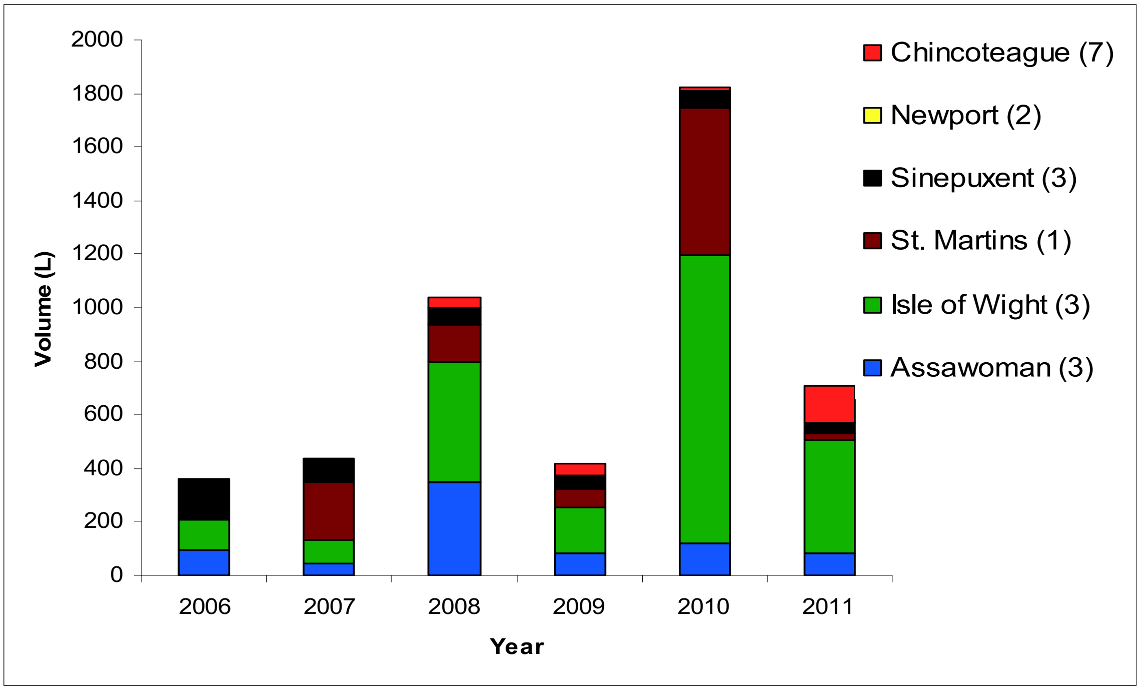

Figure 36. Total volume (L) of (red and green) macroalgae by region for Coastal Bays Fisheries Investigation Beach Seine Survey. The number in parenthesis after the region name is the number of seine sites in that region. Macroalgae were present in all regions; no graphical representation indicates total volume from that region is less than 0.1%.

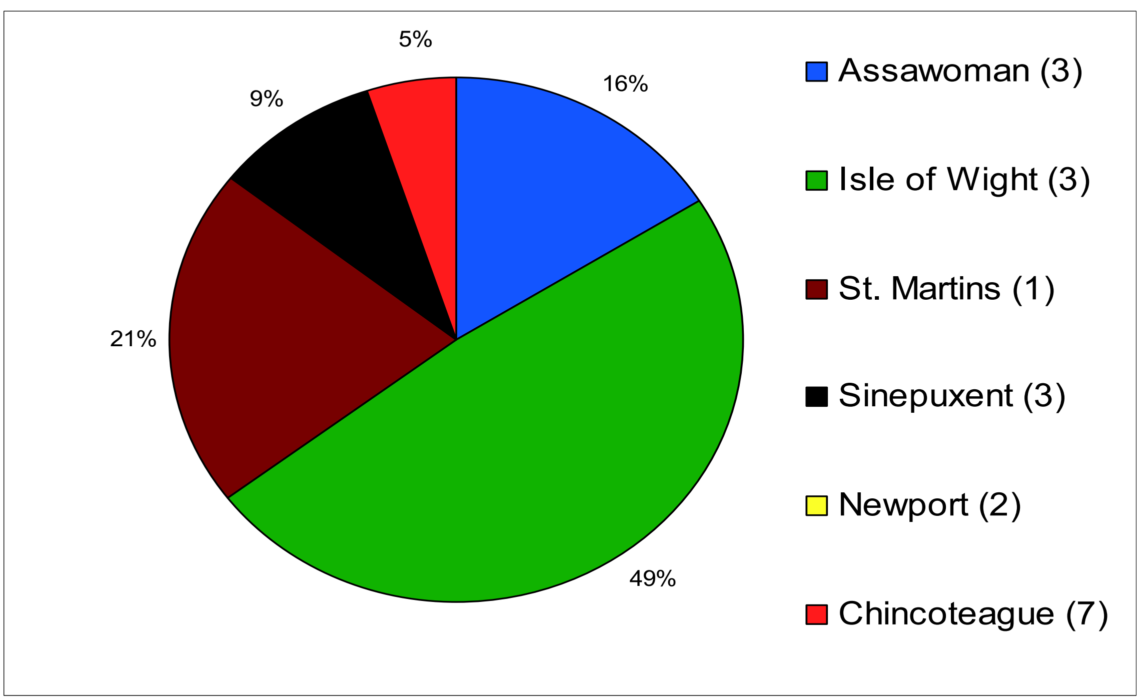

Figure 37. Percentage of total volume of macroalgae by region from 2006 – 2011 for Coastal Bays Fisheries Investigation Beach Seine Survey. The number in parenthesis after the region is the number of trawl sites in that region. Macroalgae were present in all regions; no graphical representation indicates total volume from that region is less than 0.1%.

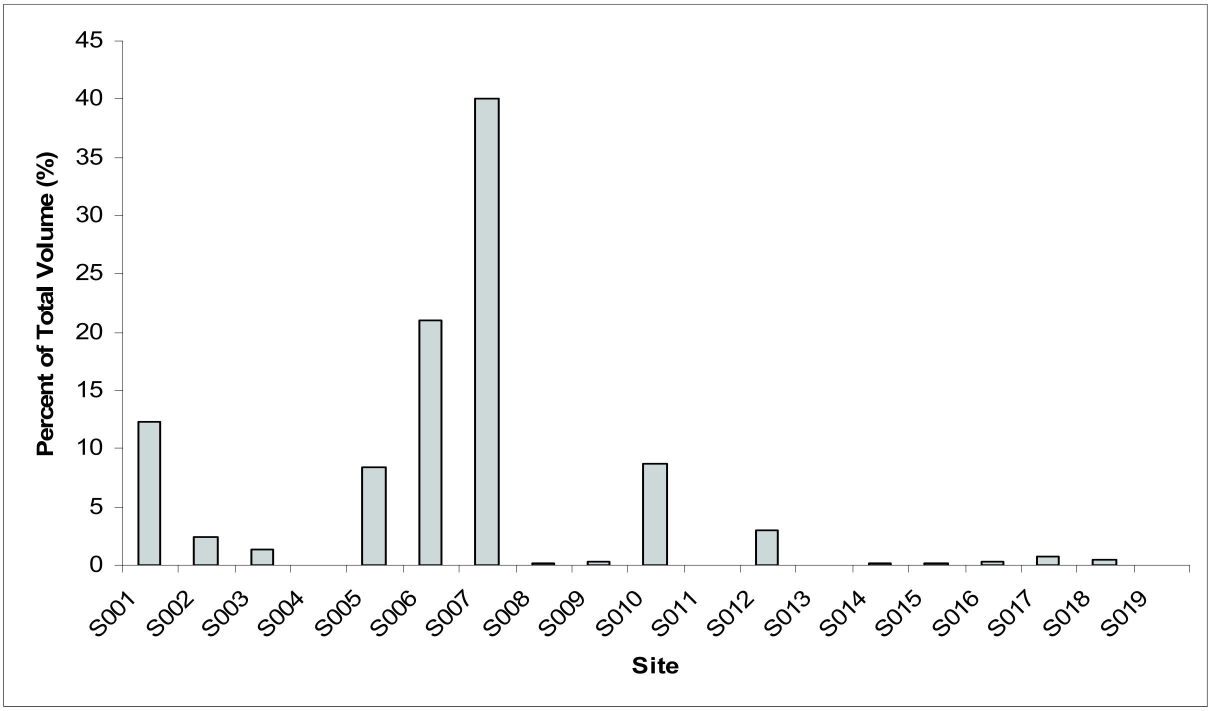

Figure 38. Percent of total (red and green) macroalgae by site from 2006 – 2011 in the Coastal Bays Fisheries Investigation Beach Seine Survey. Macroalgae were present at all sites; no bar indicates that total volume was less than 0.1%.

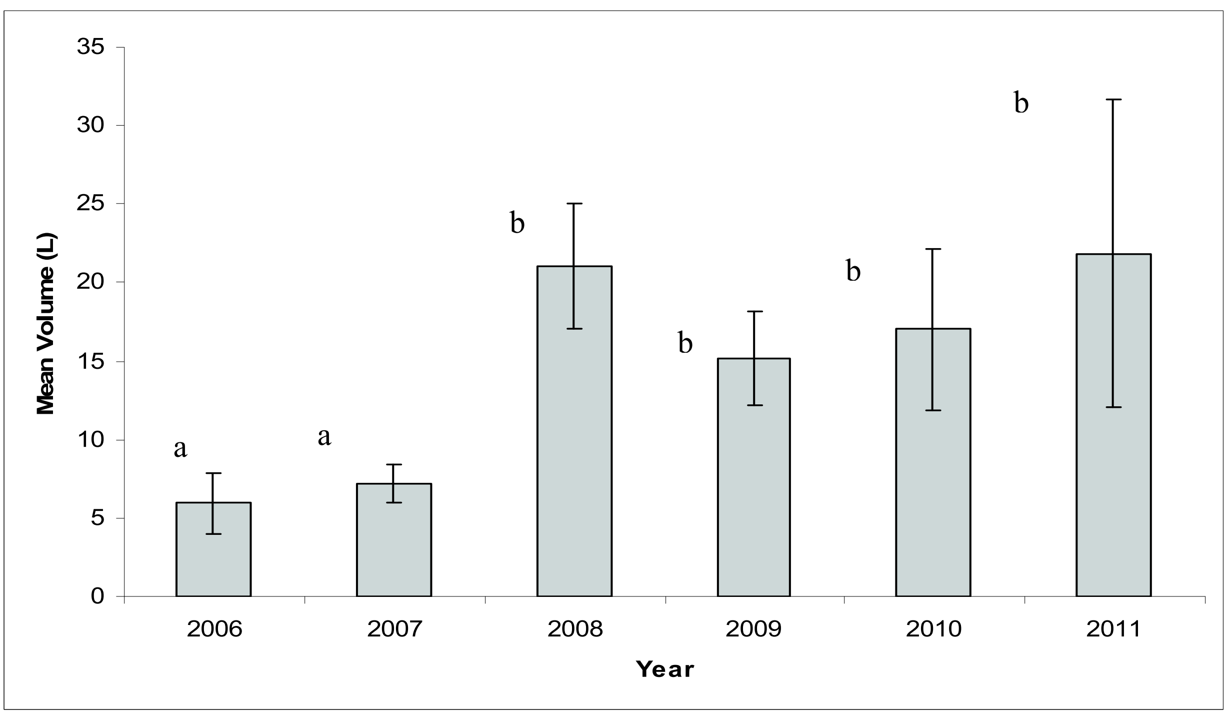

Figure 39. Mean volume (L) ± standard error of total (red and green) macroalgae by year from 2006 – 2011 for the Coastal Bays Fisheries Investigation Trawl Survey. Years with different letters are significantly different from each other.

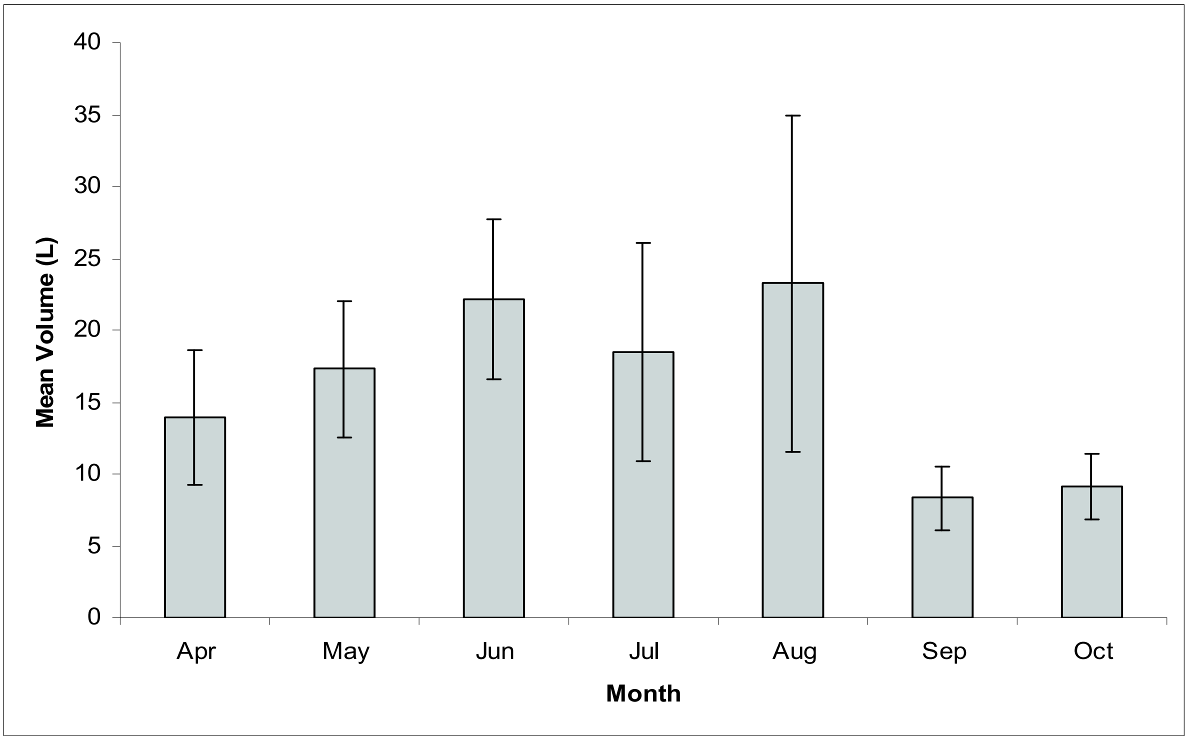

Figure 40. Mean volume (L) ± standard error of total (red and green) macroalgae by month from 2006 – 2011 for the Coastal Bays Fisheries Investigation Trawl Survey.

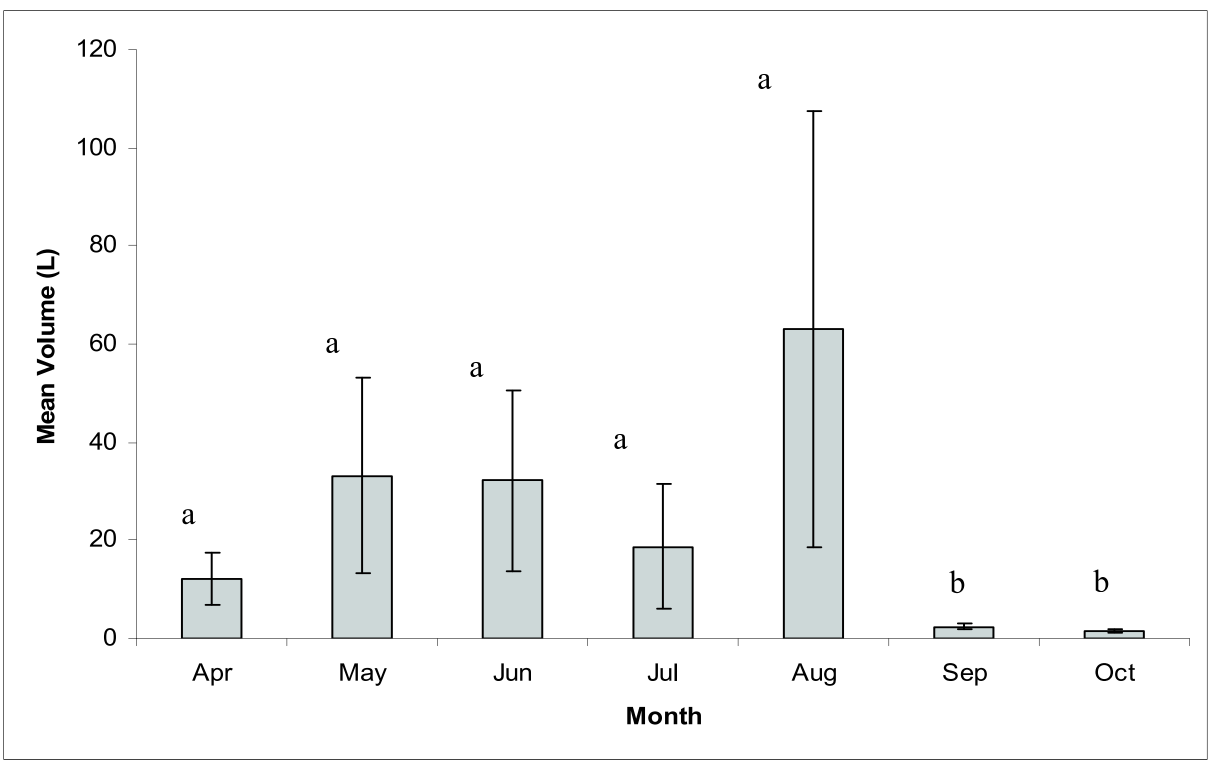

Figure 41. Mean volume (L) ± standard error of total (red and green) macroalgae by month for 2011 for the Coastal Bays Fisheries Investigation Trawl Survey. Months with different letters are significantly different from each other.

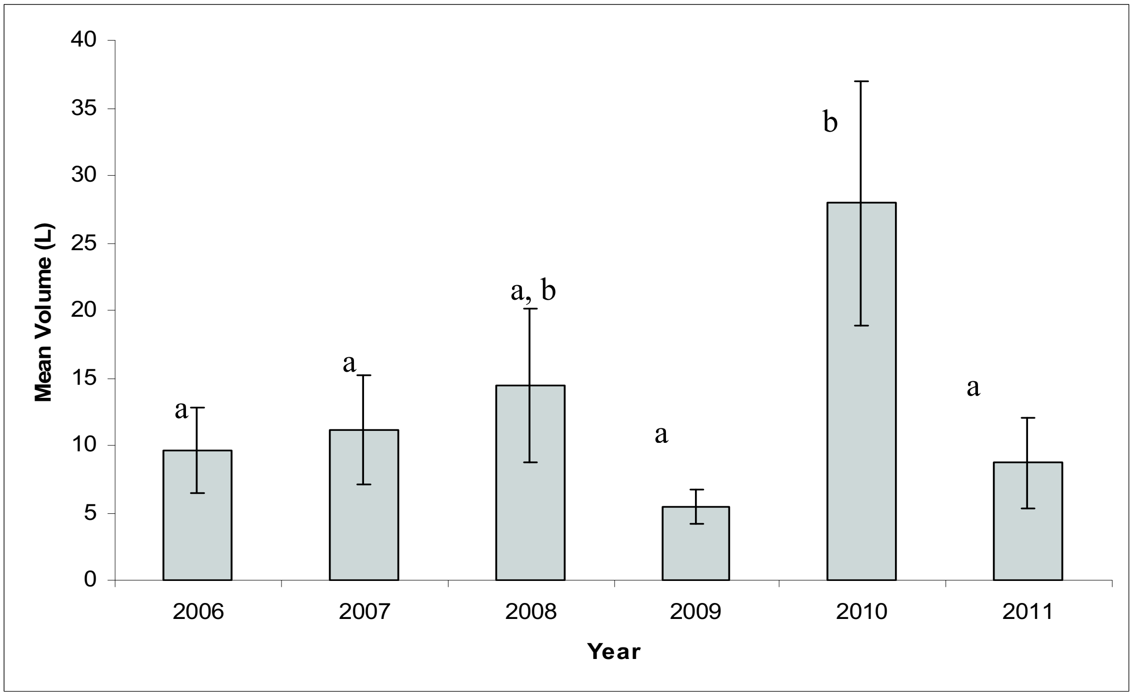

Figure 42. Mean volume (L) ± standard error of total (red and green) macroalgae by year from 2006 – 2011 for the Coastal Bays Fisheries Investigation Beach Seine Survey. Years with different letters are significantly different from each other.

