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

2010 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 are included in these analyses.

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. Species codes were eliminated and common names plus the ITIS scientific name were used to ensure correct species identification.

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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 ultimately protect finfish habitats. The Maryland Department of Natural Resources (MDNR) Fisheries Service has conducted the Coastal Bays Fisheries Investigations (CBFI) Trawl and Beach Seine Survey in Maryland's Coastal Bays since 1972, sampling with a standardized protocol since 1989. These gears target finfish although bycatch of crustaceans, molluscs, sponges, and macroalgae are common.

Over 130 adult and juvenile species of fishes, 26 molluscs, and 11 macroalgae genera 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; Luisi et al, 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 (Maryland Coastal Bays Program 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 or grasses) and macroalgae (seaweeds) are common plants in these bays that provide habitat and foraging sites for finfish 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 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

<u>Trawl</u>

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

The boat operator took into account wind and tide (speed and direction) when determining trawl direction. A standard 4.9 m (16 ft) semi-balloon trawl net was used in areas with a depth of greater than 1.1 m (3.5 ft). Each trawl was a standard 6-minute (0.1 hr) tow at a speed of approximately 2.8 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).

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

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

Salinity, water temperature, and DO were taken with a Yellow Springs Instrument (YSI) 30 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 by looking at fixed objects when possible, using the GPS tide feature, or checking the published tide tables for the sampled areas. Occasional difficulties determining tide resulted from inlet influences in Ocean City, MD and Chincoteague, VA.

Sample Processing
Fish, invertebrates, and crustaceans are identified, enumerated, and total lengths (mm) recorded for target species. Fish species of recreational or commercial interest are counted, and the first 20 individuals at each site are measured for total length on a wooden measuring board. Species not of commercial or recreational interest are only counted and not measured.

Unknown fish species are put in Ziploc bags on ice and brought back to the lab for identification.

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

Jellyfishes, ctenophores, bryozoans, sponges, SAV and macroalgae were measured volumetrically (liters, L) using calibrated containers with small holes in the bottom to drain the excess water. Small quantities (generally ≤ 10 specimens) of invertebrates were occasionally counted. Slightly larger quantities of invertebrates were sometimes visually estimated. For each trawl or seine, macroalgae and bryozoans were combined for one total volume measurement (L) and identified to genera (for example, *Agardhiella, Gracilaria, Ulva*). The percent composition by genera was estimated visually.

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). Only one specimen was added to the voucher collection in 2010.

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).

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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 (1989-2010). 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 GM was calculated from the $\log_e(x+1)$ transformation of the catch data and presented with 95% Confidence Intervals (CIs; Ricker 1975). The GM and CIs were calculated as the antilog [$\log_e$-mean(x+1)] and antilog [$\log_e$-mean(x+1) ± standard error * (t value: α=0.05, n-1)], respectively. A geometric grand mean was calculated for the time series (1989-2010) and used as a point estimate for comparison to the annual (2010) 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 1989-2010. A subsequent multiple pairwise comparison of means test (Duncan's Multiple Range Test) was performed to determine differences among sites. The site or group of sites most abundant were classified as primary sites; secondary sites were second most abundant.

To summarize macroalgae presence in the Trawl and Beach Seine Surveys, the number of samples with light, moderate and heavy macroalgae volume were 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 2006-2010 by year and month. Tukey multiple comparison tests were used to identify years or months with significant differences in macroalgae abundance. Seine data was log transformed to meet ANOVA assumptions. Separate trends for red and green macroalgae were also examined using the same process. Significance was determined at α=0.05.

Because red and green macroalgae accounted for at least 97% of total macroalgae captured in trawls and seines from 2006-2010, only red and green macroalgae were included when considering data over this time period. Trawls or seines with incomplete macroalgae data were not included in analyses.

Results and Discussion

Finfish were the most abundant taxa captured in the survey. Specifically, they accounted for 45,439 fish caught trawling (10,887 fish) and beach seining (34,552 fish; Table 4**).** Collected fishes represented 75 species.

Above average year-classes were found for Atlantic Menhaden and American Eel.
A below average year-class was found for Summer Flounder in the seine portion of the survey while the trawl potion was average. However, due to habitat preferences, summer flounder are usually better represented in trawl data than in seine data.

Crustaceans were the second most abundant taxa captured in this survey. Specifically, they accounted for 40,588 specimens caught trawling (35,143 crustaceans) and beach seining (5,445 crustaceans; Table 5). Nineteen crustacean species were identified. The third most abundant taxa captured in the survey were molluscs. Specifically, they accounted for 3,292 specimens caught trawling (2,039 molluscs) and beach seining (1,253 molluscs; Table 5). Molluscs were represented by 25 different species. Both crustacean and mollusc counts reported here include visual estimations. Other types of animals captured trawling and beach seining included: ctenophores, tunicates, and sponges (Table 6). 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 7).

Species Results: American Eel (*Anguilla rostrata*)

American Eels were captured in 11 of 140 trawls (7.9%) and in 10 of 38 beach seines (26.3%). A total of 75 American Eels were collected in trawl (38 fish) and seine (37 fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). American Eel ranked 21st out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.2 fish/hectare and 1.0 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl and seine were both equal to the grand mean (Figures 2 and 3).

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 8). Secondary trawl sites included T012, 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 9).

Discussion

The abundance indices for trawl and seine were both equivalent to the grand mean. Although not significantly higher than the grand mean the trawl and seine indices were near the high end of the historical range, and the trawl index appears to be trending up in recent years. Since American eels spawn offshore, environmental conditions and ocean currents may be a factor influencing relative abundance (Murdy *et al* 1997).

American Eels were more frequently caught in the trawls at site T006, and were widely dispersed in the seines. Site T006 is in Turville Creek, where the American Eel Monitoring Project within Fisheries Service 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 secondary preference trawl sites where American Eels are captured are also in narrower, creek-type areas and not open water. The large distribution of preferred and secondary sites for American Eels in the seine is due to their preference for near shore shallow weedy areas. Since 1989, the trawl relative abundance estimates rarely (three years) varied from the grand mean, and the seine relative abundance estimates also rarely (four year) varied from the grand mean.

Management
American Eels are managed by the State of Maryland in cooperation with Atlantic States Marine Fisheries Commission (ASMFC). Maryland's 2010 recreational American Eel regulations were comprised of a 25 fish creel and a six inch minimum size limit (Table 10). Commercial restrictions included a six inch minimum size. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Croaker (*Micropogonias undulatus*)
Atlantic croakers were captured in 23 of 140 trawls (16.4%) and in zero of 38 beach seines Due to habitat preferences, Atlantic Croakers are better represented in the trawl data. A total of 643 juvenile Atlantic Croakers were collected in trawls (643 fish) conducted on Maryland's Coastal Bays in 2010 (Table 4). Atlantic Croakers ranked 7th out of 75 species in overall finfish abundance. The trawl CPUE was 36.6 fish/hectare.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl data were equal to the grand mean and the seine data were below the grand mean (Figures 4 and 5).

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 8). Secondary trawl sites included T003, and T011. Due to the inefficiency of seines to capture Atlantic Croakers, seine site preferences are not presented here.

Discussion
The abundance index for trawl was equal to the grand mean. Since Atlantic Croakers spawn offshore, environmental conditions and ocean currents may be a factor influencing relative abundance (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. Since 1989, the trawl relative abundance estimates frequently (11 years) varied from the grand mean, although 2010 was in the middle of the range of historical values therefore was a more typical year for abundance.

Primary and secondary trawl sites for Atlantic Croaker 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 2010 recreational Atlantic Croaker regulations were comprised of a 25 fish creel and a nine inch minimum size limit (Table 10). Commercial restrictions included a nine inch minimum size and a season closure. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Menhaden (*Brevoortia tyrannus*)

Atlantic Menhaden were captured in 16 of 140 trawls (11.4%) and in 30 of 38 beach seines (79.0%). A total of 25,621 Atlantic Menhaden were collected in trawl (154 fish) and beach seine (25,467 fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). Atlantic Menhaden ranked first out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 8.8 fish/hectare and 670.2 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl data was equal to the standardized grand mean and beach seine data above the grand mean (Figures 6 and 7).