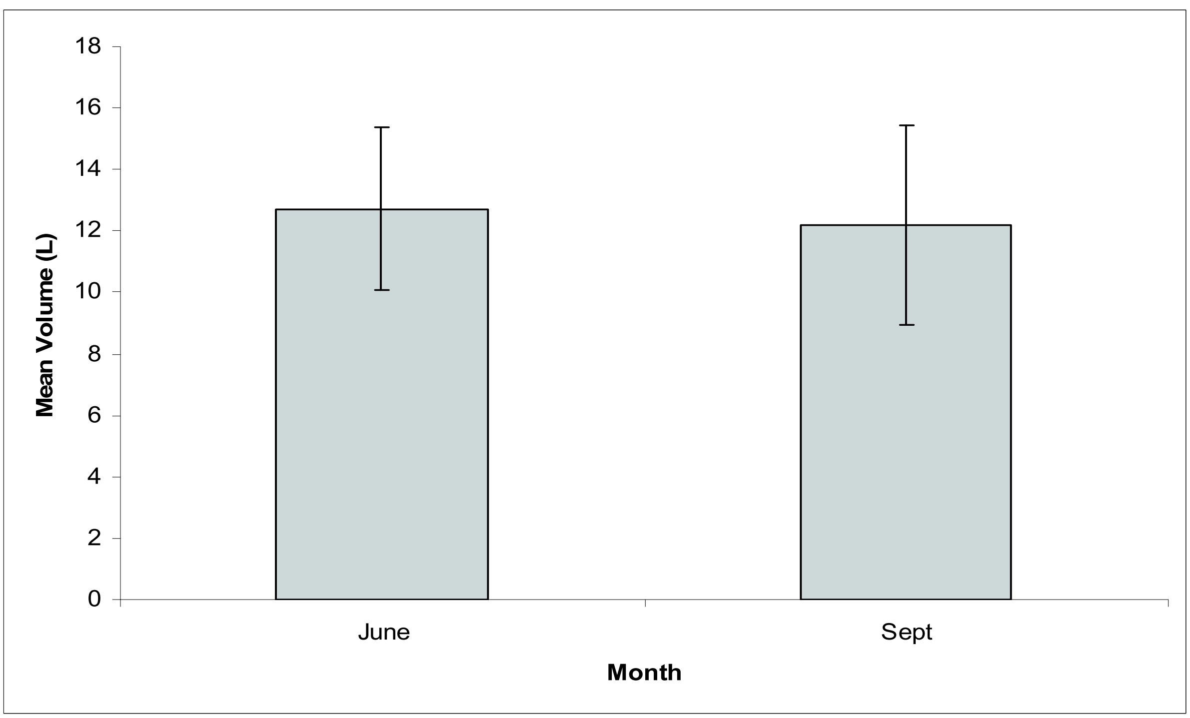

Figure 43. Mean volume (L) ± standard error of total (red and green) macroalgae by month from 2006 – 2011 for the Coastal Bays Fisheries Investigation Beach Seine Survey.

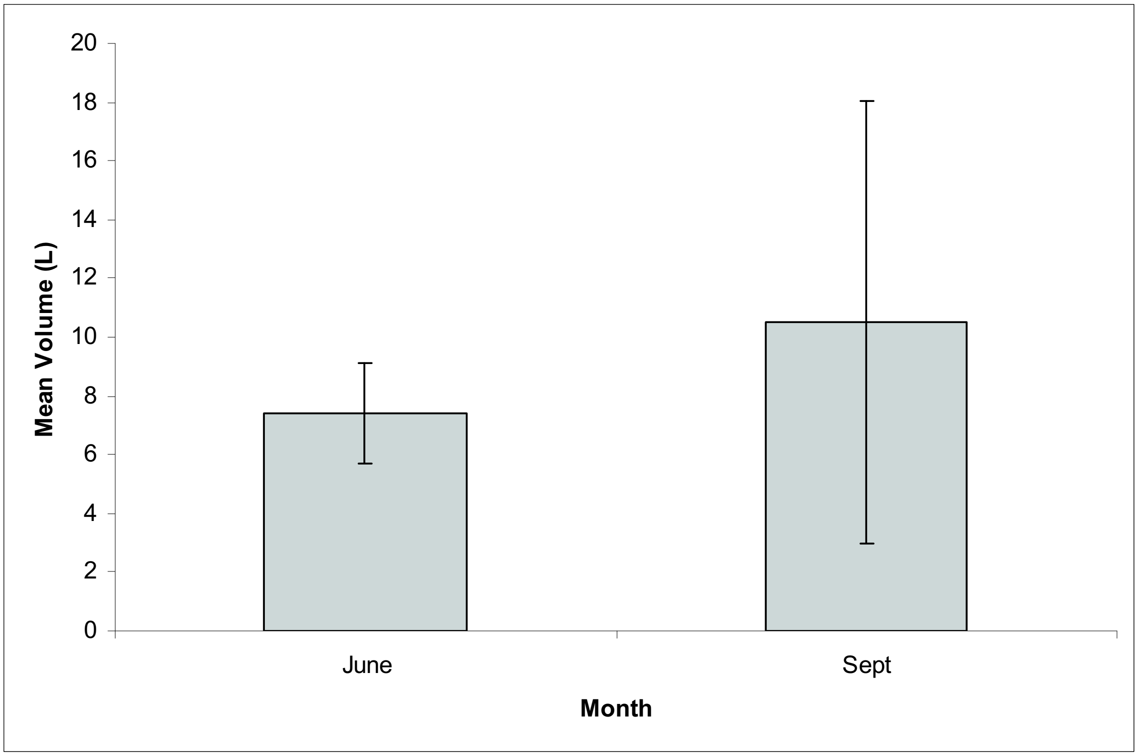

Figure 44. Mean volume (L) ± standard error of total (red and green) macroalgae by month for 2011 for the Coastal Bays Fisheries Investigation Beach Seine Survey.

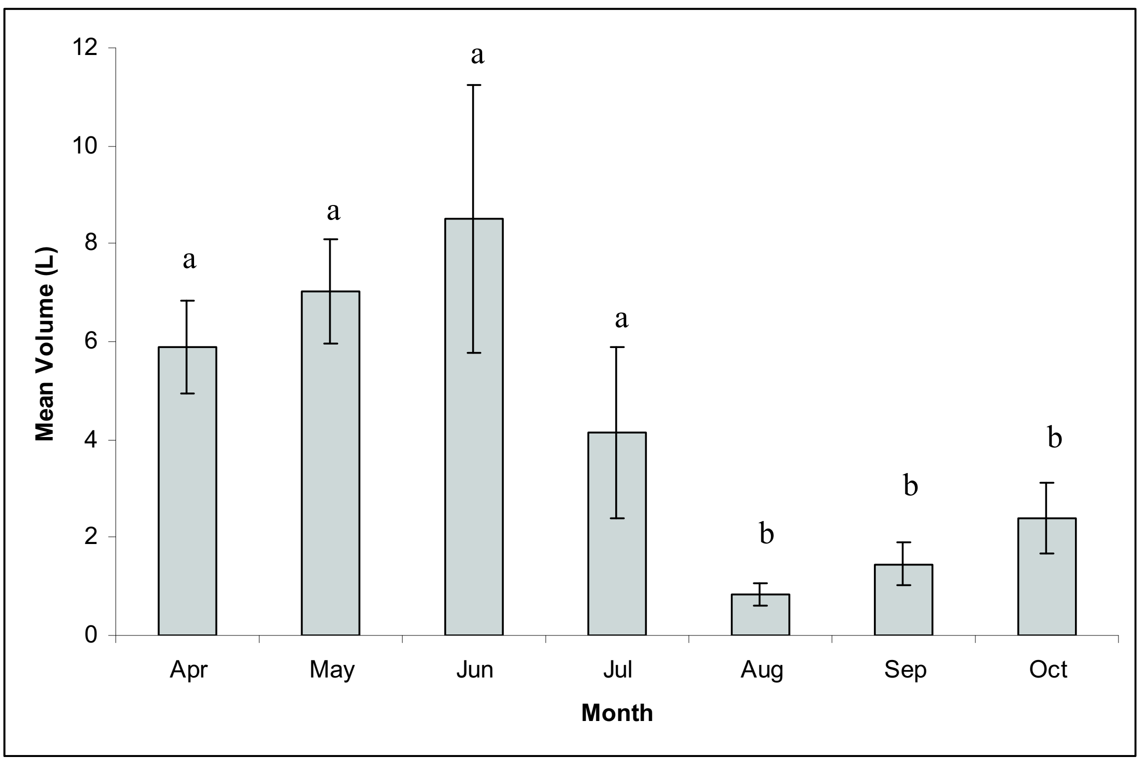

Figure 45. Mean volume ± standard error of green macroalgae by month from 2006-2011 in the Coastal Bays Fisheries Investigation Trawl Survey. Months with different letters are significantly different from each other.

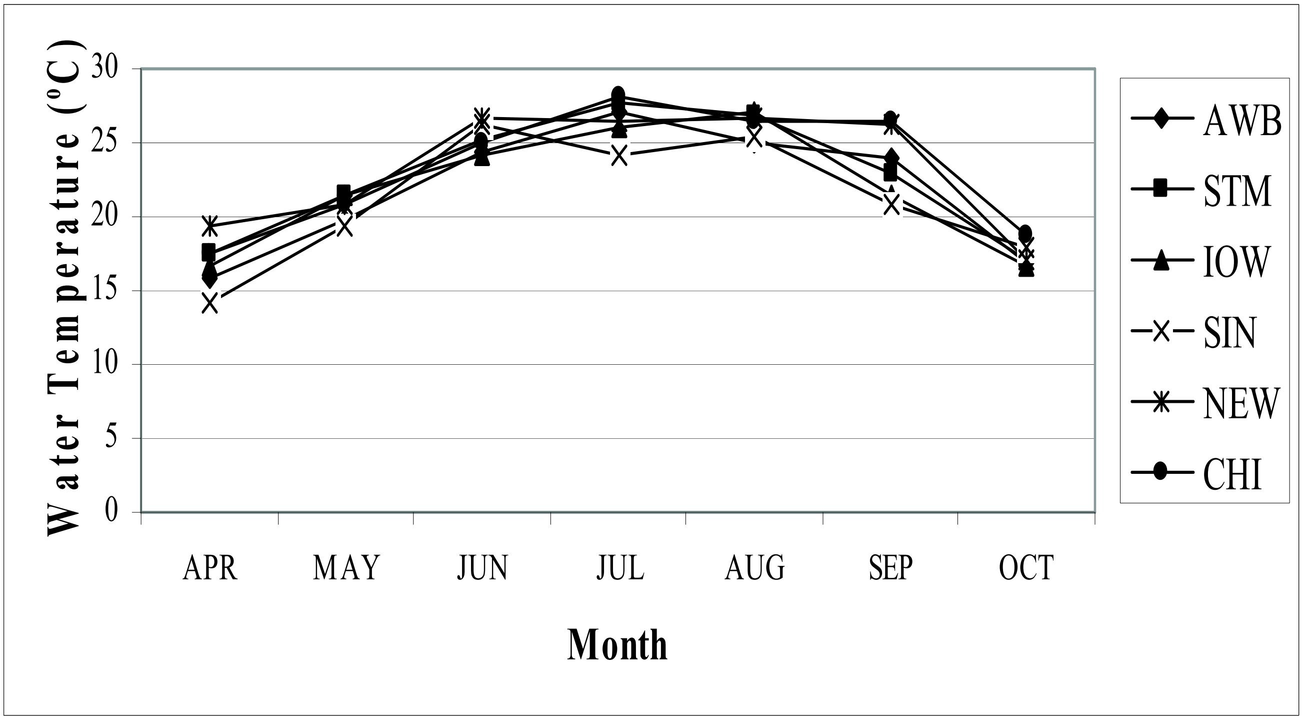

Figure 46. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (^{0}C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

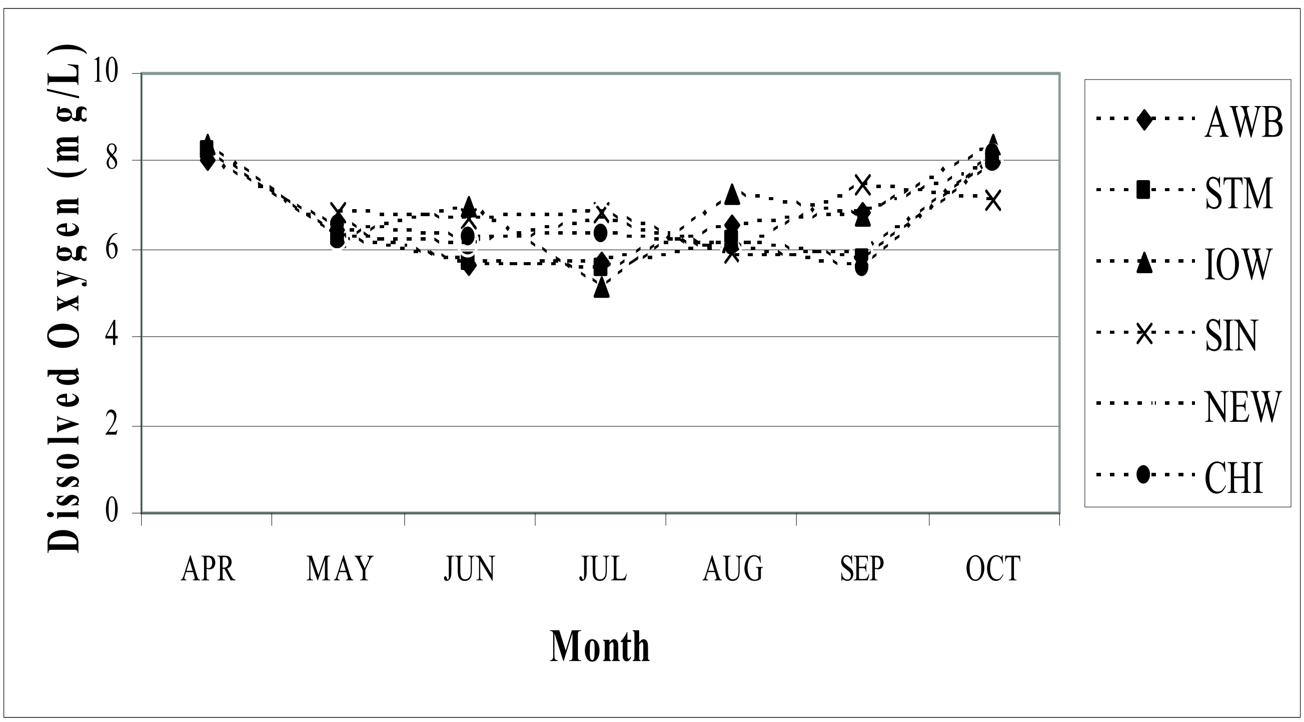

Figure 47. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI). In April YSI with DO probe broken and replacement YSI could not measure DO for Sinepuxent, Newport and Chincoteague Bays.

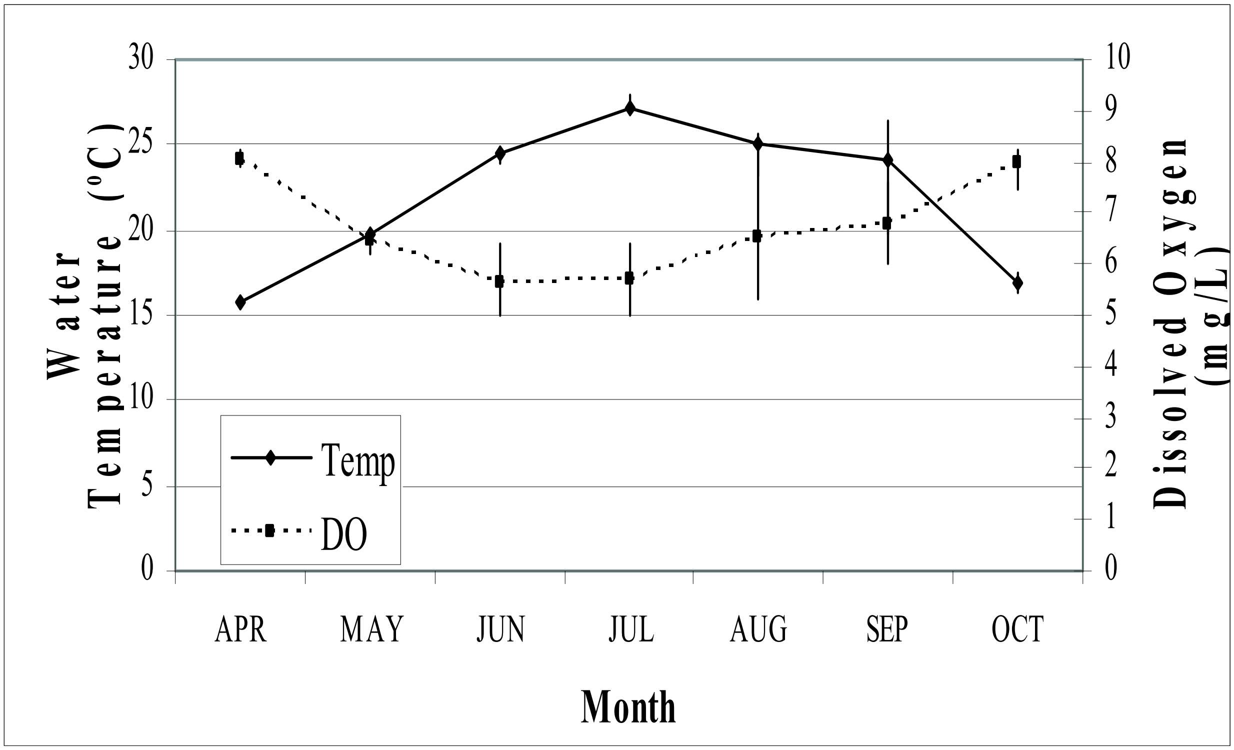

Figure 48. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (^{0}C) and dissolved oxygen (mg/L) by month in Assawoman Bay. Error bars represent the range of values collected.

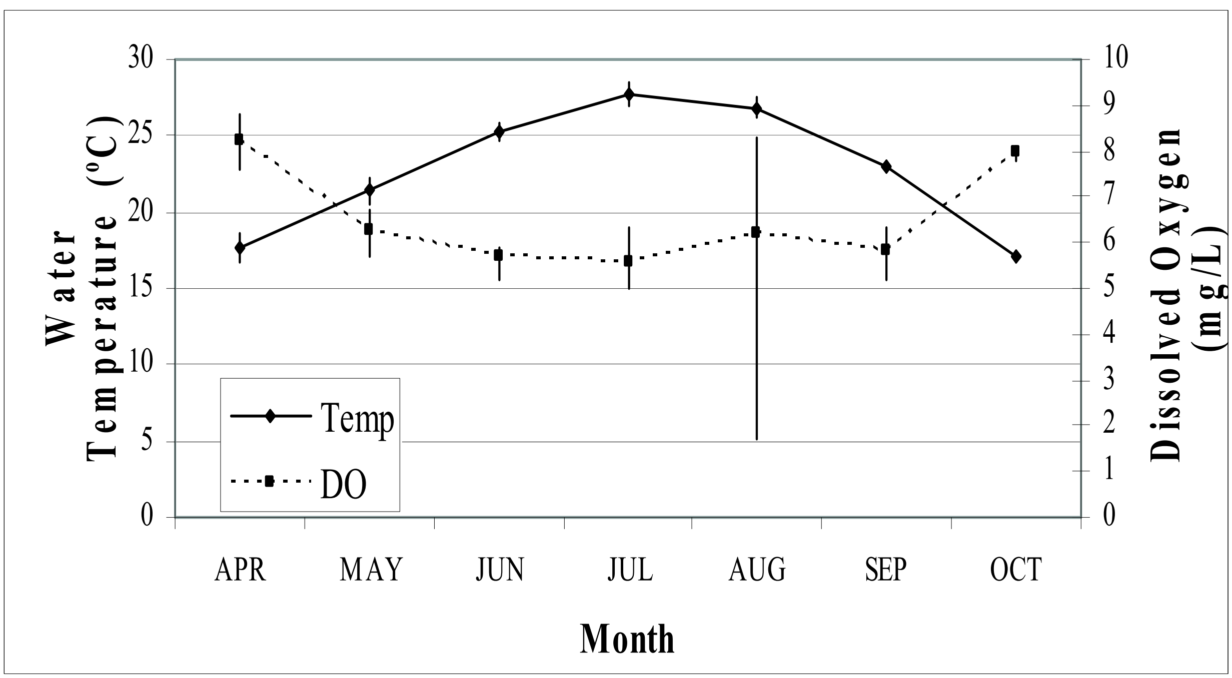

Figure 49. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (^{0}C) and dissolved oxygen (mg/L) by month in St. Martins River. Error bars represent the range of values collected.

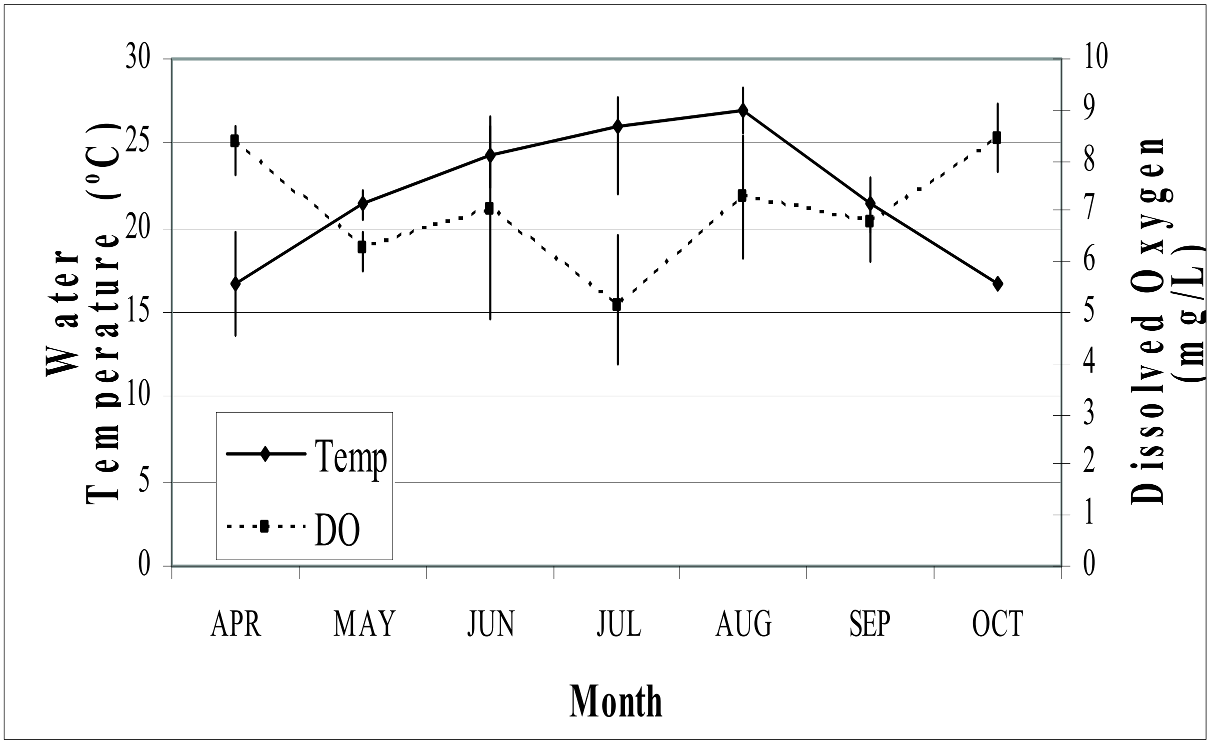

Figure 50. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (^{0}C) and dissolved oxygen (mg/L) by month in Isle of Wight Bay. Error bars represent the range of values collected.

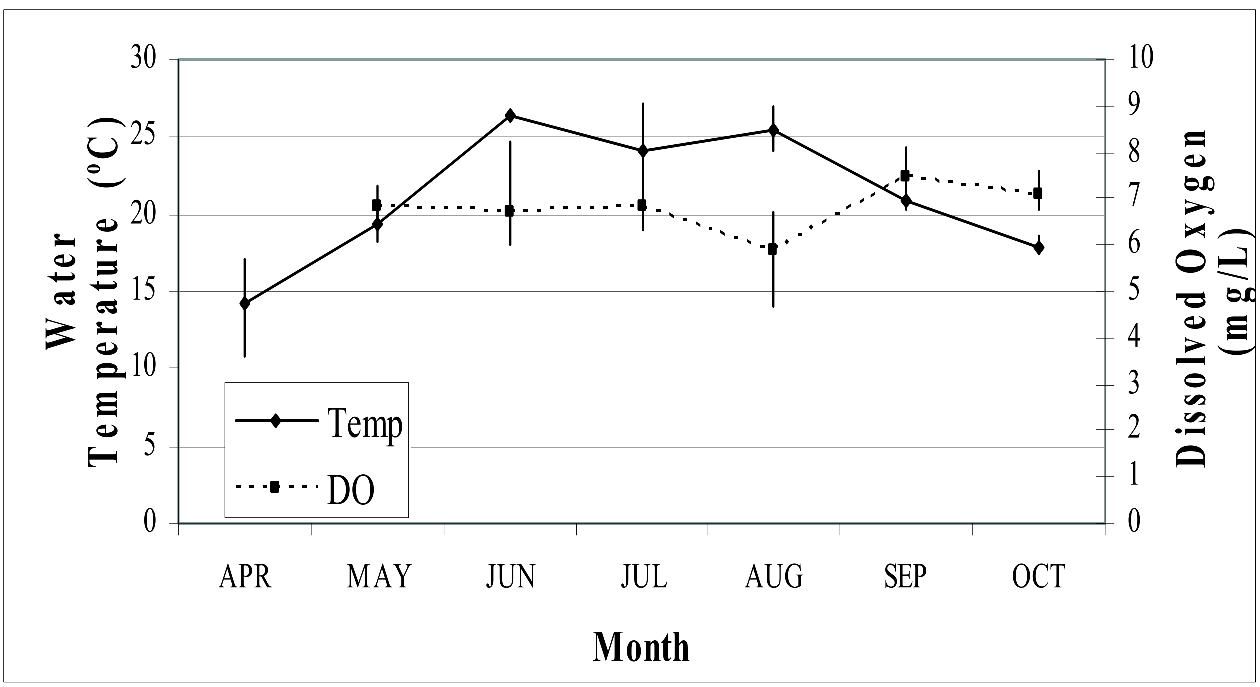

Figure 51. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (^{0}C) and dissolved oxygen (mg/L) by month in Sinepuxent Bay. Error bars represent the range of values collected. April DO values were not available due to equipment malfunction.

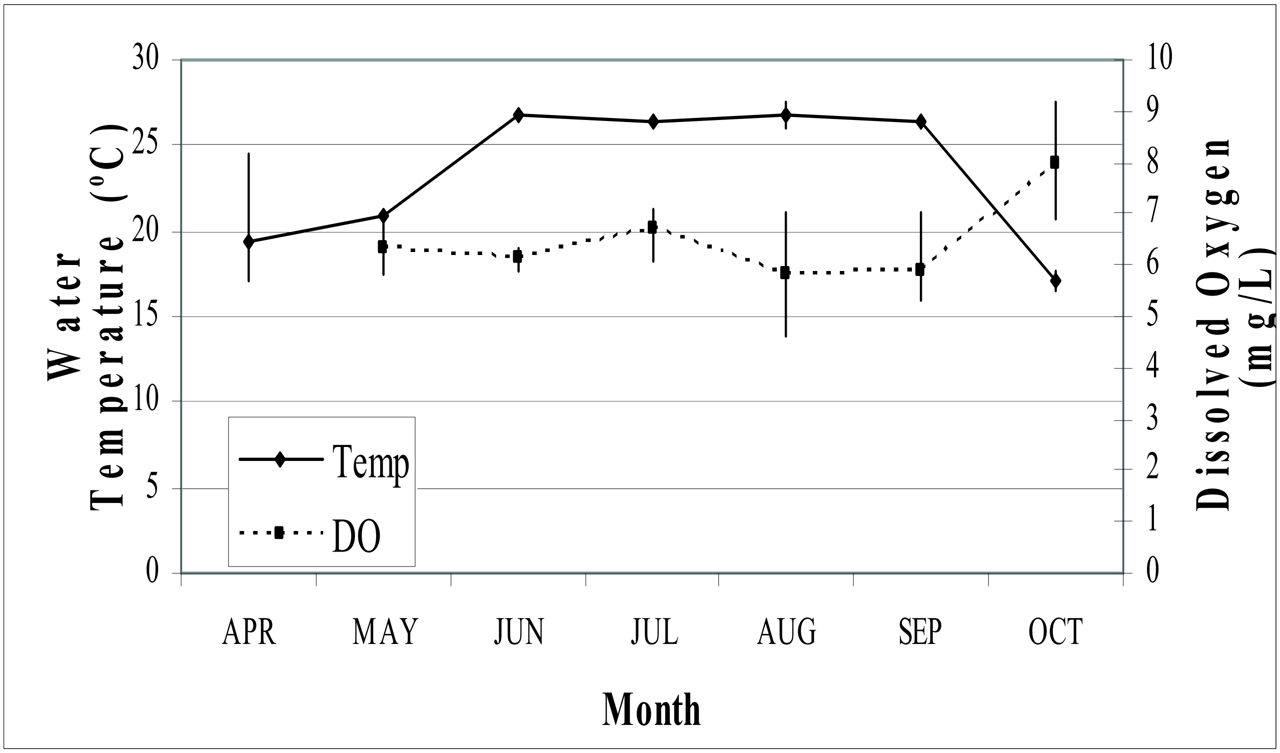

Figure 52. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (^{0}C) and dissolved oxygen (mg/L) by month in Newport Bay. April DO values were not available due to equipment malfunction. Error bars represent the range of values collected. .

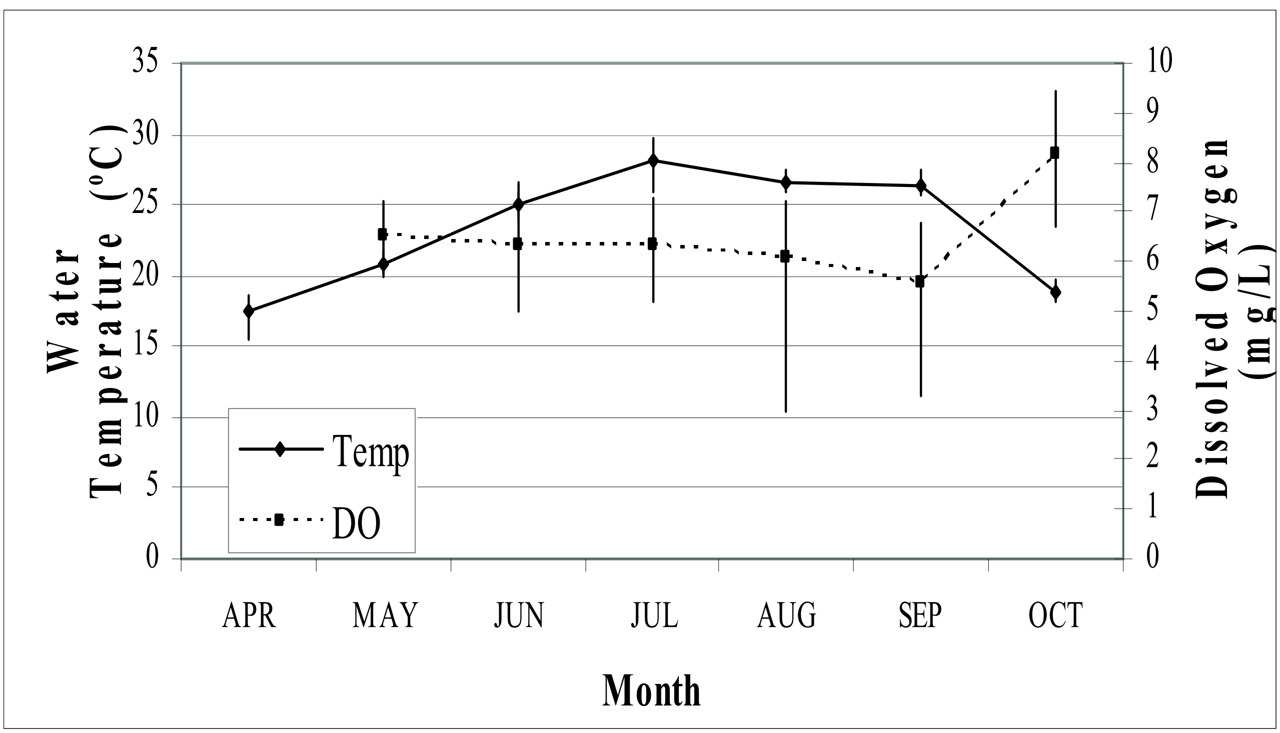

Figure 53. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (^{0}C) and dissolved oxygen (mg/L) by month in Chincoteague Bay. April DO values were not available due to equipment malfunction. Error bars represent the range of values collected.

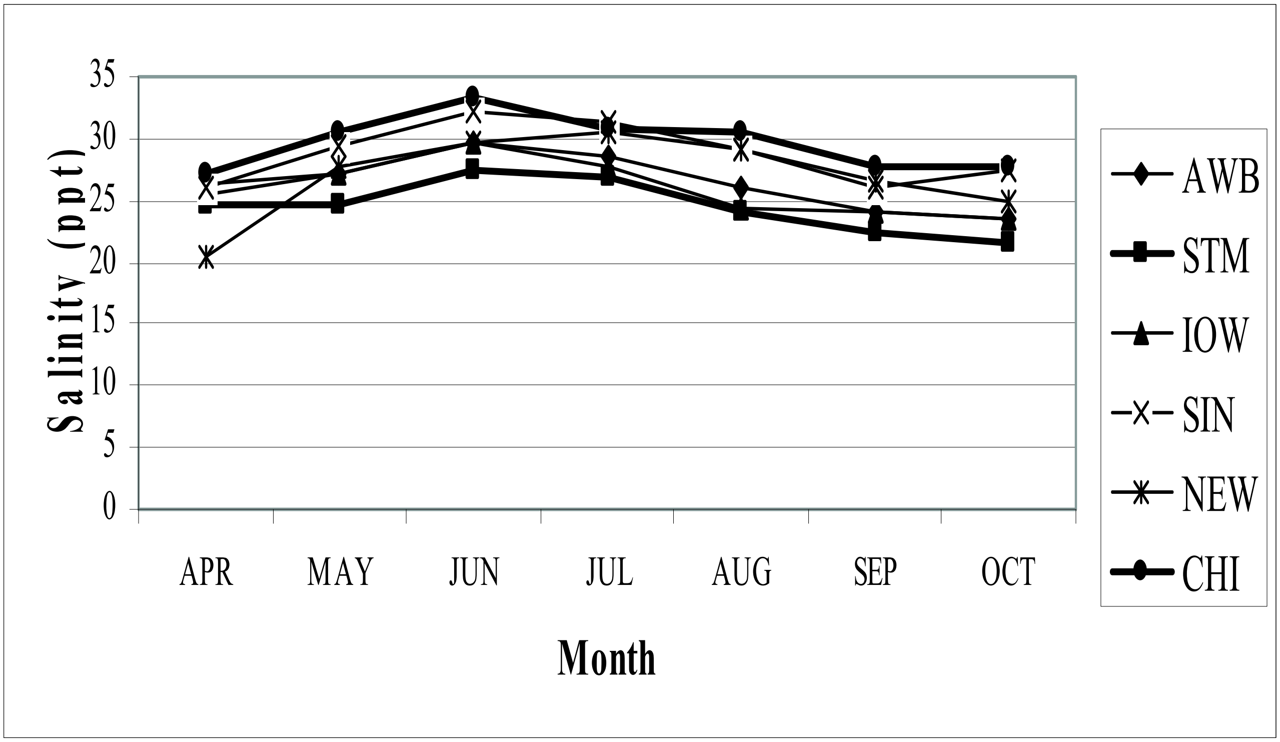

Figure 54. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

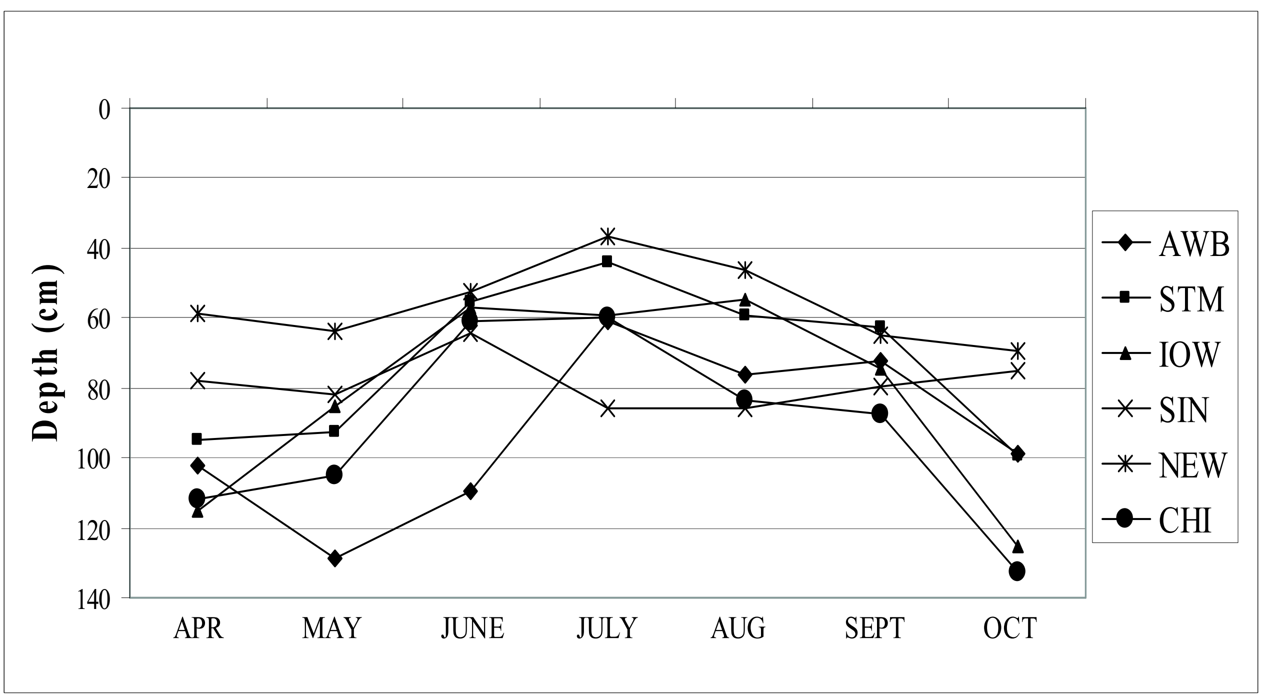

Figure 55. 2011 Coastal Bays Fisheries Investigations Trawl Survey mean turbidity (cm) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

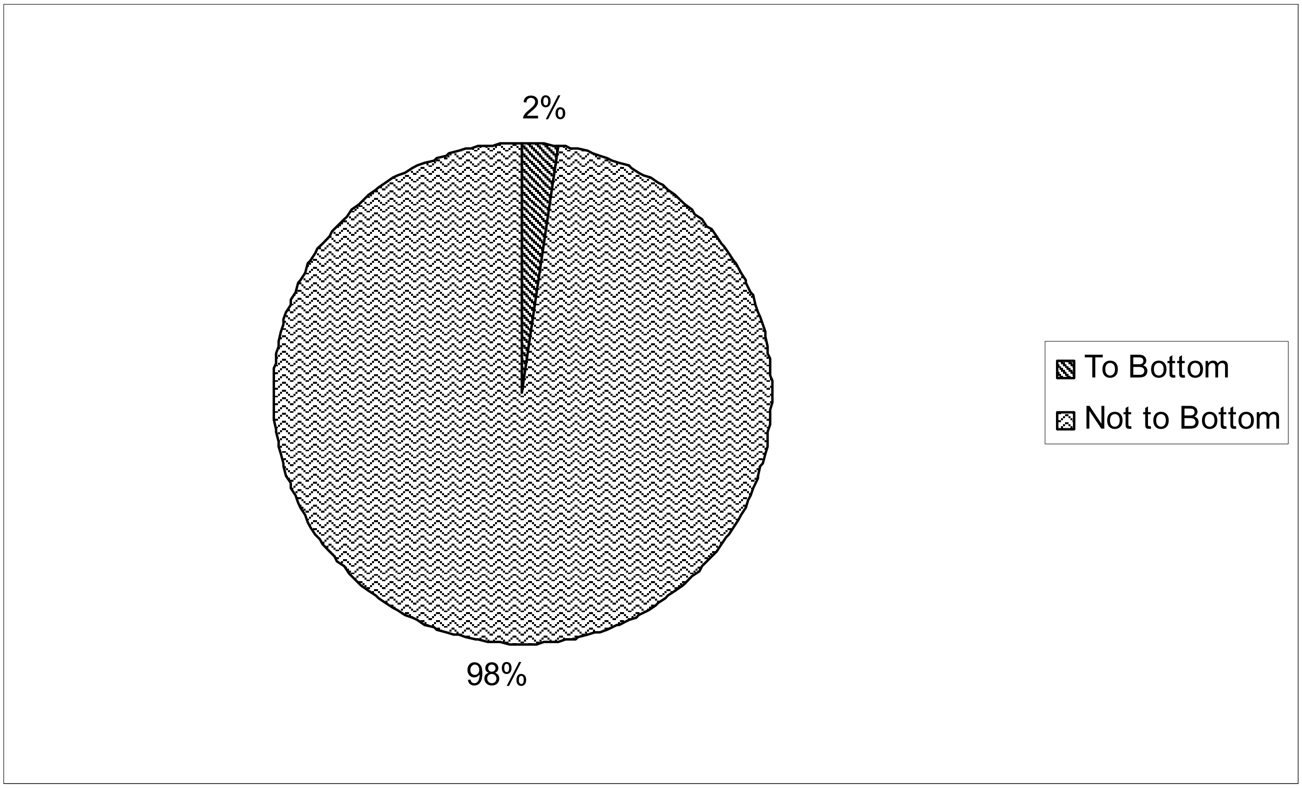

Figure 56. 2011 Coastal Bays Fisheries Investigation Trawl Survey total occasions Secchi disk reached to bottom during sampling.