Duncan's Multiple Range Test indicated that trawl site T005 and T006 had the highest level of abundance (CPUE) and those locations were classified as a primary sites (Figure 1, Table 8). The secondary trawl sites were T002, T004, T012, T015, T018, and T019. 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 9).

Discussion

The abundance index for seine was above the grand mean while the trawl index was 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. Since 1989, the beach seine relative abundance estimates occasionally (seven years) varied from the grand mean. It appears that 2010 was an excellent year for reproduction of Atlantic Menhaden. The 2010 seine and trawl indices were well above any values we have seen in this time series. Significant changes in relative abundance may reflect a combination of changes in environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and/or management.

The primary and secondary trawl sites were in protected areas at the head of Turville Creek and in the St. Martins River, and in the bays in the southern areas. Turville Creek is known to have high nutrient levels (Maryland Department of the Environment, 2001) and may attract the food sources of Atlantic Menhaden. 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). 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 2010. A Chesapeake Bay-wide commercial harvest cap of 109,020 metric-tons was implemented in 2006 (Table 10; ASMFC 2006). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Silverside (*Menidia menidia*)
Atlantic Silversides were captured in 11 of 140 (7.8%) trawls and in 37 of 38 beach seines (97.4%). A total of 1,861 Atlantic Silversides were collected in trawl (35 fish) and beach seine (1,826 fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). Atlantic Silversides ranked 5th out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.0 fish/hectare and 48.1 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl and seine indices were both equal to the grand mean (Figures 8 and 9).

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 8). Secondary trawl sites included T002, T005 and T007, 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 9).

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. Since 1989, the beach seine relative abundance estimates seldom (four years) varied from the grand mean.

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.

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 95 of 140 trawls (67.8%) and in 27 of 38 beach seines (71.0%). A total of 5,526 Bay Anchovies were collected in trawl (4,854 fish) and (672 fish) beach seine samples collected in Maryland's Coastal Bays in 2010 (Table 4). Bay Anchovies ranked 2nd out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 267.5 fish/hectare and 17.7 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl index and the seine index were equal to the grand mean (Figures 10 and 11).

Duncan's Multiple Range Test indicated that trawl site T001, T002, T004, T011, T012, and T014 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 1, Table 8). Secondary trawl site included site T003, T005, T013, T016 and T018. Beach seine sites S003, S011, S012, S013, S015, and S016 were determined to be primary locations and S006, and S014 were classified as secondary sites (Figure 1, Table 9).

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.

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. Since 1989, the relative abundance estimates seldom (five years trawl, four years beach seine) varied from the grand means.

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 being filter feeders like areas with available plankton to feed on. Also their delicate nature precludes them from areas with greater current that require greater swimming ability. Because of their wide dispersion and relatively great abundance Bay Anchovies make up a substantial portion of the forage base for game fish in the coastal bays.

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 29 of 140 trawls (20.7%) and three of 38 seines (7.9%). A total of 90 juvenile Black Sea Bass were collected in trawl (82 fish) and beach seine (eight fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). Black Sea Bass were ranked 19th out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 4.67 fish/hectare and 0.2 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl and beach seine indices were both equal to the standardized grand means (Figures 12 and 13).

Duncan's Multiple Range Test indicated that trawl sites T003, T004, T007, T008, T009, T016, and T019 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 1, Table 8). Secondary trawl sites included T001.

Discussion
The 2010 trawl and beach seine indices were both equal to 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 (Shepard 2009). The last stock assessment update for Black Sea Bass was completed in 2009. The conclusion of the assessment update is that Black Sea Bass are not overfished and overfishing is not occurring. However, underlying these conclusions is the uncertainty associated with an assessment of a data poor stock as noted in the Northeast Data Poor Stocks Working Group report (NEFSC 2009). Black Sea Bass were caught in both near-shore (beach seine) and open-water (trawl) locations reflecting a wide range preferred habitats as long as structure is present. Since 1989, the relative abundance estimates frequently (12 years trawl, five years beach seine) varied from the grand means. Recent increasing trends in the trawl data may reflect an increase in structured bottom habitat off the coast of Maryland. As natural and artificial reefs increase, structure necessary for Black Sea Bass habitat, there may be an increase in Black Sea Bass recruitment to Maryland waters. However, long-term trends indicate cyclical abundances, and habitat may not be the driving factor in the trawl data.