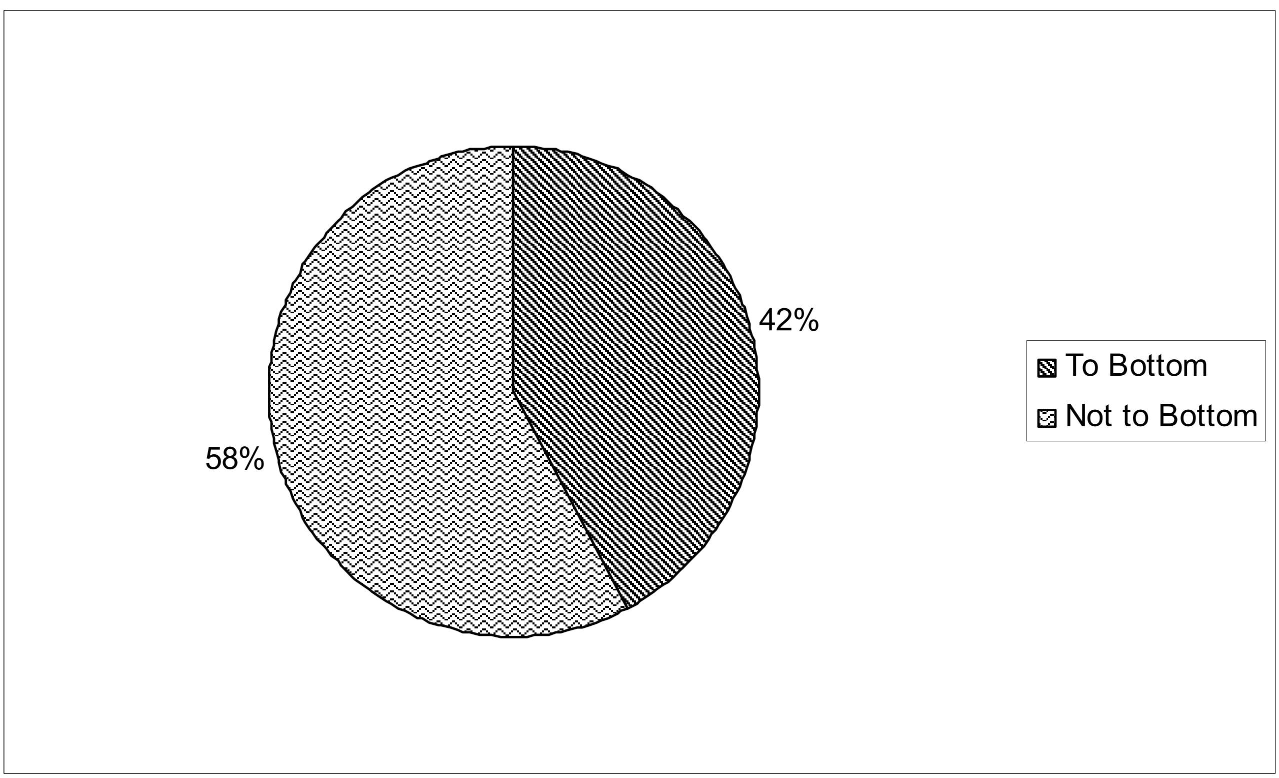

Figure 57. 2011 Coastal Bays Fisheries Investigations Seine Survey total occasions Secchi disk reached bottom during sampling.

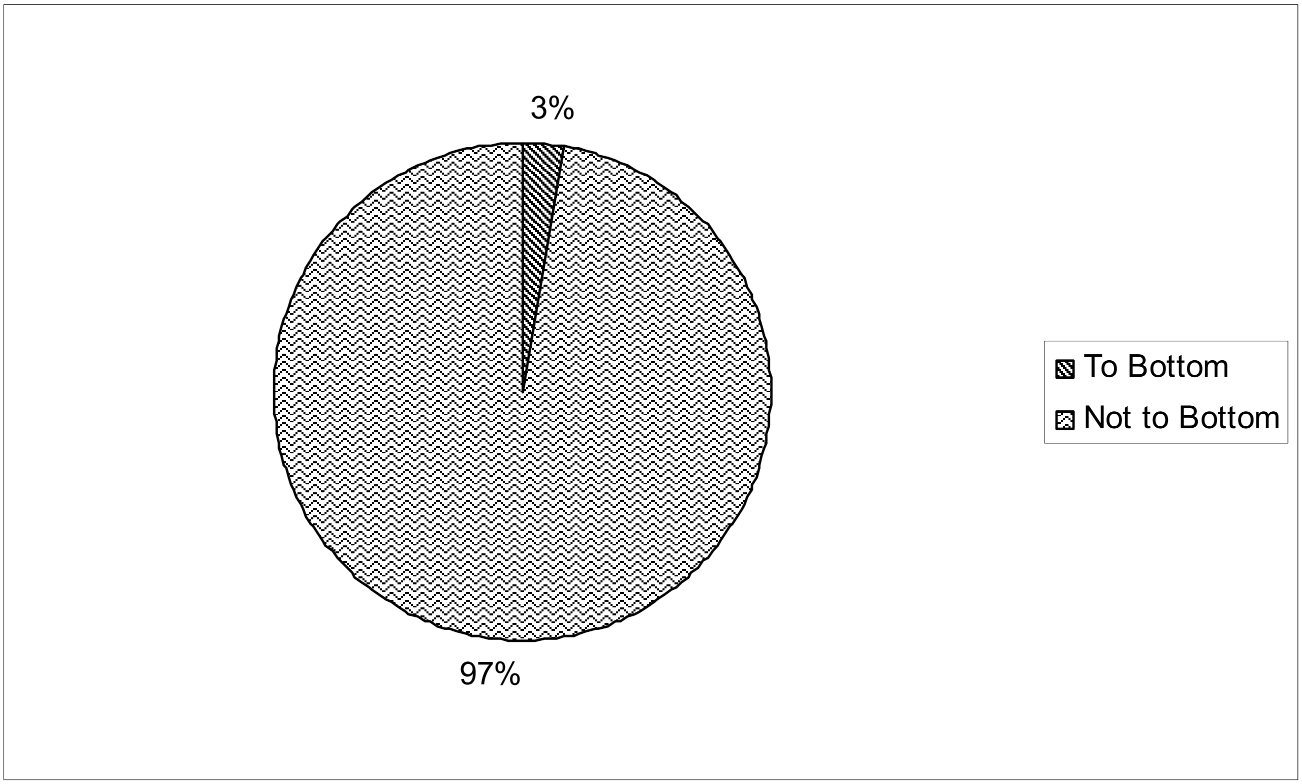

Figure 58. 2010 Coastal Bays Fisheries Investigation Trawl Survey total occasions Secchi disk reached to bottom during sampling.

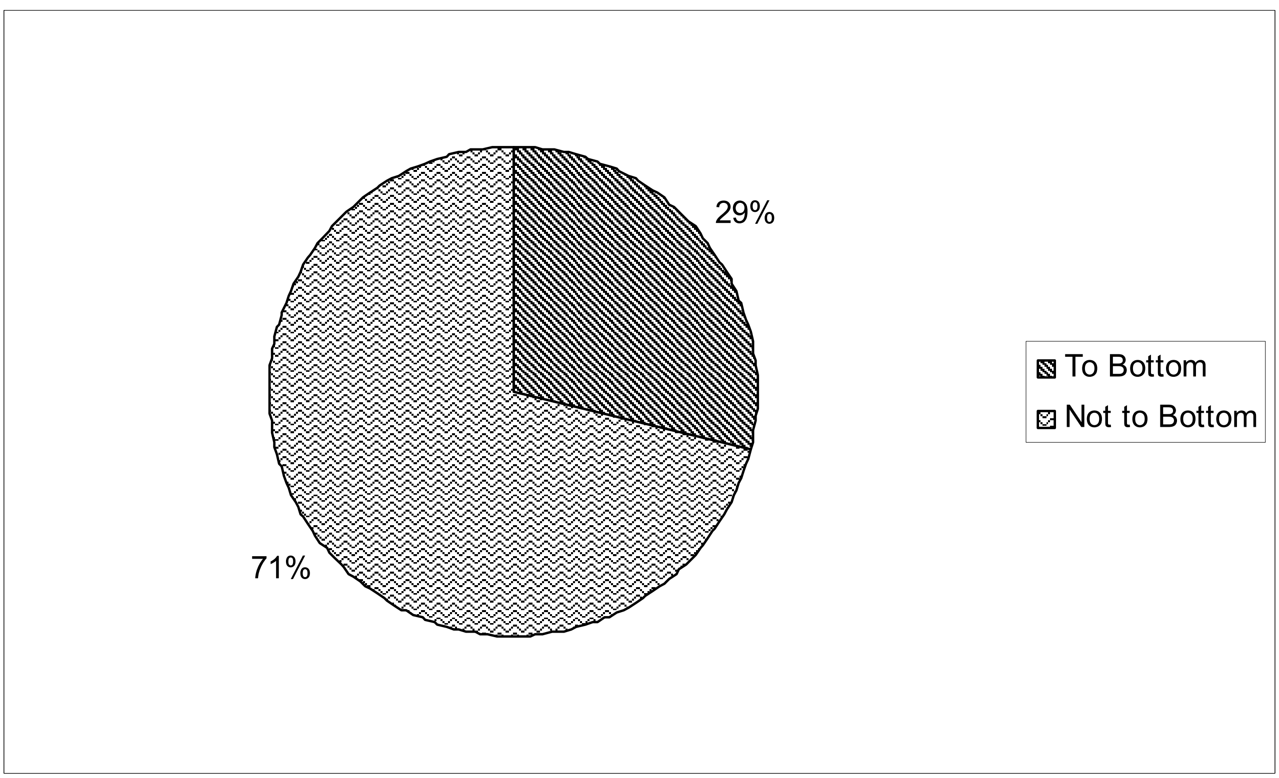

Figure 59. 2010 Coastal Bays Fisheries Investigations Seine Survey total occasions Secchi disk reached bottom during sampling.

Chapter 2

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
In the final year of the five year segment, commercial sampling trips were conducted on June 7, July 7, August 17, September 27, and October 11. Trawl time varied, with times ranging between 15 and 47 minutes.

Gear and Location
Sampling was conducted on commercial trawlers targeting Horseshoe Crabs. For the trips occurring June through October, the net was a standard Summer Flounder bottom trawl net with a 13.97 cm mesh net body, with a 13.97 cm cod end. The head and foot rope widths for the first outing were 18.3 m and 24.4 m, respectively. For all other trawls the head and foot rope widths were 21.3 m and 27.4, respectively. This was the only gear differences during the sampling season. Long Range Navigation (LORAN) coordinates were recorded as well as start and stop depths (m) of each trawl sample.

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.

There is a daily limit on how many Horseshoe Crabs are commercially collected and there is a daily limit on the male to female ratio, so the commercial fishermen count each Horseshoe Crab by sex on every haul. This is useful when we are trying to estimate the sub-sample in relation to the total volume of the haul. When the individuals of a species could not be counted and compared to the total harvest from that haul (most often Horseshoe Crabs), the sub-sample to catch ratio was estimated.

Water temperature (ºC) was taken from shipboard equipment and weather including wind direction and speed (knots) were estimated by the sampler. Data were recorded on a standardized data sheet (Appendix 4). Staff biologists consulted the *Peterson Field Guide-Atlantic Seashore* (1978) and *Peterson Field Guide-Atlantic Coast Fishes* (1986) for assistance in species identification.

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

Results:
Trawl time varied, with time ranging between 15 and 47 minutes. Water temperature ranged from a high of 24.4 C in August to a low of 18.3 C in June. Depth over the course of the surveys ranged from 8.2 m to 17.6 m (Table 1).

From the first sampling trip in June, 140 individual animals were counted and 127 were measured. Seven species were represented (Table 2). During July's trip, eight species and 252 individual animals were counted. This trip generated measurements for 242 animals. During the August trip, 154 animals were counted, representing 18 species. Measurements for 121 animals were collected. On September 27th, 107 animals were counted from 13 species and 105 measurements were taken. One hundred and thirty-seven animals were measured during the October trip and160 animals were counted. Twenty-two species were collected in the sub-samples. Predominant species encountered from all trawls were Horseshoe Crabs (*Limulus polyphemus*), Summer Flounder (*Paralichthys dentatus)*, and Knobby Whelk (*Busycon carica*; Table 2).

From all 2011 trips combined, a total of 155 Summer Flounder were measured. Lengths ranged in size from 170 mm to 620 mm (Figure 1). The mode was 370 mm and the mean was 409.4 mm. For 2011, the mean Summer Flounder length was 409.4 mm which was smaller than the mean from 2007 through 2009. It was similar to last year's mean of 407.1 mm, although no statistical comparisons of lengths were done between years. The largest mean for Summer Flounder was from 2009 (456.8 mm).

From June to October, prosomal lengths were collected for 457 Horseshoe Crabs (Figure 2). There were 168 females with a mean carapace width 168.1 mm and 289 males with a mean carapace width of 174.5 mm.

In 2011 there were 51 Knobby Whelks measured (Figure 3). The minimum size for Knobby Whelks in Maryland to retain for harvest is 6 inches (153mm). The mean size was 178.4 mm and 80% were above the minimum size.

The past five years have seen a change in the most frequently encountered fish species (Table 3). Changes in directed trawling and sampling occurred because of variations in availability of desired species and regulatory changes. Recently the Horseshoe Crabs biomedical industry has dominated the local trawler effort so most of the trips have been closer to port as this is where Horseshoe Crabs dominate. Summer Flounder are often caught when trawling for Horseshoe Crabs as a standard Summer Flounder net is used to capture Horseshoe Crabs, so they have been a more prevalent the fish species in recent years. Weakfish have been declining in samples since 2007. None were seen for the offshore component of sampling during 2008 and 2009.

In 2010, sampling trips from June to October used a standard Summer Flounder trawl net with a mesh body and cod end both measuring 13.97 cm. The mesh body and cod ends were only slightly larger on the net employed in November, though the same species were targeted. Measurements for 295 Summer Flounder and for 414 Horseshoe Crabs were obtained.

During 2009, there were four trips which used a standard Summer Flounder bottom trawl. The fifth trip on January 1, 2010 used a fly-net net and targeted Striped Bass. The January 1st trip data was included with the 2009 data.

In 2008, there were three trips. August and October trips targeted Horseshoe Crabs. While a standard Summer Flounder net was used for all three trawl trips, the December trip specifically targeted that species and went further offshore. Lengths were obtained for 253 Summer Flounders and 263 Horseshoe Crabs that year.

In 2007, there were two trips targeting Horseshoe Crabs and Summer Flounder and in November a fly-net trawl targeting Butterfish and Croaker was used. That season, 132 Weakfish, 291 Summer Flounder, 90 Butterfish, 92 Croaker and 184 Horseshoe Crabs were measured.

Discussion:

The target species for the past five years were Summer Flounder and Horseshoe Crabs for most of the offshore commercial trawls sampled. When feasible, offshore fly-nets trawls have been sampled. However, due to a decrease in the availability of Weakfish and restrictions on the harvest of Butterfish, local commercial fishermen have been doing less fly-net trawling which makes accessing these trips less possible. Over the past five years, variances in species caught can be partially explained by the utilization of different nets due to changes in target species and seasonal changes in fish availability and sampling dates.

The Summer Flounder histogram for 2011 shows a balanced population structure with many age classes and a good number of adult fish in the population (Figure 1). A smaller mean length may have resulted from the influx of recent Summer Flounder year classes or this may be indicative of a slight change in stock structure of the adult population sampled between years.

The Horseshoe Crab histogram for 2011 shows a balanced population with bipolar peaks for both sexes indicating both adults and juveniles in the population. The female adults attain a larger size and this is confirmed in the length frequency plot. The male adults have a appear to have more compressed adult maximum size distribution although they exhibit a proper bell shaped curve of size distribution indicating we have obtained a sufficient number of samples to adequately summarize the size distribution .

The Knobby Whelk length distribution for 2011 shows a reasonably wide distribution, though the number of samples is low. It is encouraging that a large percentage of animals measured are over the minimum size as this indicates that length overfishing is probably not occurring, although it may also indicate low recruitment which may affect harvests in future years. The length of captured animals is also affected by the mesh size and the 5.5” and 6” mesh is a large determinant on the size of captured whelks.

Future sampling will be directed at obtaining lengths, presence data, and abundance for Summer Flounder and other fish species of management interest. Data on Horseshoe Crabs size and abundance, as well as Knobby Whelk lengths and widths, and shark lengths and abundance will also be of interest in sampling for management issues to be addressed in the future.

References:

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

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

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Table 1. Depth Range for Each Survey Trip

Date of Trip	Depth Range (m)
June 7	8.2-9.1
July 7	15.8-17.4
August 17	16.2-17.6
September 27	10.7-13.0
October 11	10.4-13.1

Table 2. List of species collected in Sub-sampled Commercial Offshore Trawls from June through October 11, 2011 by the Maryland Department of Natural Resources, n= 813. Species are grouped (Finfish, Crustaceans, Mollusks, Other) and listed by order of Extrapolated Total Number, n= 26,082 (Numbers under Total Number Column are extrapolated: Number of individuals multiplied by X factor). The actual number of animal counts is presented under Total Number Counted (not in order).

Common Name	Scientific Name	Extrapolated Total Number Captured	Total Number Counted
Finfish Species			
Clearnose Skate	*Raja eglanteria*	1603	40
Summer Flounder	*Paralichthys dentatus*	155	155
Southern Kingfish	*Menticirrhus americanus*	330	9
Spotted Hake	*Urophycis regia*	110	3
Weakfish	*Cynoscion regalis*	81	3
Spot	*Leiostomus xanthurus*	60	2
Northern Kingfish	*Menticirrhus saxatilis*	50	2
Smooth Dogfish	*Mustelus canis*	41	12
Striped Burrfish	*Chilomycterus schoepfii*	41	2
Butterfish	*Peprilus triacanthus*	41	2
Red Hake	*Urophycis chuss*	41	2
Windowpane Flounder	*Scophthalmus aquosus*	40	1
Northern Searobin	*Prionotus carolinus*	30	1
Southern Stingray	*Dasyatis americana*	7	7
Atlantic Angel Shark	*Squatina dumeril*	2	2
Black drum	*Pogonias cromis*	30	1
Winter Skate	*Leucoraja ocellata*	1	1
Smooth Butterfly Ray	*Gymnura micrura*	1	1
Atlantic Croaker	*Micropogonias undulatus*	1	1
Atlantic Sturgeon	*Acipenser oxyrinchus*	1	1
	Total Finfish	**2,666**	**248**

Table 2. (con't.). List of species collected in Sub-sampled Commercial Offshore Trawls from June 2011 through October 2011 by the Maryland Department of Natural Resources, n= 813. Species are grouped (Finfish, Crustaceans, Mollusks, Other) and listed by order of Extrapolated Total Number, n= 26,082(Numbers under Total Number Column are extrapolated: Number of individuals multiplied by X factor.). The actual number of animal counts is presented under Total Number Counted (not in order).

Common Name	Scientific Name	Extrapolated Total Number	Total Number Counted
Crustacean Species			
Broad-Clawed Hermit Crab	*Pagurus pollicaris*	540	15
Nine-Spined Spider Crab	*Libinia emarginata*	480	11
Rock Crab	*Cancer irroratus*	230	7
Blue Crab	*Callinectes sapidus*	160	4
Lady Crab	*Ovalipes ocellatus*	120	3
Iridescent Swimming Crab	*Portunus gibbesii*	55	2
Pink Shrimp	*Farfantepenaeus duorarum*	1	1
	Total Crustaceans	**1,586**	**43**
Mollusc Species			
Knobby Whelk	*Busycon carica*	559	51
Channeled Whelk	*Busycotypus canaliculatus*	146	10
Brief Squid	*Lolliguncuta brevis*	30	1
	Total Molluscs	**735**	**62**
Other Species			
Horseshoe Crab	*Limulus polyphemus*	20995	457
Sea Star	*Asterias forbesi*	100	3
	Total Other	**21,095**	**460**

Table 3. Most commonly caught five species and the extrapolated number of individuals of these species caught by year in offshore commercial trawls for the past five years.

Common Name	Year	Extrapolated Total Number Captured
Finfish Species		
Weakfish	2007	25896
Butterfish		18790
Atlantic Croaker		7554
Windowpane Flounder		1579
Winter Skate		1404
Summer Flounder	2008	2465
Clearnose Skate		531
Little Skate		310
Spiny Dogfish		225
Striped Burrfish		199
Summer Flounder	2009	764
Bay Anchovy		392
Clearnose Skate		378
Atlantic Croaker		330
Spot		280
Clearnose Skate	2010	2300
Summer Flounder		1134
Atlantic Croaker		900
Spot		220
Weakfish		97
Clearnose Skate	2011	1603
Summer Flounder		155
Southern Kingfish		330
Spotted Hake		110
Weakfish		81

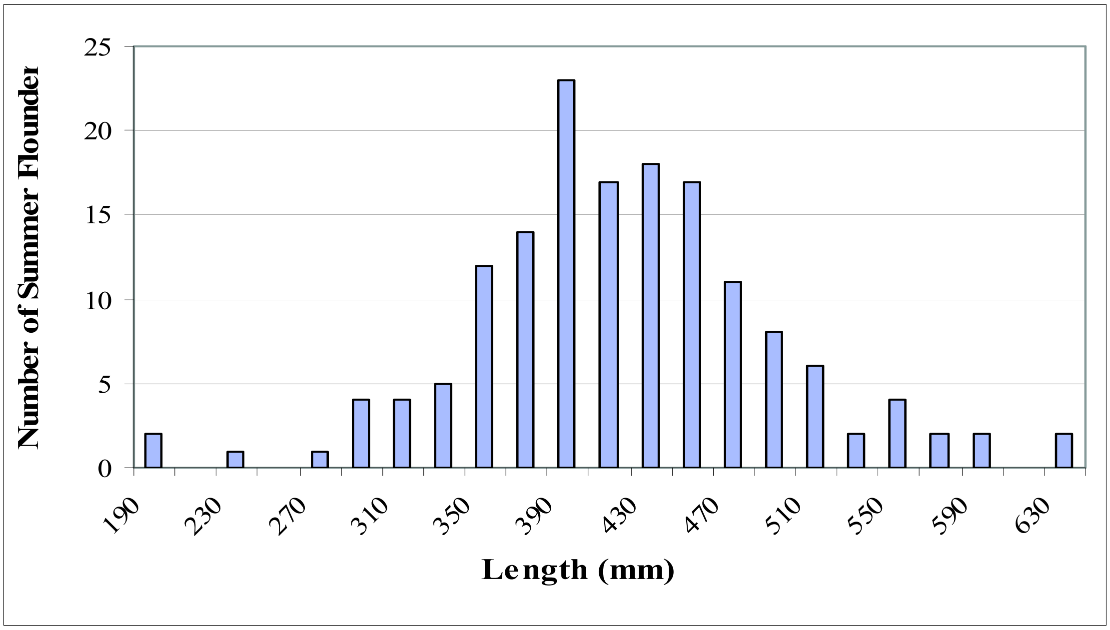

Figure 1. Summer Flounder (*Paralichthys dentatus)* Length Frequency from Commercial Offshore Trawls Sub-sampled by the Maryland Department of Natural Resources Between June and October 2011 n=155. Data were derived from five trawl trips taken at different water depths.

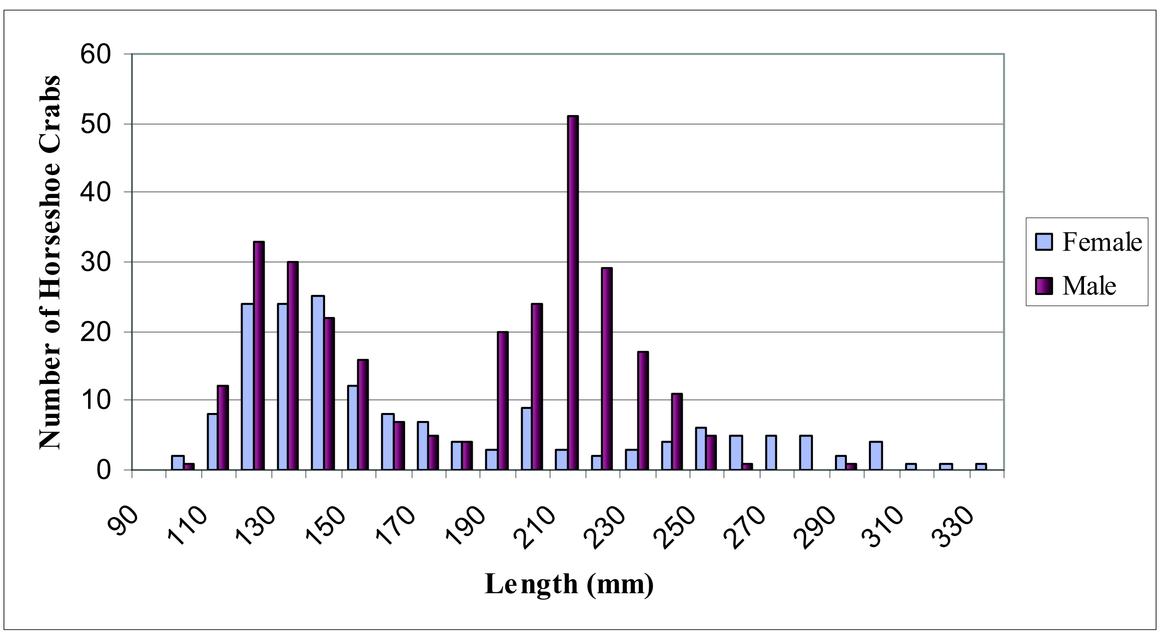

Figure 2. Horseshoe Crabs (*Limulus polyphemus*) Length Frequency from Commercial Offshore Trawls Sub-sampled by the Maryland Department of Natural Resources Between June to October 2011 n= 457. Data were derived from five trawl trips taken at different water depths.

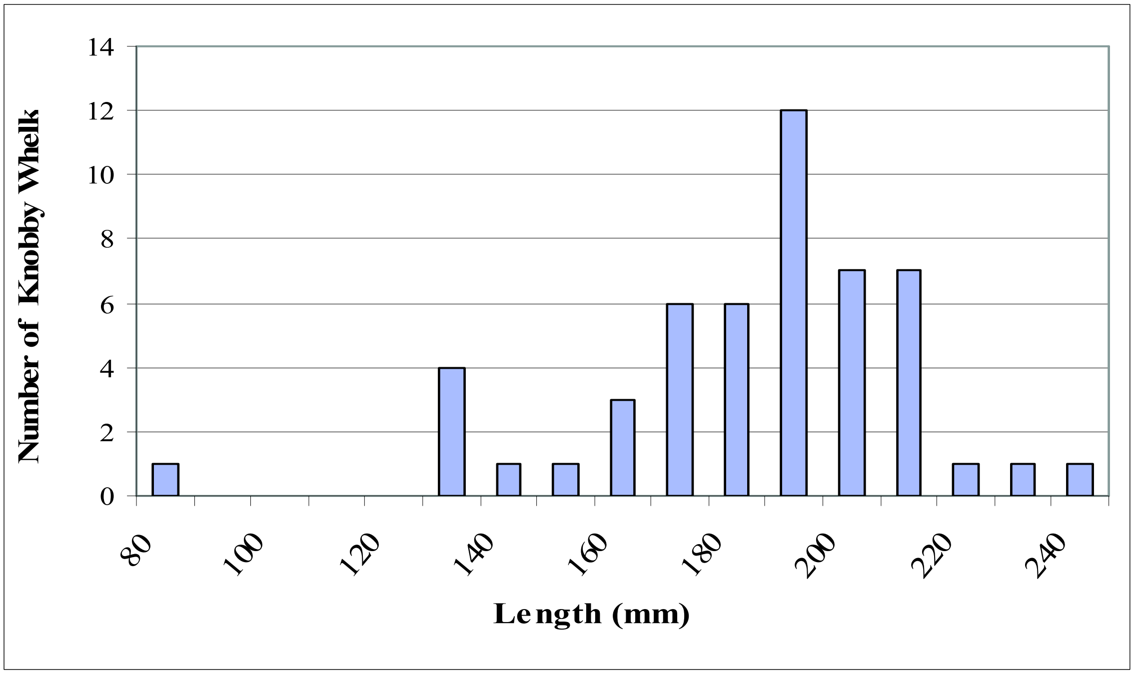

Figure 3. Knobby Whelks (*Busycon carica*) Length Frequency from Commercial Offshore Trawls Sub-sampled by the Maryland Department of Natural Resources Between June to October 2011 n= 51. Data were derived from five trawl trips taken at different water depths.

Chapter 3

2010 and 2011 Seafood Dealer Catch Monitoring

Introduction:
Dockside data have been collected for several years in Maryland to fulfill compliance requirements of the Atlantic States Marine Fisheries Commission (ASMFC) for use in the coastal stock assessment for Weakfish (*Cynoscion regalis*). The ASMFC Weakfish stock assessment committee uses age and size information of commercially harvested fish along the Atlantic Coast to develop coastwide assessments for this species.

Data from 2010 commercial Weakfish sampling are included in this report. Those data were not available at the time of printing the annual 2010 report.

Results and Discussion:
During the final year of this five year grant segment (2011), Weakfish were rarely seen at the coastal packing houses making it impossible to obtain any for size measurements and otolith extraction. For 2007, 2008, 2009 and 2010 the average ages for the Weakfish were 2.0 years, 1.4 years, 1.2 years and 1.4 years (Table 1).

Despite more fish available in 2010 compared to 2009, there appears to be a decline in this fishery. Maryland commercial Weakfish landings (Atlantic Coast and Chesapeake Bay combined; source: Maryland Commercial Reporting Program, personal communication) were 4,879 pounds for 2009. The average is far beneath the 1929 to 2008 yearly harvest average of 643,650 pounds. This marked the fifth year in a row the total for commercial landings in this state has declined (Rickabaugh, 2010). The interception of such a small sample from the coastal fishery for 2009 and no sample at all from 2011 may not be unexpected considering the reduction of total commercial landings over the previous few years. Regulations became more restrictive in Maryland waters in 2010. Current commercial regulations include a limitation to 100 pounds of weakfish per day or trip, whichever is longer. These regulations likely explain the limited availability of weakfish for sampling.

For 2010, a total of 115 Weakfish were sampled from commercial trawls. These fish had a mean length of 330.3 mm (range 297-385 mm; 95%CI: ± 3.69) and a mean weight of 365.2 g (range 243-580 g; 95%CI: ± 13.65; Figures 2 and 3). In 2011 zero Weakfish samples were acquired.

A total of 41 Weakfish were sampled from the commercial trawl harvest in 2009. These fish had a mean length of 364.3 mm (ranges 330-392 mm, 95% CI: ± 4.84). Mean weight was 551.4 g (range 346-726 g; 95% CI: ± 24.95).

A total of 94 Weakfish were sampled from the commercial trawl harvest in 2008. These fish had a mean length of 354.3 mm (13.9 inches; ranges 280-495 mm, 95% CI: ± 8.9). Mean weight was 496.0 g (1.09 lbs.; range 265-1220 g; 95% CI: ± 41.3).

In 2007, Weakfish were commercially harvested using both trawl and gillnet. In 2007, 183 fish were collected from trawls and 34 fish from gill net. The 2007 mean Weakfish length was 343 mm (range 269-532 mm) with a 95 % confidence interval of $\pm$ 4.84. Mean weight was 425 g (range 250-1600 g) with a 95 % confidence interval of $\pm$ 22.75.

Out of the five year period, 2009 had the highest average length at 364.3 mm, but that year also had the lowest sample size (n = 41). From the limited data we have there does not appear to be a trend in mean length, weight or age for the time period from 2007 to 2011, though no statistical analyses were conducted to determine if that was the case. There were a few larger individuals sampled in 2007 and 2008, with fewer larger individuals sampled through the time period notable in the range data.

Reference:

Rickabaugh Jr., Harry W. 2010. Maryland Weakfish (Cynoscion regalis) Compliance Report to the Atlantic States Marine Fisheries Commission. Maryland Department of Natural Resources. Annapolis, Maryland

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Table 1. The number, average age and mean length for Weakfish sampled along Maryland's coast from 2007 to 2011.

Year	Number Sampled	Average Age	Year Range
2007	217	2.0	1-4
2008	94	1.4	1-3
2009	41	1.2	1-2
2010	115	1.4	1-3
2011	0	0	0

Table 2. Weakfish length ranges and confidence intervals from 2007 to 2011.

Year	Mean Length (mm)	Range	CI
2007	343.0	269-532	± 4.84
2008	354.3	280-495	± 8.90
2009	364.3	330-392	± 4.84
2010	330.3	297-385	± 3.69
2011	0	0	0

Table 3. Weakfish weight ranges and confidence intervals from 2007 to 2011.

Year	Average Weight (g)	Range	CI
2007	425.0	250-1600	± 22.75
2008	496.0	265-1220	± 41.26
2009	551.4	346-726	± 24.95
2010	365.2	243-580	± 13.65
2011	0	0	0

Chapter 4
Maryland Volunteer Angler Summer Flounder Survey (MVASFS)

Introduction:
The MVASFS began in 2002 after anglers expressed dissatisfaction with the Marine Recreational Fisheries Statistical Survey (MRFSS) harvest numbers which resulted in an increase in the minimum size and a creel reduction. Data collected from this survey have been used by the Maryland Department of Natural Resources (MDNR) Fisheries Service for the following:

- to fulfill the Atlantic States Marine Fisheries Commission reporting requirements in conjunction with other recreational flounder harvest data;
- to determine whether a certain size and creel limit affected the Chesapeake Bay differently than the Atlantic Coast;
- characterize the recreational catch of Summer Flounder in Maryland; and
- promote public participation in fisheries management and data collection.

In addition to Maryland's direct use of this survey, these data also influence management decisions along the Atlantic Coast. Fisheries managers in Virginia and Delaware have used these data for estimating creel and size limits. Until the state of Connecticut started a similar program, the MVASFS was one of the only sources of discard data for the recreational summer flounder fishery along the Atlantic coast.

Methods:

Data Collection
The survey was promoted by outdoor columnists as well as several newspapers catering to the maritime industry. Local sport fishing organizations, tackle shops, and marinas also promoted voluntary participation via newsletters, announcements at meetings, and Internet content. Additional promotional techniques included:

- presentations to fishing clubs;
- summary content in the MDNR Fishing Report Year in Review http://www.dnr.state.md.us/fisheries/fishingreport/ (Figure 1);
- advertisements on the MDNR website home page http://www.dnr.state.md.us/fisheries/;
- content on the Coastal Conservation Association-Maryland chapter website http://www.ccamd.org;
- distribution of survey materials (instruction sheets, paper forms, postage paid return envelopes, survey business cards, and summary of previous years results) at three winter fishing shows (Timonium Bass Expo & Boat Show, Pasadena Sportfishing Flea Market, and the Eastern Sports & Outdoor Show in Harrisburg, PA ;
- printed MVASFS form in the weekly *Coastal Fisherman* in the summer of 2009 ;
- post card survey form, specific to the Ocean City, MD area distributed at local sport-fishing meetings, the Waterman's Expo, and area tackle shops .

As in previous years, the survey operated from April through the end of October. Anglers continued to submit data of released fish after the recreational season was closed. Anglers were requested to complete a survey for trips targeting summer flounder even if no fish were caught. Recreational anglers, charterboat captains, and partyboats were asked to count the total number of fish caught, measure only the first 20 summer flounder to the nearest ¼ of an inch, and indicate fate of fish (kept or released). Data collected included: number of anglers, time spent fishing, area fished, mode (such as shore or party boat), and method used. All survey information was required to be submitted online or mailed by November 1st. Anglers were reminded not to submit the same information twice (i.e. use multiple reporting methods). Survey forms received in the mail were entered into the online survey to simplify data storage. In 2010, the survey became online only; paper forms were no longer distributed.

Statistical Analysis
The data were downloaded, cleaned and descriptive statistics were calculated using Microsoft Excel. Descriptive statistics included total number of trips, total number of trips where no fish were caught, total number of anglers, total number of individuals that submitted a survey(s), total number of fish caught, total number of fish measured, total number of fish kept, total number of fish released, percent of legal sized fish in the survey, and mean length. An Analysis of Variance (ANOVA) was performed using Statistical Analysis Software (SAS) to determine if annual mean lengths were significantly different.

Length frequency was calculated for various Atlantic fishing modes (*Bay Bee*, private boat, and shore) to gather length information on encountered fish. All lengths were truncated and placed into one-inch intervals.

The partyboat, *Bay Bee*, submitted length data from its twice-daily flounder fishing trips from April through October. In 2009, the MVASFS 2005-2009 Atlantic data were reviewed to determine if *Bay Bee* data created bias in the survey results. For each year, a chi-square test of independence was performed to determine if a significant difference in the length frequency developed from *Bay Bee* data and measurements from all other recreational anglers' data.

Results and Discussion:
After 2009, the MVASFS gathered data only through the online data entry form. This change was due to an analysis by Maryland Fisheries' Service Analysis and Assessment program that found bias in our volunteer angler program. There is inherent bias in any volunteer angler program's catch rate information because: 1) some anglers are more likely to report successful trips rather than trips where no fish were kept; 2) some anglers are more likely to report unsuccessful trips where they only released fish in an effort to influence future regulations; and 3) the most active anglers are the ones reporting any harvest, the bulk of fishermen are not reporting their angling effort. These biases prevent the data from being accurate for use in determining creel limits, or characterizing the summer flounder recreational fishery in Maryland. Additionally, data entry became an inefficient use of staff time compared to the information gathered; however, the data are still gathered through an online data entry form. The length data are used in creating annual regulations as well as in the summer flounder stock assessments. Since we have identified these biases, in an effort to improve efficiency, we have not been summarizing the survey results or providing descriptive statistics to our stakeholders. The length data are still necessary data, however the remaining information is of limited use.

References:

Terceiro M. 2011. Stock Assessment of Summer Flounder for 2011. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-20; 141 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

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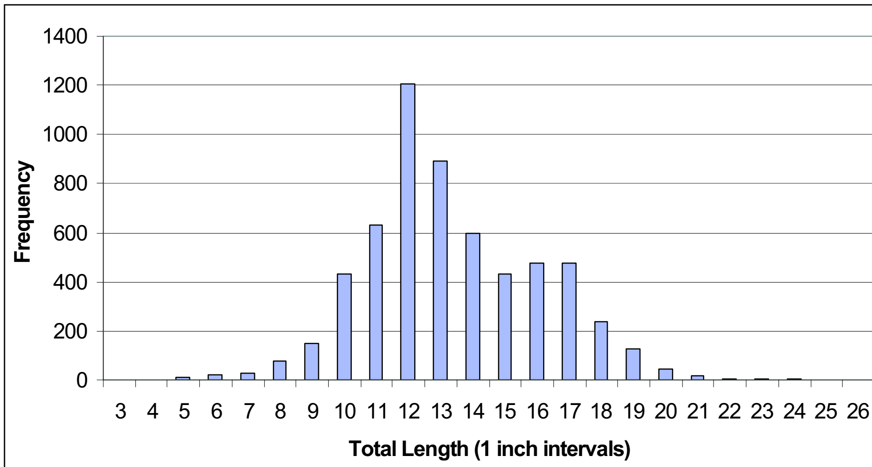
Table 1. Summary of Summer Flounder Regulations and MVASFS data for the Atlantic Coastal Bays 2007–2011.

Year	2007	2008	2009	2010	2011
Regulations: Creel @ Minimum Size (inches)	4 @ 15.5	3 @ 17.5	3 @ 18	3 @ 19	3 @ 18
Number of Individuals Submitting Surveys	166	105	55	19	25
Total Number of Trips	1098	829	561	248	230
Total Number of Trips without catches (Skunked Trips)	114	88	37	209	136
Total Number Summer Flounder Caught	15,064	10,745	10,861	2,370	7,327
Kept	1,625	685	559	50	185
Released	13,439	10,060	10,302	2,320	7,142
Total Number Summer Flounder Measured	9,563	7,019	5,814	1,519	3,067
Measured and Kept	1,325	499	393	44	91
Measured and Released	8,119	6,520	5421	1,475	2,956
Unknown Fate	119	0	0	0	0
Mean Length (inches) of Measured Summer Flounder	13.1	13.4	13.6	13.6	13.5
% of Measured Summer Flounder ≥ Minimum Size	15%	8%	7%	8%	3%

Maryland Department of Natural Resources (DNR) Fisheries Service
2009 Maryland Volunteer Angler Summer Flounder Survey Summary
December 2009

THE ANGLERS...
- 67 anglers reported
- 4,757 anglers fished
- Most were from MD, PA, DE
- 19% belonged to an organization

THE FISH...
- 10,939 fish reported caught
- 5,875 fish measured
- Average length: 13.6 inches
- The length distribution of the overall summer flounder catch has been steady for the past 8 years (2002-2009).



Length frequency of kept and released 2009 Atlantic Coast and Chesapeake Bay fish from the Maryland Volunteer Angler Summer Flounder Survey, n = 5,875.

THE TRIPS...
- 580 trips reported: 561 trips along the Atlantic Coast (97%), 19 trips in the Chesapeake Bay (3%).
- 38 skunked trips: 37 Atlantic coast (7%), 1 Chesapeake Bay (5%).

USES OF THESE DATA...
- Calculate population length distribution;
- perform creel (minimum size) analysis;
- and guide the management approach for Atlantic and. Chesapeake Bay populations.

CONCLUSIONS...
Your participation in this survey is VERY important to summer flounder management along the East Coast. In addition to Maryland DNR, neighboring states of Delaware and Virginia have used these data to guide their management decisions for establishing creel, minimum size, and season limits. The success of this survey resulted in other states implementing a similar program.

For 2010, please continue to:
- encourage others to participate, including friends fishing the Chesapeake Bay where the average number of trips for the past few years is 30;
- measure to the nearest ¼ inch (very important for determining minimum size limits);
- continue to report trips where summer flounder were targeted but none were caught;
- only include one trip per form.

Figure 1. 2009 MVASFS Angler summary for the MDNR Fishing Report, winter edition (Jan. 2010).

Figure 2. Copy of the multi-species business cards, which were distributed at fishing shows, Maryland Sport Fishing Tournament Citation Centers, and presentations.

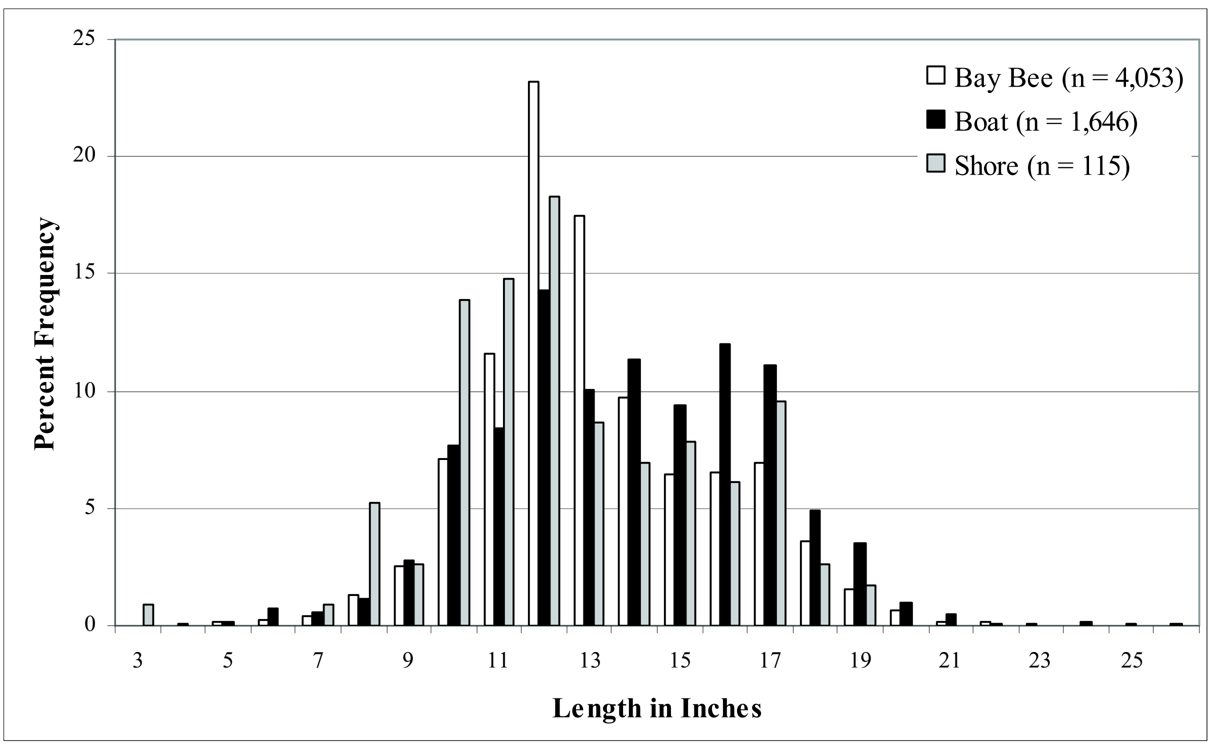


Figure 3. Percent length frequency of kept and released 2009 Atlantic Coast measured data by mode collected from the Maryland Volunteer Angler Summer Flounder Survey, n = 5,814.