Primary and secondary trawl sites for black sea bass were located in Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, and Chincoteague Bay. Trawl sites of primary and secondary preference were locations with or near structure such as channels, drop offs, rip rap, or crab pots. Preferred seine sites were included in Table 9 as black sea bass have been most frequently caught at a few seine sites over the course of the survey. However, due to the low catch in 2010 we cannot identify preferred sites based on this year's data. 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 2010 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 to December 31(Table 10). Commercial restrictions included an 11 inch minimum size and required a landing permit which contained an individual fishing quota issued by the State. Commercially licensed fishermen without a landing permit were permitted 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 seven of 140 trawls (5.0%) and in 11 of 38 beach seines (29.9%). A total of 55 juvenile Bluefish were collected in trawl (seven fish) and beach seine (48 fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). Bluefish ranked 24th out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.4 fish/hectare and 1.3 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl and beach seine indices were both equal to the grand means (Figures 14 and 15, respectively).

Duncan's Multiple Range Test indicated that trawl site T002, T003, T004, T005, had the highest level of abundance (CPUE) and those locations were classified as a primary sites (Figure 1, Table 8). Secondary trawl sites included T001, T007 and T008. Beach seine sites S001, S002, S003, S004, S005 and S006 were determined to be primary locations and S010 and S007 were classified as secondary sites (Figure 1, Table 9).

Discussion

The 2010 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. Since 1989, the relative abundance estimates occasionally (five years trawl, six years beach seine) varied from the grand means.

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 and T008 which are 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 2010 recreational bluefish regulations were comprised of a 10 fish creel and an eight inch minimum size limit (Table 10). Commercial restrictions included an eight inch minimum size and no seasonal closures. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Spot (*Leiostomus xanthurus*)

Spot were collected in 85 of 140 trawls (60.1%) and 33 of 38 seines (86.8%). A total of 4,502 spot were collected in trawl (2,551 fish) and beach seine (1,951 fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). Spot ranked 3rd out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 145.3 fish/hectare and 51.3 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2010 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 2010 trawl index was equal to the grand mean and the beach seine index was equal to the grand mean (Figures 16 and 17).

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 a primary sites (Figure 1, Table 8). Secondary trawl sites included: T003, T004, T014, T015, T017, T018, and T019. Spot were ubiquitous at beach seine locations. The only sites not classified as primary or secondary seine sites were S004 and S016 (Figure 1, Table 9).

Discussion

The 2010 trawl index and the beach seine index were both equal to the grand mean. Since Spot spawn offshore, environmental conditions 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. Since 1989, the relative abundance estimates frequently (16 years trawl, 12 years beach seine) varied from the grand means, indicating variability in abundance over the time period.

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. Seine sites S004 and S016 were neither primary or secondary sites; both of these two sites have low overall finfish catches and high neighboring bird populations which may affect the local Spot abundance.

Management
Spot were managed by the State of Maryland in cooperation with ASMFC. There were no recreational or commercial fishing regulations for this species. A recent anecdotal increase in the use of baitfish pots ("Spot pots") to collect Spot for use as bait may result in regulations in the coming years. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Summer Flounder (*Paralichthys dentatus*)
Summer Flounder were collected in 90 of 140 trawls (64.3%) and 12 of 38 seines (31.6%). A total of 317 Summer Flounder were collected in 2010, in trawl (302 fish) and beach seine (15 fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). Summer Flounder ranked 12th out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 17.2 fish/hectare and 0.4 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2009 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 2010 trawl index was equal to the grand mean and the beach seine index was below the grand mean (Figures 18 and 19, respectively).

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 8). Secondary trawl sites included: T001, T002, and T006. Beach seine site S012 was the only primary location and S001, S002, S003, S005, S006, S010, S011, S013, S014, S015, and S017 were classified as secondary sites (Figure 1, Table 9).