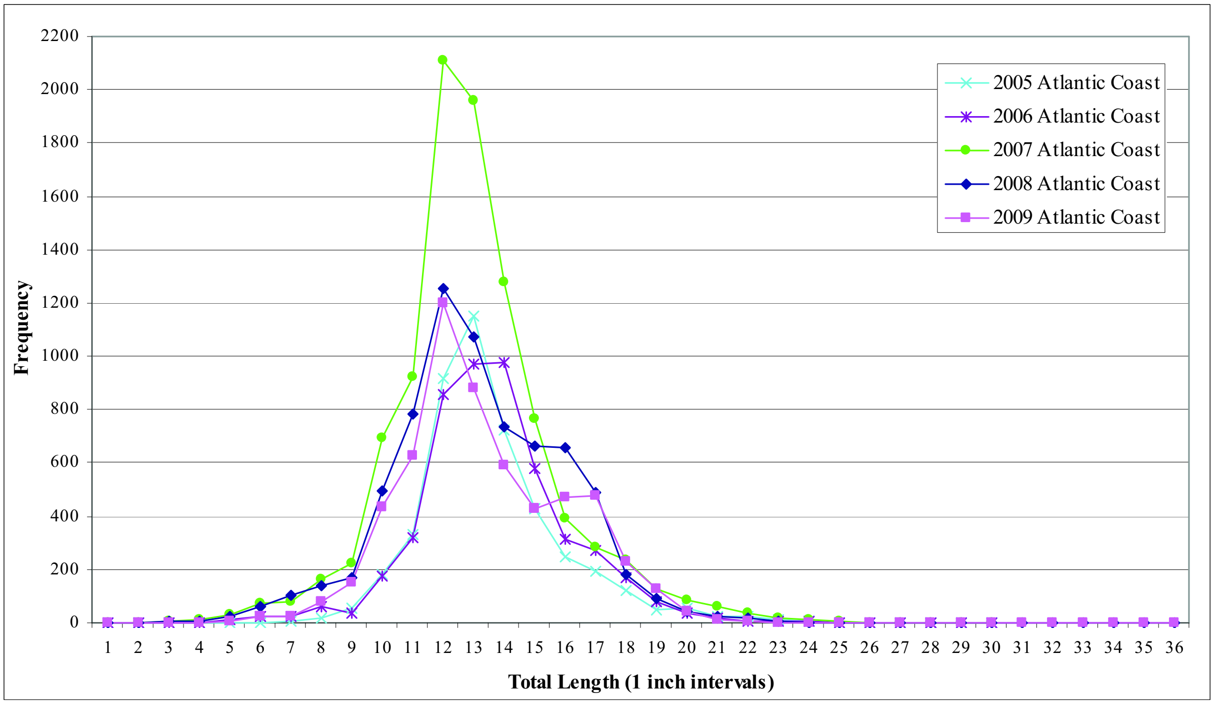


Figure 4. Length frequency of kept and released 2004-2009 Atlantic Coast measured data collected from the Maryland Volunteer Angler Summer Flounder Survey, n = 31,889 (2005 = 4,549, 2006 = 4,952, 2007 = 9,563, 2008 = 7,019, 2009 = 5,814).

Chapter 5

Submerged Aquatic Vegetation Drop Net Program

Introduction
Data describing nekton (fish, crustaceans) presence and abundance in Submerged Aquatic Vegetation (SAV) beds do not exist for the Maryland Coastal Bays. Currently, assumptions about fishes using SAV beds in Maryland's Coastal Bays are based on published life history information and data collected from the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey. Specific data qualifying and quantifying fishes in SAV could be valuable in defining/refining Essential Fish Habitat (EFH) and monitoring species diversity.

Documenting species diversity in SAV is important to fisheries management because it may indicate changes in the food web, displacement of native species, commercial and recreational fisheries dynamics, and anthropogenic behaviors. Species diversity can change over time through shifts in composition, range extension or contraction, and introductions of invasive species (Raposa and Roman 2001). Studies have shown that species diversity in SAV beds are sometimes equal to or greater than other habitats found in estuaries, including: non-vegetated areas adjacent to eelgrass and salt marshes (includes tidal creeks, pools; Raposa and Roman 2001, Clark *et al* 2004, Connolly and Hindell 2006). However, not all SAV beds are equal in importance to fish habitat. Variables such as shoot density, proximity to land (marsh, beach, etc.), or open water influence the quality of the SAV bed as habitat (Beck *et al.* 2003).

The primary goal of the 2009 drop net work was to update the species list for fishes and invertebrates utilizing SAV in Sinepuxent Bay. Comparing lengths of fishes from the drop net samples with those from nearby trawl and beach seine sites was a secondary goal.

Methods
Study Area
One sample location was chosen in Sinepuxent Bay for the two sample sites (Figure 1). This location is on the east side of the Bay just south of the Verrazano Bridge. Sample site selection criteria included:

- SAV was present 23 meters (75 ft) or more away from the shoreline;
- there was an area 23 m (75 ft) or more apart from the vegetated area without SAV;
- water depth was no more than 1 m (3.5 ft) at high tide.

The Verrazano site meets the above listed criteria. Assateague Island State Park borders this site to the east and residential and park properties were located to the west. The vegetated site had a mud bottom and was called D101. The non-vegetated site bottom was hard sand and labeled D100.

Submerged aquatic vegetation and macroalgae (seaweeds) were common in Sinepuxent Bay and provided habitat and foraging sites for fishes and shellfishes (Beck *et al.* 2003). The common species of SAV was eelgrass, *Zostera marina*. *Agardhiella sp*., *Gracilaria sp.*, and *Ulva sp*. were common species of macroalgae found in Sinepuxent Bay.

Data Collection

Gear - Drop Trap

Two 3 m x 3 m x 1.5 m (10' x 10'x 5') drop traps were deployed to target fishes inhabiting SAV and nearby non-vegetated areas. PVC measuring 7.62 cm in diameter (3 inch) was used to construct the frame. Trap legs were cut into 1.52 m (five foot) lengths with one end slanted at a 45° angle to allow posts to slide easier into the bottom. Posts were driven 30 cm (12 in.) into the bottom using a rubber mallet or twisting motion. The top of the frame attached to the vertical posts using 7.62 cm PVC T's. Top frame corners were made with 90° PVC parts. Nylon knotless seine netting (0.6 cm (¼ in.) mesh, 1.8 m (6 ft) height) was attached to the top frame using size 9 twine (84 lb. test) and 5/8th zinc plated chain was zip tied to the bottom of the net in each of the 4 segments. Velcro® connected the seams of the four net segments. Four, 36 cm (14 inch) surveyors steel pins placed in predrilled holes near the top of each vertical post supported the net in the upright position until deployment (Homer *et al* 1978). Zip ties connected the chain at each corner and reduced separation of the net panels when in the pre-deployment position. Size 4 diamond braid line (1.6 cm (1/8 in.), 500 lb. test) was tied to each surveyor steel pin and a snap swivel was attached to the end. Snap swivels were clipped to a central ring which attached to a single rope (main line). The end of the main line was 30 m (100 ft) from the trap and was connected to another PVC post for later retrieval (Homer *et al* 1978).

Deployment

Each trap was set in pre-deployment position and left alone for a minimum of one hour prior to dropping the net to minimize disturbance effects (Homer *et al* 1978). After the trap was deployed by pulling the main line, the lead line was tapped into the bottom to prevent escapement and the Velcro® corners checked to confirm closure. A 3 m (10 ft) bag seine with 0.6 cm (¼ in.) mesh wings was used inside the net to collect specimens. Seining continued until one empty haul occurred (Steele, *et al* 2006). Specimens from all seine hauls were placed into one tub for processing.

Water Quality and Physical Characteristics

Physical and chemical data were documented at each sampling location after the trap was deployed (Homer *et al* 1978). 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.

Salinity, water temperature, and DO were taken with a Yellow Springs Instrument (YSI) 30 at 30 cm (1 foot) below the surface at each site. The YSI cord was marked in 30 cm intervals and the probe had a 26 ounce weight attached to it with a string that measured 30 cm. The weight was used to keep the probe at the proper depth and as vertical as possible. The YSI was calibrated daily, and the unit was turned on at the beginning of each day and left on from that time until the last site readings were taken that day.

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. A biologist marked the position on the string with their fingers and measured the length of the string to the end of the disk.

Wind speed measurements were acquired using a La Crosse handheld anemometer with digital readout. Measurements were taken facing into the wind. Tidal states were estimated by looking at fixed objects when possible, and checking the published tide tables for the sampled areas. Latitude and longitude coordinates in degrees, minutes, and fraction of minutes (ddmm.mmm) were recorded to facilitate navigation back to the same site.

Sample Processing

Fishes were identified, counted, and measured using a wooden millimeter (mm) measuring board with a 90° right angle. Total Length (TL) measurements were taken for most fishes. The first 20 fish of each species were measured and the remainder counted.

Small quantities (generally ≤ 10) of invertebrates were counted although blue crabs (*Callinectes sapidus*) were measured for carapace width, sexed, and maturity status determined. Sex and maturity categories included: male, immature female, mature female (sook), and mature female with eggs.

Statistics

Microsoft Excel was used to perform descriptive statistics, create histograms, and to perform t-tests (t value: α=0.05). Statistical Analysis Software (SAS) was used to perform an Analysis of Variance (ANOVA). An ANOVA (α=0.05) was performed to compare lengths of Atlantic silversides (*Menidia menidia*) from drop net (vegetated site D101 and non-vegetated site D100) and beach seine (S008) during the month of June from 2007-2009. Vegetated and non-vegetated water quality data were averaged since the values were periodically different.

Results

Fishes and Crustaceans

Thirteen species of fishes and crustaceans were collected from monthly samples taken June through September 2009 (Tables 1- 2). Species diversity was highest at the vegetated site. Three fishes (fourspine stickleback (*Apeltes quadracus*), naked goby (*Gobiosoma bosc*), and rainwater killifish (*Lucania parva*)) and two crustaceans, (iridescent swimming crab (*Portunus gibbesii*) and sand shrimp (*Crangon septemspinosa*)), were not previously captured in the first two years of sampling. Five fishes captured in 2007 or 2008 were not captured in 2009 (black sea bass (*Centropristis striata*), oystertoad fish (*Opsanus tau*), spot (*Leiostomus xanthurus*), striped anchovy (*Anchoa hepsetus*) and summer flounder (*Paralichthys dentatus*)). Throughout the survey, 20 species of fishes and crustaceans were collected and species diversity was greatest at the vegetated site.

Unlike previous years, in 2009 fish abundance was higher at the non-vegetated site and was dominated by Atlantic silversides (Tables 1-2). Although fewer grass shrimp were captured in 2009 than previous years, this species was the most abundant crustacean. Only two crustaceans were captured all season (June) at the non-vegetated site.

Since monthly catches were small, data were grouped by type (crustacean or fish) as in past years (Table 3). September (49 individuals) and June (43 individuals) were months with the highest crustacean catches. The highest monthly catch for fishes at both locations occurred in July and June (Table 3).

Atlantic silversides were present throughout the season at both sites (Table 4). A t-test of the cumulative data confirmed that no significant length difference exists between those captured in vegetated or non-vegetated sites (p=0.31). In 2009, Atlantic silversides were also captured at nearby trawl (T010) and beach seine sites (S008; Figure 2). Unfortunately, those 2009 samples were too small to compare with lengths collected from drop nets samples. As a result, data collected from 2007 to 2009 were grouped by gear and the one trawl sample (species count of five) was excluded since it's not a suitable gear for that species. The resulting histogram shows some overlap in lengths, but that both drop net sites had more 30 to 60 mm fish than the beach seine site (Figure 3). An ANOVA was performed on all drop net (vegetated site D101 and non-vegetated site D100) and beach seine (S008) data collected during the month of June from 2007-2009. Results indicated that there was no significant length difference between silversides collected from the two drop net sites (Figure 4). There was a significant length difference between the two drop net sites and beach seine site S008 (p<0.01). Comparison of species counts collected from drop net to beach seine showed that Atlantic silversides were present in shallow areas of Sinepuxent Bay that were not well sampled beach seining in 2009 (Table 4).

Macroalgae and SAV

Three species of macroalgae were collected in 2009. One new macroalga, barrel weed (*Champia sp.*), was collected in 2009 (Tables 5-6). Less macroalgae was collected in 2009 (1.75 L) than in 2008 (4.26L). Small amounts of macroalgae were collected from both sites although the vegetated site (1.62 L) had more than the non-vegetated (0.13 L). Agardh's red weed (*Agardhiella tenera*) was the dominant macroalgae collected at both sites (1.5 L).

Two species of SAV were collected in 2009. Widgeongrass (*Ruppia maritima*) had not been previously collected, but accounted for a small portion of the catch. More dead eel grass was collected in 2009 than 2008. Little SAV was collected from the non-vegetated site. It is important to note that SAV beds extended over 25% more area in 2009 than in 2008, which encroached on the non-vegetated site.

Water Quality and Physical Characteristics

Mean water temperature was highest in August (28.9 C) and lowest in September (22.7 C; (Figure 5)). In 2009, mean water temperatures were cooler than 2008 for all months except August. Unlike 2008, the highest mean water temperature was in August, which is generally considered the hottest month in Maryland. August was the coolest month reported in 2008.

Mean Dissolved Oxygen (DO) was lowest in June and July (4.91 mg/L) and highest in August (7.99 mg/L; Figure 6)). Mean DO was lower than 2008 for the first three months. September had the highest mean DO level, which was expected because the coolest water temperature was reported in September (Figure 7). As water temperatures decrease, DO levels increase as a result of temperature's effect on water's solubility properties.

Salinity readings were consistent between both sample sites. Salinity decreased each month with the highest value in June (28.1) and lowest in September (24.6 ppt; Figure 8). Except in June, the 2009 salinity values were lower than 2008.

Numerically, the worst mean turbidity was in June (30 cm) and the best was July (65 cm; Figure 9). However, when factoring in water depth, the best turbidity was in August and September, when the secchi disk values were to bottom at 57 cm and 60 cm respectively. A similar comparison to 2008 cannot be made since depth data were not available. However, the monthly patterns are similar.

Discussion

The non-vegetated site caught more total fish than the vegetated site in 2009, which was different than the previous two years. This may have resulted from two chance encounters with schools of Atlantic silversides when the nets were triggered. Overall, the vegetated site supported higher species diversity and abundance, which was anticipated from known life histories and literature reviews. Crustaceans, demersal, and structure-oriented fishes were almost exclusively found in vegetated areas.

Unlike 2008, July was the month with the highest catch. This shift from June and July in 2008 may be related to abnormally high tides or cooler temperatures. According to a NOAA report, a rare combination of persistent northeast winds, perigean-spring tide (an extreme predicted tide when the moon is closest to the Earth during a *spring* tide) and a slowed Florida Current were factors influencing tidal height on the Eastern Seaboard (NOAA 2009). The unusual high tides were greatest where these factors overlapped between the Chesapeake Bay Bridge Tunnel and Sandy Hook, NJ. Air and water temperatures are generally cooler when the wind blows over the ocean water from the northeast. Water temperatures were lower for that time period than for 2008.

The drop net captured more Atlantic silversides than trawls and beach seines from nearby sites in the past three years. Additionally, the drop net captured smaller silversides better than beach seining. In both cases, 30 to 60 mm Atlantic silversides are small enough to swim through the mesh, but perhaps the lack of motion by the perimeter of the drop net, resulted in easier capture. Preference of small Atlantic silversides for drop net areas in 2009 may also be related to eelgrass encroachment, reducing the size of the non-vegetated site. Additionally, the unusually high 2009 Atlantic silverside catches coincided with a rare combination of persistent northeast winds, perigean-spring tide and a slowed Florida Current (NOAA 2009).

Although staffing issues limited the number of samples, this gear met the primary objective of monitoring SAV to develop a species list. After two full seasons of collecting data, the secondary objective to compare lengths of fishes from the drop net samples with those from the nearby beach seine site was achieved. Drop net data demonstrated that this gear can pick up species missed by trawl or beach seine because of gear efficiency or location. Although the sampling protocol has value, the project needs to be expanded to include more sites. Additional sites could help with objective one and provide more robust results and flexibility for objective two. Unfortunately, expansion of this program was not possible due to limitations of staff time. The last sampling that occurred as part of this program was in 2009.

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Table 1. Fishes and crustaceans collected during the 2007 through 2009 Drop Net Study in Sinepuxent Bay, Maryland from June through September at the vegetated site, n=966.

Common Name	Scientific Name	2007*	2008	2009	Totals
Atlantic Silverside	*Menidia menidia*	0	11	170	181
Bay Anchovy	*Anchoa mitchilli*	8	45	1	54
Big Claw Snapping Shrimp	*Alpheus heterochaelis*	1	6	0	7
Black Sea Bass	*Centropristis striata*	0	1	0	1
Blue Crab	*Callinectes sapidus*	10	12	34	56
Brown Shrimp	*Farfantepenaeus aztecus*	0	1	0	1
Dusky Pipefish	*Syngnathus floridae*	2	12	1	15
Fourspine Stickleback	*Apeltes quadracus*	0	0	18	18
Grass Shrimp	*Palaemonetes spp.*	217	280	68	565
Iridescent Swimming Crab	*Portunus gibbesii*	0	0	1	1
Naked Goby	*Gobiosoma bosc*	0	0	1	1
Northern Pipefish	*Syngnathus fuscus*	0	3	2	5
Oyster Toadfish	*Opsanus tau*	1	0	0	1
Pipefishes	*Gasterosteiformes*	1	0	0	1
Rainwater Killifish	*Lucania parva*	0	0	7	7
Sand Shrimp	*Crangon septemspinosa*	0	0	5	5
Say Mud Crab	*Dyspanopeus sayi*	0	2	1	3
Silver Perch	*Bairdiella chrysoura*	9	0	1	10
Spot	*Leiostomus xanthurus*	0	32	0	32
Striped Anchovy	*Anchoa hepsetus*	0	1	0	1
Summer Flounder	*Paralichthys dentatus*	1	0	0	1
	Totals	250	406	310	966

*Samples were only collected in August and September.

Table 2. Fishes and crustaceans collected during the 2007 through 2009 Drop Net Study in Sinepuxent Bay, Maryland from June through September at the non-vegetated site, n=472.

Common Name	Scientific Name	2007*	2008	2009	Totals
Atlantic Silverside	*Menidia menidia*	1	2	445	448
Bay Anchovy	*Anchoa mitchilli*	7	0	1	8
Blue Crab	*Callinectes sapidus*	0	3	1	4
Brown Shrimp	*Farfantepenaeus aztecus*	1	0	0	1
Dusky Pipefish	*Syngnathus floridae*	0	1	0	1
Fourspine Stickleback	*Apeltes quadracus*	0	0	1	1
Grass Shrimp	*Palaemonetes spp.*	0	2	0	2
Sand Shrimp	*Crangon septemspinosa*	0	0	1	1
Silver Perch	*Bairdiella chrysoura*	1	0	0	1
Spot	*Leiostomus xanthurus*	0	5	0	5
	Totals	10	13	449	472

*Samples were only collected in August and September.

Table 3. 2009 monthly totals of fishes and crustaceans collected during the Drop Net Study at both sample locations in Sinepuxent Bay, Maryland, n=759.

Month	Number of Fishes Vegetated\Non-Vegetated	Number of Crustaceans Vegetated\Non-Vegetated	Total Vegetated\Non-Vegetated
June	39/106	41/2	80/108
July	144/312	19/0	163/312
August	8/29	0/0	8/29
September	10/0	49/0	59/0
Totals	201/447	109/2	310/449

Table 4. 2009 monthly Atlantic silverside (*Menidia menidia*) counts collected during the Drop Net Study and Beach Seine Survey site S008 in Sinepuxent Bay, Maryland, n=620.

Site Type	June	July	August	September	Totals
Vegetated	23	135	7	5	170
Non Vegetated	105	311	29	0	445
Beach Seine (S008)	4	Not Applicable	Not Applicable	1	5
Totals	132	446	36	6	620

Table 5. Macroalgae and Submerged Aquatic Vegetation (SAV) collected during the 2008-2009* Drop Net Study at the vegetated site in Sinepuxent Bay, Maryland from June through September.