Discussion
The 2010 trawl index was equal to the grand mean and the beach 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 forage species composition and habitat type (NEFSC 2009). Based on the 2008 Stock Assessment Workgroup (SAW) 47 assessment biological reference points, the Summer Flounder stock was not overfished and overfishing was not occurring in 2009. Spawning stock biomass (SSB) was estimated to be 53,458 in 2009, about 89% of the target reference point (60,074 mt). In 2010 the projections estimate a median (50% probability) F in 2010 of 0.241 and a median SSB on November 1, 2010 of 72,367 mt, above the biomass target of 60,074 mt. The trends in juvenile recruitment found in this survey are consistent with the recruitment of Summer Flounder in the stock assessment. Excellent year

classes were found in this survey and coastally in 2008 and 2009. The 2010 assessment is not yet complete so the comparison for this year class could not be completed.

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. Since 1989, the trawl relative abundance estimates occasionally (12 years) varied from the grand mean. This indicates some variability in reproduction through the time series.

Primary and secondary trawl and beach seine sites were located in Assawoman Bay, tributaries of Isle of Wight Bay, Sinepuxent Bay, and Chincoteague Bay. Site T012 was the only primary trawl site. That 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.

Management

Summer Flounder are managed by the State of Maryland in cooperation with ASMFC and the MAFMC. Maryland's 2010 recreational Summer Flounder regulations were comprised of a three fish creel and 19.0 inch minimum size limit. The open season was April 17th through November 22nd (Table 10). Commercial restrictions included a 14 inch minimum size for all gears with the exception of commercial hook-and-line which had a 19.0 inch minimum size. Permitted fishermen in the Atlantic Ocean and Coastal Bays could harvest 5,000 pounds per day while non-permitted fishermen could land 200 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: Weakfish (*Cynoscion regalis*)

Weakfish were collected in 42 of 140 trawls (30.0%) and four of 38 seines (7.9%). A total of 628 juvenile weakfish were collected in trawl (623 fish) and beach seine (five fish) samples conducted on Maryland's Coastal Bays in 2010 (Table 4). Weakfish ranked eighth out of 75 species in overall finfish abundance. The trawl and beach seine CPUEs were 35.5 fish/hectare and 0.1 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2009 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 2010 trawl and beach seine indices were both equal to the grand means (Figures 20 and 21, respectively).

Duncan's Multiple Range Test indicated that trawl sites T00, T002, T003, T004 and T012 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 1, Table 8). The secondary trawl site of greatest abundance was T005.

Discussion
The 2010 trawl and beach seine indices were both equal to the grand means. Changes in relative abundance may reflect a combination of overfishing, environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in species composition and habitat type. Weakfish are considered overfished by the most recent stock assessment (NOAA/NMFS 2009). The stock is a low historical abundance. This is particularly perplexing considering the good reproduction in recent years. There is concern that the young of the year fish are not making the transition to piscavorous predation because of lack of forage and competition from other species including Striped Bass. The stock is at such low abundance levels there is concern that recruitment may begin to fail in the coming years.

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. Since 1989, the relative abundance trawl estimates occasionally (eight years) varied from the grand mean.

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 2010 recreational Weakfish regulations were comprised of a one fish creel and a 13 inch minimum size limit (Table 10). Commercial regulations in 2010 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 (i.e. Atlantic Ocean, Coastal Bays, and Chesapeake Bay). Monitoring will continue in the CBFI Trawl and Beach Seine Survey. 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. In 2010 the fishery was transitioned from a directed fishery to a bycatch fishery only, both recreationally and commercially.

Additional Discussion on Species Results
In 2010 catches of several species were increased over previous years'. Those species include Atlantic Menhaden, Spot, Striped Bass, and Blue Crabs. These species have historically shown increased coastwide production in years with cooler temperatures and increased water flow. Those conditions were present in Maryland during 2010 and may have impacted our catches. Recent research by Wood and Austen (2009) indicates that Chesapeake Bay anadromous and shelf-spawning fishes (CBASS) have been responding to the Atlantic Multidecadal Oscillation (AMO). Those same responses can be seen in our Spot trawl data and Atlantic Menhaden seine data. This research indicates an increase in management complexity in the near future and an increased need for attention to climate effects on fish stocks.