Common Name	Scientific Name	Volume (L) Vegetated 2008	Volume (L) Vegetated 2009	Total Volume (L)
Macroalgae				
Agardh's Red Weed	*Agardhiella tenera*	0.00	1.40	1.4
Banded Weeds	*Ceramium Sp.*	0.03	0.00	0.03
Barrel Weeds	*Champia Sp.*	0.00	0.09	0.09
Graceful Red Weed	*Gracilaria Sp.*	3.50	0.00	3.5
Green Hair Algae	*Chaetomorpha Sp.*	0.05	0.13	0.18
	Totals	3.58	1.62	5.2
SAV				
Eel Grass	*Zostera marina*	5.22	18.13	23.35
Widgeongrass	*Ruppia maritima*	0.00	0.19	0.19
	Totals	5.22	18.32	23.54

*No macroalgae was collected in 2007.

Table 6. Macroalgae and Submerged Aquatic Vegetation (SAV) collected during the 2008-2009 Drop Net Study at the non-vegetated site in Sinepuxent Bay, Maryland from June through September.

Common Name	Scientific Name	Volume (L) Collected 2008 Non-vegetated	Volume (L) Collected 2009 Non-vegetated	Total Volume (L)
Macroalgae				
Agardh's Red Weed	*Agardhiella tenera*	0.01	0.10	0.11
Graceful Red Weed	*Gracilaria Sp.*	0.53	0.00	0.53
Green Hair Algae	*Chaetomorpha Sp.*	0.00	0.02	0.02
Hollow Green Weed	*Enteromorpha Spp.*	0.01	0.00	0.01
Sea Lettuce	*Ulva Sp.*	0.05	0.00	0.05
	Totals	0.68	0.13	0.81
SAV				
Eel Grass	*Zostera marina*	0.22	2.62	2.84
Widgeongrass	*Ruppia maritima*	0.00	0.003	0.003
	Totals	0.22	2.63	2.85

*No macroalgae was collected in 2007.

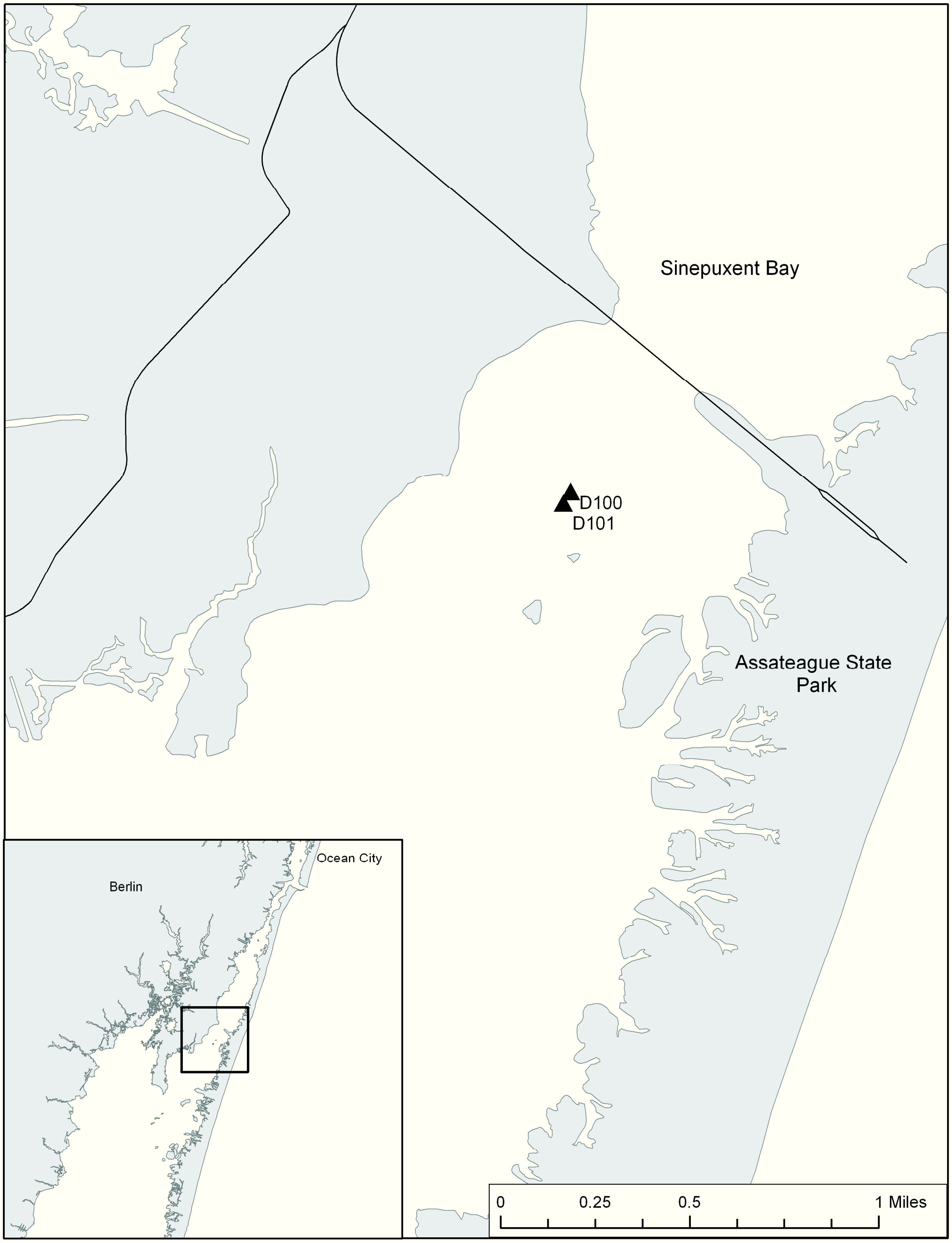

Figure 1. Site locations for the 2007-2009 Submerged Aquatic Vegetation Drop Net Study.

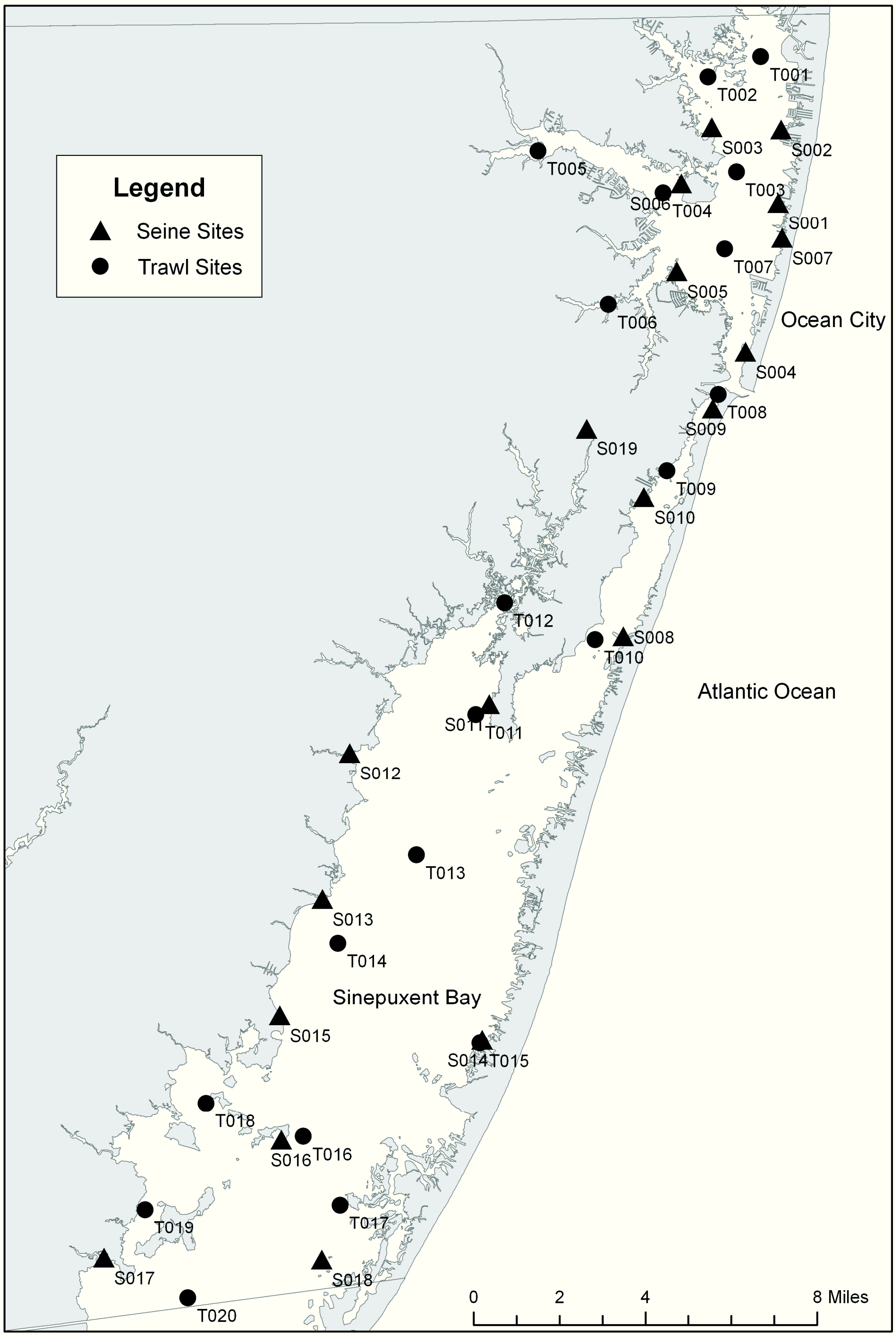

Figure 2. Site locations for the 2007-2009 Coastal Bays Fishery Investigations Trawl and Beach Seine Survey.

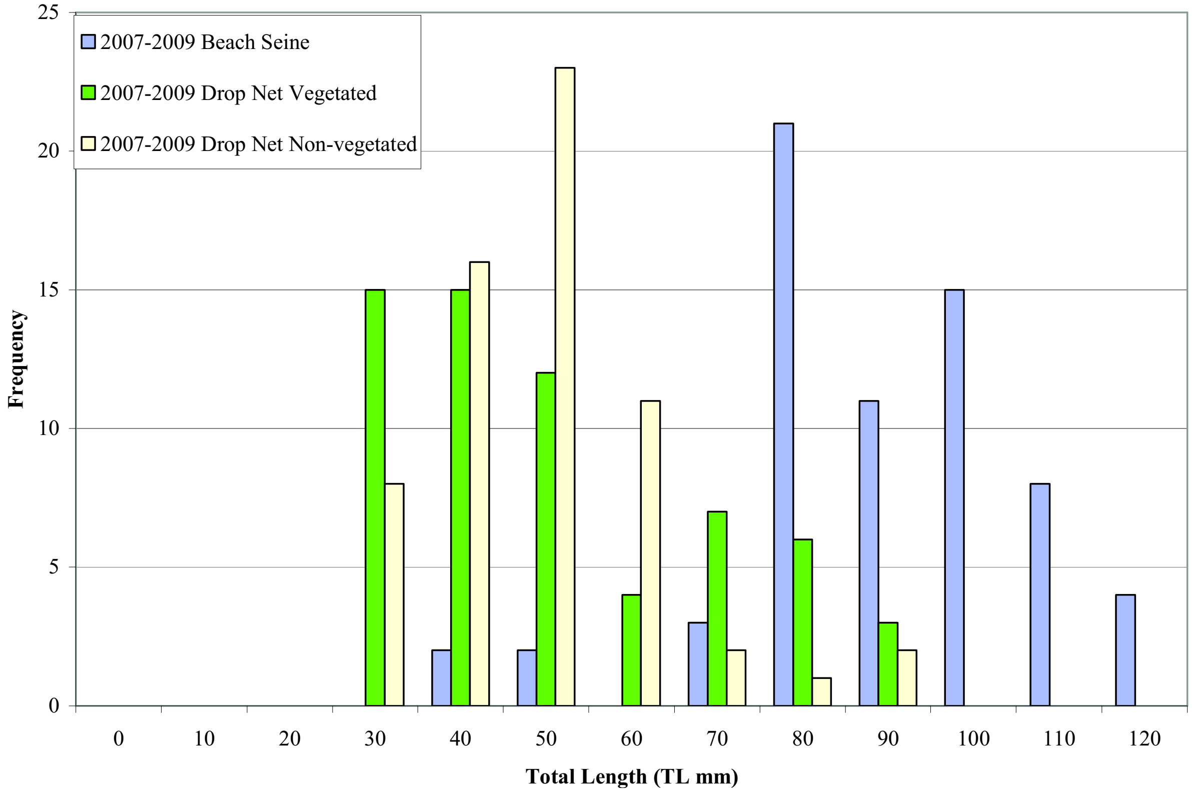

Figure 3. Histogram of Atlantic silversides (*Menidia menidia*) captured in Sinepuxent Bay, Maryland by beach seine and drop net from 2007 through 2009, n=191.

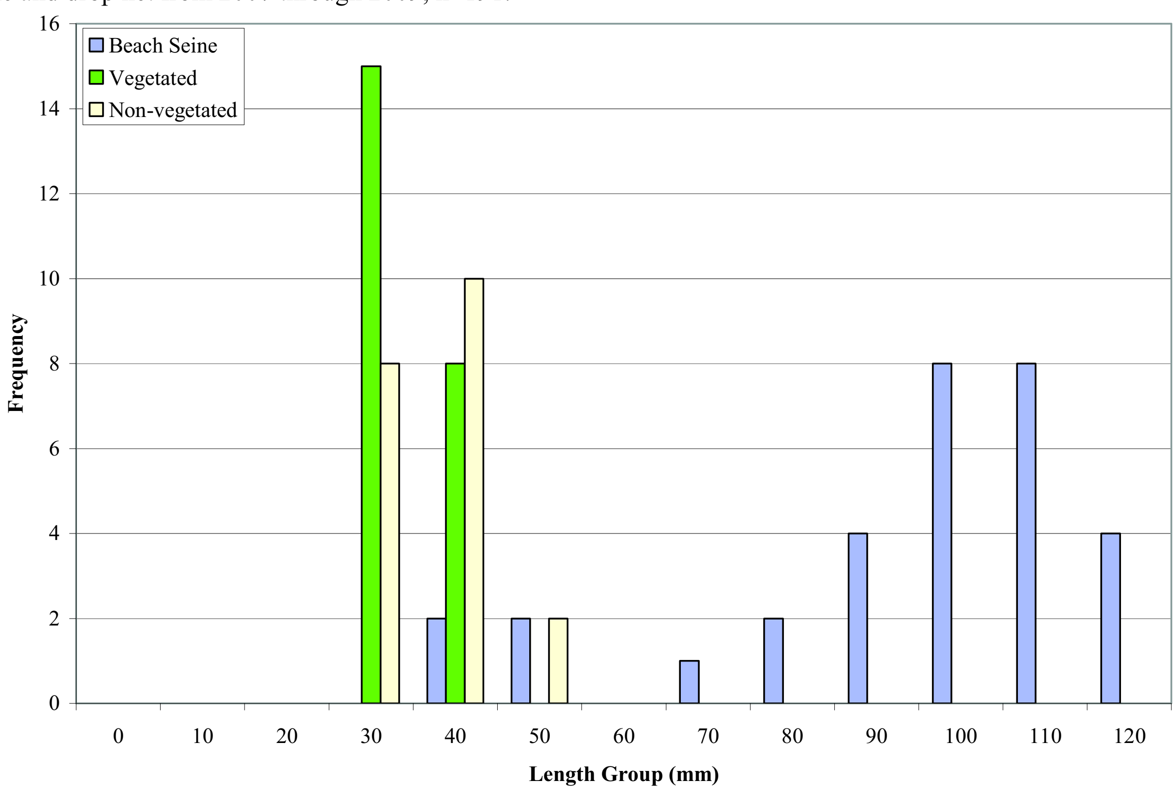

Figure 4. Histogram of Atlantic silversides (*Menidia menidia*) captured in Sinepuxent Bay, Maryland by beach seine and drop net during the month of June 2007 through 2009, n=74.

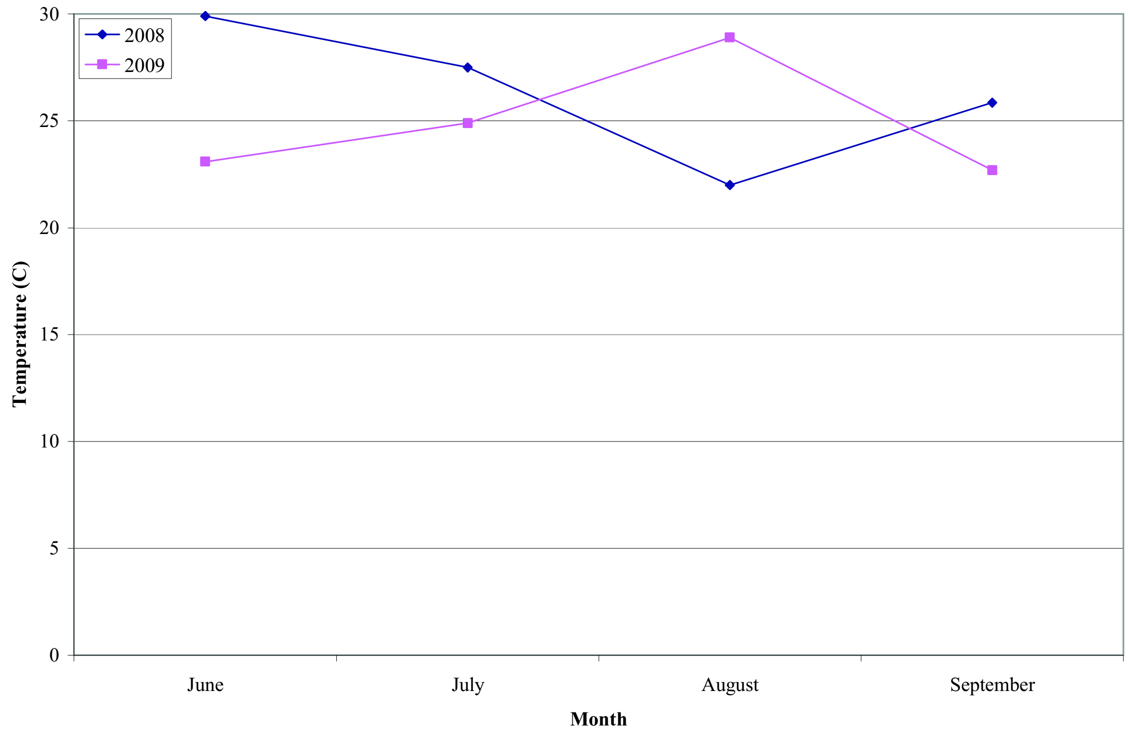

Figure 5. 2008 - 2009 Drop Net Study mean monthly water temperatures collected from Sinepuxent Bay, Maryland.

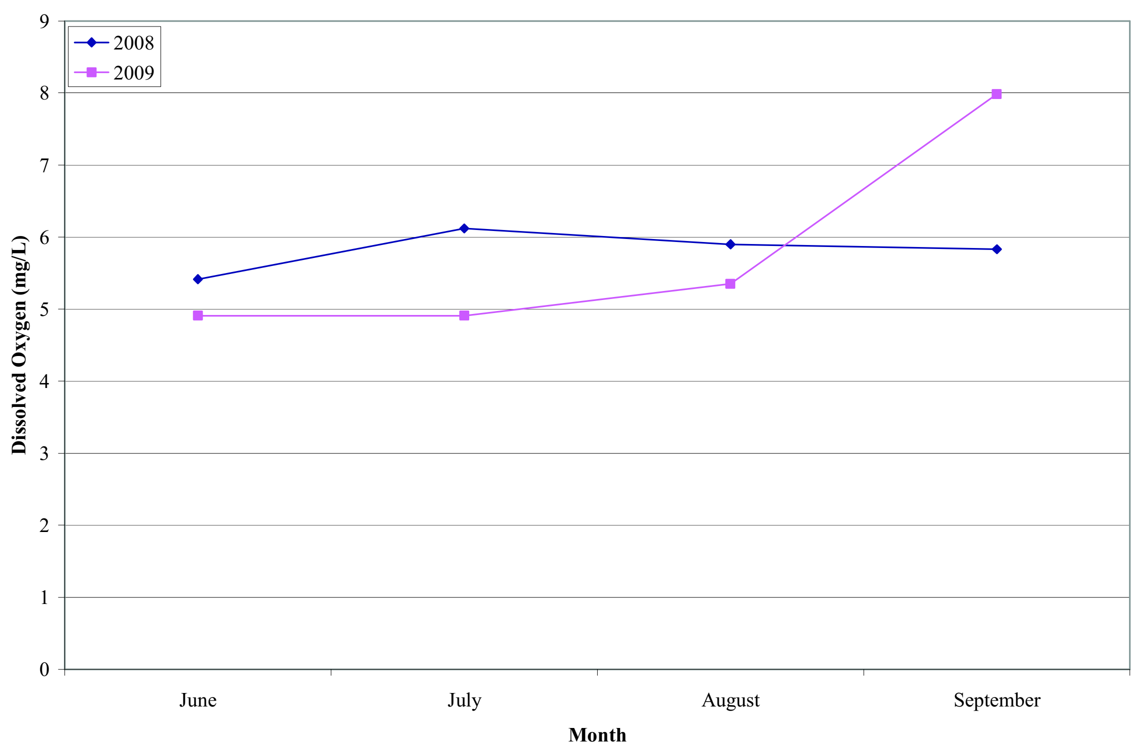

Figure 6. 2008 - 2009 Drop Net Study mean monthly dissolved oxygen measurements collected from Sinepuxent Bay, Maryland.

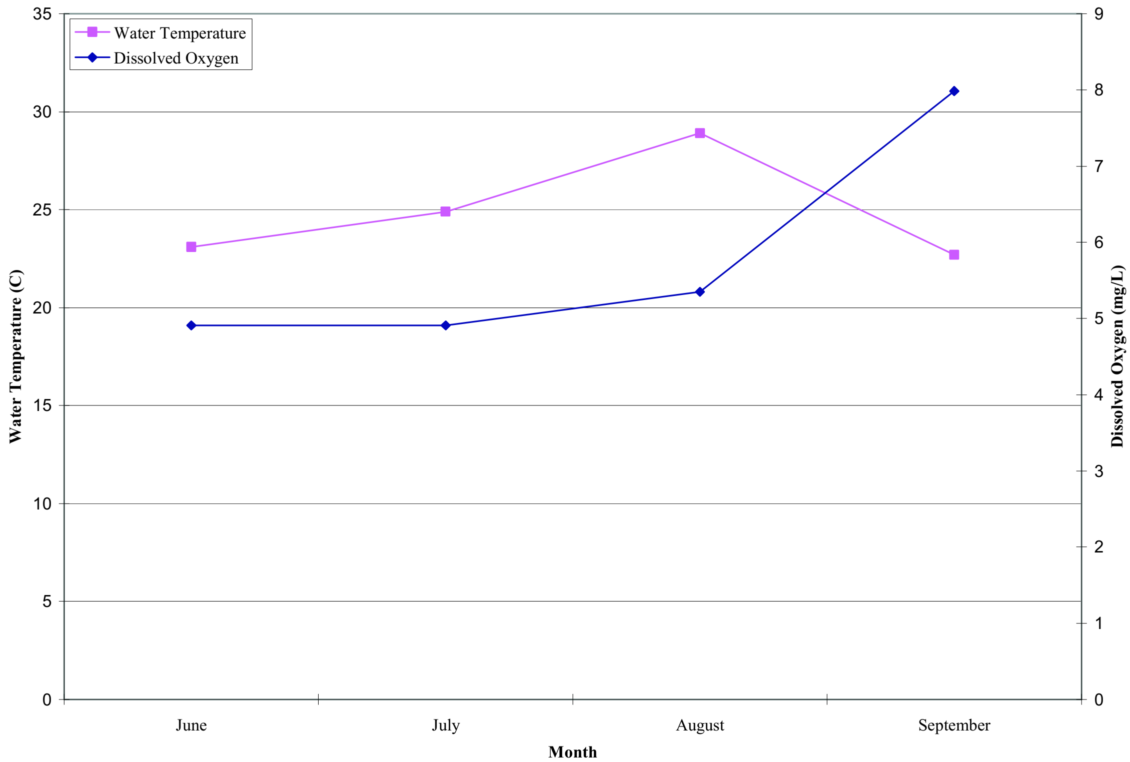

Figure 7. Drop Net Study mean monthly dissolved oxygen and water temperatures collected from Sinepuxent Bay, Maryland.

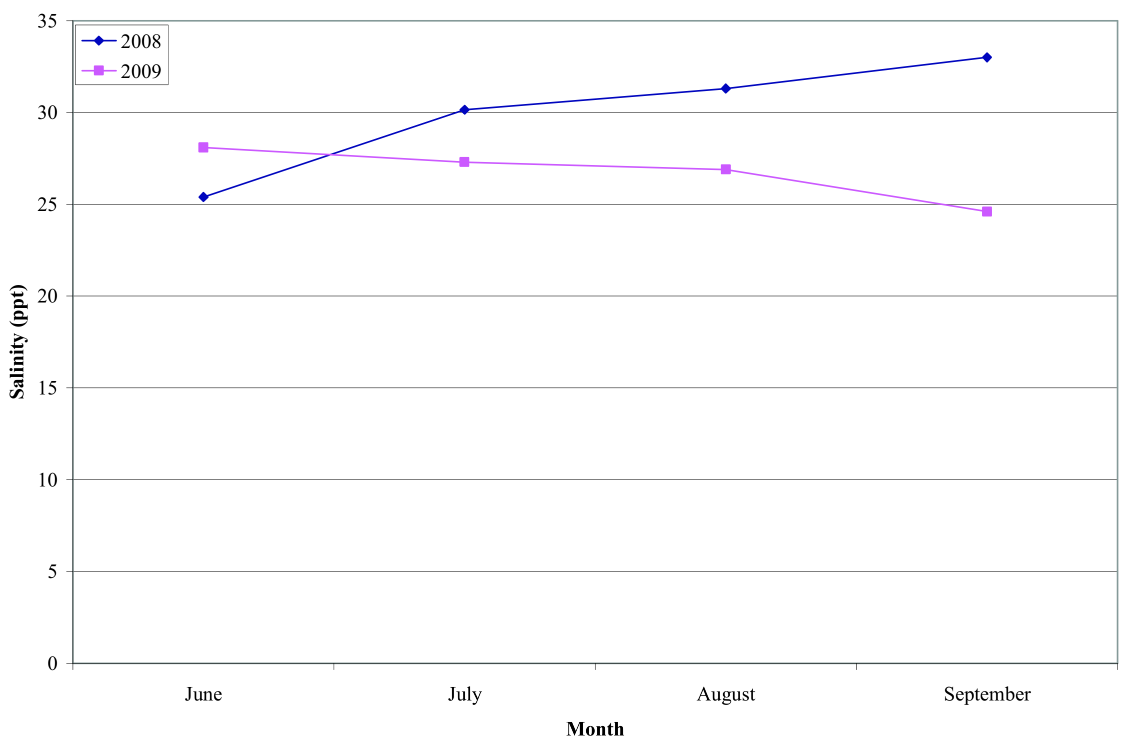

Figure 8. 2008 - 2009 Drop Net Study mean monthly salinity measurements collected from Sinepuxent Bay, Maryland.

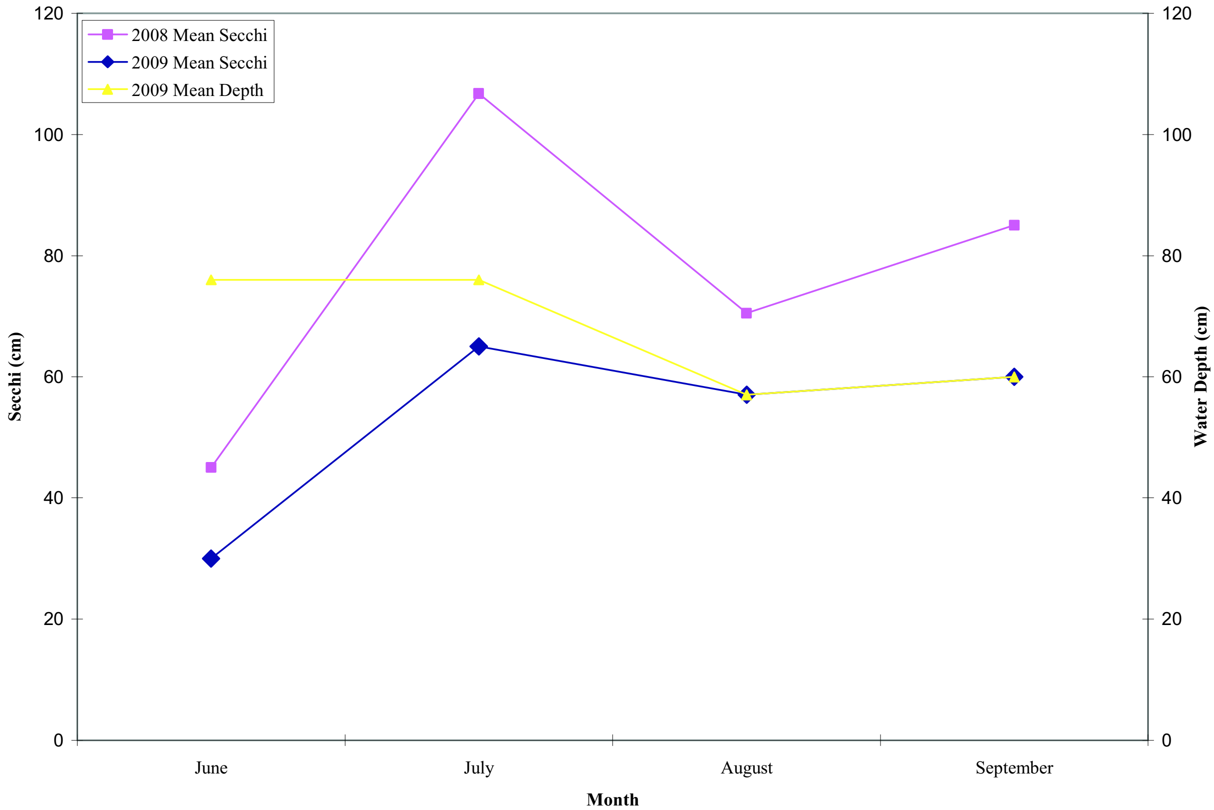

Figure 9. 2008 - 2009 Drop Net Study mean monthly secchi disk and depth measurements collected from Sinepuxent Bay, Maryland. Note: Depths were not available for 2008.

MD DNR Coastal Bays Trawl Data Sheet

Appendix 1.

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

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

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

Species Name	Counts	Total

Species Name	Counts	Total

MD DNR Coastal Bays Trawl Data Sheet

Date	Start Time (12 hr)	Collector	Set#
______/______/2011			

Site#	Station Description
T0	

Waypoint Start	Waypoint Stop	Temp (C)	Sal (ppt)	DO (mg/L)
		Surface	Surface	Surface
		Bottom	Bottom	Bottom

Latstrt	Latstop	Secchi (cm)	Weather	Tide
38° .	38° .			

Longstrt	Longstop	Depth (ft)	Wind Direction & Speed (Knots)
75° .	75° .	Start / Stop	@

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

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

MD DNR Coastal Bays Beach Seine Data Sheet

Appendix 2.

Date (MM/DD/YYYY) ______/_______/2011	**Start Time (12 hr)**	**Collector**	**Set#**
Site# S0	**Station Description**		
Seine Length: 100 foot 50 foot		**Temp (°C)**	**Sal (ppt)**
Waypoint Start	**Waypoint Stop**	**DO (mg/L)**	**Secchi (cm)**
Latstrt 38° .	**Latstop** 38° .	**Weather**	**Tide**
Longstrt 75° .	**Longstop** 75° .	**Depth (ft)**	**Est. % Net Open**
%SAV – Choose One 0–No SAV in sample area 1-up to 25% 2-26-50% 3-51%-75%, 4-76%-100% 5-SAV present 6-Undeterminable – give reason (use Comments)		**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_20
Hat/Sunglasses/sun screen
Oil Skins

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

List species collected for vouchers & quantities

21 L Bucket Cnt

Comments

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

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

MD DNR Coastal Bays Beach Seine Data Sheet

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

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

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

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

Species Name	Counts	Total

Species Name	Counts	Total

Appendix 3.

Atlantic Program Fish Voucher Collection Protocol

Purpose:
Fish collected from the Maryland Coastal Bays and Atlantic Ocean will be used as identification vouchers and staff training.

Safety Information:
Safety goggles and disposable gloves should be worn whenever working with formalin or ethanol. Immediately wash any skin that comes in contact with these chemicals. Visit the OSHA website (http://www.osha.gov/SLTC/formaldehyde/) for more information.

Field Procedure:
1. Try to collect 3-5 specimens of a particular species at the same time. Keep any unusual or unknown specimens.
2. Photograph specimens if possible.
3. Place all specimens in a communal holding tank or bucket. Use battery operated aerator or change water frequently to keep specimens alive. Place any dead specimens in a separate container of water.
4. In the comments section of field datasheet record what fishes were collected from that sample.
5. Upon return to the field office:
    - Make a small incision in the belly on the right hand side for specimens 6 inches (150 mm) or longer and puncturing the swim bladder (Stranko 2006; AFS 1983) to facilitate fixation, which may not thoroughly occur without the incision.
    - Completely submerge specimens in a plastic container containing buffered 10% formalin solution (= 4% formaldehyde).
6. Place a label (make one out of Rite in the Rain paper) inside container with site number, latitude, longitude, date, species if known, and number of each species for each location. If the specimen was not part of the CBFI survey, include gear type on the label.

Laboratory Procedure:
In a well ventilated area:
1. Keep specimens in formalin for at least 24 hours.
2. Pour formalin off specimens into the hazmat 55 gallon drum using a funnel.
3. Cover specimens with water and soak for 24 hours.
4. Pour water off specimens into the hazmat 55 gallon drum using a funnel.
5. Cover specimens with water and soak for another 24 hours.
6. Pour water off specimens into the hazmat 55 gallon drum using a funnel.
7. Place specimens of the same species in glass jar(s) filled with 70% ethanol and capped with a polypropylene lid and polyethylene liner and new label. Larval fishes can be permanently fixed in 5% formalin solution (AFS, 1983).
    a. If specimens of the same species were collected at different locations and dates, then combine all into one jar with a label for each location and assign a separate catalog number for each.

b. If specimens of the same species were collected at different location on the same date, then combine all into one jar with a label for each location and assign the same catalog number.

Label Information:

<table>
<tr><td colspan="3">Maryland Dept. of Natural Resources - Fisheries Service - Atlantic Program Coastal Bays Fisheries Investigation (CBFI)</td></tr>
<tr><td colspan="3">Scientific Name:</td></tr>
<tr><td colspan="3">Common Name:</td></tr>
<tr><td colspan="2">Body of Water:</td><td>County: Worcester</td></tr>
<tr><td colspan="3">Collection Site:</td></tr>
<tr><td colspan="2">Lat. 38°</td><td>Long. 75°</td></tr>
<tr><td colspan="3">Collected By: MD DNR Fisheries Service Atlantic Program</td></tr>
<tr><td colspan="2">Date Collected:</td><td>Preservation Date:</td></tr>
<tr><td>Preservative: 70% ETOH</td><td>Catalog #:</td><td># Specimens</td></tr>
</table>

a. Scientific Name ≡ with older nomenclature if possible
b. Common Name ≡ name used in CBFI program
c. Body of Water ≡ main body of water that the specimen came from. Choices include Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, and Chincoteague Bay (includes Newport Bay)
d. County ≡ county where the specimen was collected
e. Collection Site ≡ description of where the specimen was collected. Includes CBFI site number when possible.
f. Lat. ≡ start latitude where the specimen(s) where collected
g. Long. ≡ start longitude where the specimen(s) where collected
h. Collected By ≡ program that collected the specimen(s)
i. Date Collected ≡ date that the specimen(s) where captured/collected. This is also when the specimen(s) would have been placed in 10% formalin for fixation.
j. Preservation Date ≡ date the specimen(s) where permanently preserved. Removal from fixative would have taken place two days prior to this date.
k. Preservative ≡ chemical used to permanently store the specimens. In most situations, this will be 70% ETOH.
l. Catalog ID ≡ unique code that relates each jar and or specimen back to the voucher database. Codes start at 0001.
m. # Specimens ≡ number of specimens & sex (when obvious from physical characteristics) For example, 2♀ ,1♂

Allow label to thoroughly dry before placing into the jar.

8. Add to voucher database
    a. Catalog ID ≡ assign a unique code. Codes start at 0001. Codes starting at 8000 were historical specimens added to this collection.
    b. SiteID ≡ Site number used in the CBFI seine and trawl survey. SiteID is composed of a letter followed by 3 numbers. The letter S indicates the gear was a seine and T indicates the gear was trawl.
    c. Family ≡ family name of the specimen. This information is located in the American Fisheries Society Special Publication 29, Common and Scientific Names of Fishes from the United States, Canada, and Mexico. 6^{th} edition.
    d. Common Name ≡ name used in CBFI database
    e. Scientific Name ≡ taken from the American Fisheries Society Special Publication 29 Common and Scientific Names of Fishes from the United States, Canada, and Mexico. 6^{th} edition.
    f. Body of Water ≡ main body of water that the specimen came from. Choices include Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, and Chincoteague Bay (includes Newport Bay), Coastal Bays (generic term for when the field label was not completely filled out)
    g. County ≡ county where the specimen was collected
    h. Collection Site Description ≡ description of where the specimen was collected. Includes CBFI site number when possible.
    i. Latitude ≡ start latitude where the specimen(s) where collected. This number should be taken off the datasheet.
    j. Longitude ≡ start longitude where the specimen(s) where collected
    k. Collected by ≡ program that collected the specimen(s); typically this program will be the MD DNR Fisheries Service Atlantic Program
    l. Date Collected ≡ date that the specimen(s) where captured/collected. This is also when the specimen(s) would have been placed in 10% formalin for fixation.
    m. Survey Name ≡ CBFI
    n. No. Specimens ≡ number of specimens associated with the Catalog ID
    o. Preserved by ≡ who placed the specimen(s) into the jar and added the preservative. Valid names include Angel Bolinger, Allison Luettel, Karen Capossela, Gary Tyler, and Christopher Jones.
    p. Preservation Date ≡ date the specimen(s) where permanently preserved. Removal from fixative would have taken place two days prior to this date.
    q. Type ≡ generic label of what is in the container. Valid options include fish, mollusk, crustacean
    r. Preservative ≡ chemical used to permanently store the specimens. In most situations, this will be 70% ETOH.
    s. Storage Location ≡ location of where the jars are being stored
    t. Species ID 1st Confirmed by ≡ who identified the specimen(s) back in the laboratory that are in the jar
    u. Species ID 2nd Confirmed by ≡ who confirmed the first identification of the specimen(s) back in the laboratory that are in the jar
    v. Photos ≡ Are there photos of the specimen? Photos may have been taken when the specimen was alive, dead, fixed, or preserved. Yes or no
    w. Comments ≡ includes numbers by sex, combined specimens, etc.

Storage of specimens:
Store upstairs in the Matapeake laboratory. Check jars for evaporation and lid backing off annually. If evaporation has occurred, then completely replace the ethanol.

Disposal of Formalin:
Clean Harbors Environmental Services, Inc. **http://www.cleanharbors.com/**
EPA ID: **MDD980555189**

Phone Number: **410.244.8200**
Fax Number: **410.685.3061**
Address: **1910 Russell Street**
Baltimore, MD 21230

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Summary of the Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey Voucher Collection through 2011

The CBFI voucher collection currently holds 84 species representing 48 families for a total of 227 specimens (Table 1). The three new species encountered in 2011 that were added to the voucher collection include: Short Bigeye (*Pristigenys alta*), Atlantic Herring (*Clupea harengus harengus*), and Gizzard Shad (*Dorosoma cepedianum*).

Recommendations

- Continue collecting vouchers for species that are not already included in the collection.
- Review vouchers prior to each sampling season.

Table 1. Species list for the CBFI voucher collection, n=227.

Family	Scientific Name	Common Name	Number of Specimens
Achiridae	*Trinectes maculatus*	Hogchoker	3
Anguillidae	*Anguilla rostrata*	American Eel	2
Atherinopsidae	*Membras martinica*	Rough Silverside	5
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
Catostomidae	*Erimyzon oblongus*	Creek Chubsucker	3
Centrarchidae	*Lepomis gibbosus*	Pumpkinseed Sunfish	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 antillarum*	Web Burrfish	2
Diodontidae	*Chilomycterus schoepfii*	Striped Burrfish	1
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 diaphanous*	Banded Killifish	5
Fundulidae	*Fundulus majalis*	Striped Killifish	4
Fundulidae	*Lucania parva*	Rainwater Killifish	2
Gasterosteidae	*Gasterosteus aculeatus*	Threespine Stickleback	6
Gasterosteidae	*Apeltes quadracus*	Fourspine Stickleback	1

Table 1. Species list for the CBFI voucher collection, n=227.

Family	Scientific Name	Common Name	Number of Specimens
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	4
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
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 chuss*	Spotted Hake	3
Pleuronectidae	*Pseudopleuronectes americanus*	Winter Flounder	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	1
Scophthalmidae	*Scophthalmus aquosus*	Windowpane	1
Serranidae	*Centropristis striata*	Black Sea Bass	5
Serranidae	*Mycteroperca microlepis*	Gag Grouper	2
Sparidae	*Archosargus probatocephalus*	Sheepshead	3
Sparidae	*Lagodon rhomboides*	Pinfish	2
Sparidae	*Stenotomus chrysops*	Scup (Porgy)	3
Sphyraenidae	*Sphyraena borealis*	Northern Sennet	1
Stromateidae	*Peprilus paru (=alepidotus)*	Harvestfish	4
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	3

Table 1. Species list for the CBFI voucher collection, n=227.

Family	Scientific Name	Common Name	Number of Specimens
Trichiuridae	*Trichiurus lepturus*	Atlantic Cutlassfish	1
Triglidae	*Prionotus carolinus*	Northern Searobin	4
Triglidae	*Prionotus evolans*	Striped Searobin	5
		Total	**227**

Species with an asterisk (*) were added in 2011.

Appendix 4. 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 100 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.
LORAN start	LORAN stop			
LORAN start	LORAN stop	Sub-sample percentage of catch	Wind Dir & Speed (knots)	
Depth start	Depth end			

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 4. Maryland DNR Offshore Trawl Survey

Date Set

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_20 Pencils/ Sharpener