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 8 and 9). Several sites distinguished themselves as being primary and secondary sites for a majority of the species examined. Sites T001, T002, T003, T004, T005, S001, S002, S003, S005, and S006 were the most preferred locations based on the analysis of primary and secondary site preference (Tables 8 and 9).

Many species including Atlantic Croakers, Bay Anchovy, Atlantic Menhaden, Bluefish, Spot, Summer Flounder, and Weakfish showed a preference to the northern bays (Tables 8 and 9). The combination of the habitat type, forage, tidal current, salinities, and dissolved oxygen make this area desirable for juvenile finfish production.

Sinepuxent Bay

Beach seine sites in Sinepuxent Bay were more highly preferred when compared to the trawl sites (Tables 8 and 9). 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 8 and 9). Trawl sites ranged from one 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 most species with primary or secondary classifications (seven), 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 Croakers, Atlantic Menhaden, Atlantic Silversides, Bay Anchovy, Black Sea Bass, Spot, Summer Flounder, and Weakfish).

Trawl site T012 in Newport Bay had nine species with a primary or secondary classification. It is in a narrow channel between two areas of marsh and has always been noted as a popular destination for juvenile Summer Flounder with consistent caches in this study though the years.

Chincoteague Bay had only one species (Bay Anchovy) with primary classification for both trawl and seine (Tables 8 and 9). 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.

Water Quality and Physical Characteristics

Results

Analysis of the 2010 CBFI Trawl Survey water quality data showed an upturn in average water temperature in June for both Assawoman Bay and St. Martin's River after remaining steady from April through May. For Assawoman Bay, average water temperature peaked in July while the same measurement reached its zenith for the St. Martin's River in June. Average water temperature for Isle of Wight, Sinepuxent, Newport and Chincoteague Bays began its ascension during the month of April (Figure 22 and Table 11). Sinepuxent Bay had the lowest average water temperature at 20.4 C, while St. Martin's River had the highest with 22.5 C. These results are similar to 2009, with the average water temperature at 20.9 C and 22.9 C for Sinepuxent Bay and St. Martin's River, respectively. 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). When the temperatures of all bays were combined across the seven months comprising the survey for each of the past six sampling seasons the resultant measure is referred to as the overall temperature average per year. The highest overall temperature average belonged to 2005 at 22.7 C and the lowest is attributed to 2006 with a calculation of 21.3^{o}C. There is only 1.1 C difference between the overall average for 2010 (21.6 C) and this measure for 2005.

The seine sites yielded a temperature range in June of 22.0 C to 31.3 C. This was a greater difference in temperatures than witnessed for June of 2009 when the range was 21.0 C to 25.0 C. Three months later in 2010, the range was smaller at 20.9 C to 24.9 C. For 2009, the temperature range changed very little from June to September as evidenced by this set of values: 20.0 C to 25.0 C. The overall temperature average for all the bays in 2010 (including the St. Martin's River) during the first round of seining was 27.5 C. For September, this overall average dropped to 22.9 C. Water quality data from seining is presented in Table 12. The overall temperature average in June was higher than the previous five years with only 2008 coming close at 26.5 C for this measurement. The overall average for September was very close to four of the past sampling seasons, being surpassed only by September 2005 with the overall average of 25.1 C.

Dissolved oxygen (DO) levels in the Coastal Bays decreased from April to July in St. Martins River and Newport Bay. Average DO began to increase for St. Martin's in August and continued upward through October. Average DO appeared to level off from July to August for Newport Bay and then plunged to its lowest level of 4.8 mg/L in September. This measurement decreased steadily in Sinepuxent Bay until it, too, reached its lowest point in September. Average DO levels in Assawoman and Isle of Wight Bays decreased through June and experienced a spike in July. In August, both bodies of water experienced another plunge in average DO. The measurement increased for these bays in September and continued through the end of the yearly sampling (Figures 23-29, Table 11). Chincoteague Bay experienced a steady decrease in DO through August and began climbing in subsequent months. The range of DO across the water systems was 2.4 mg/L to 11.6 mg/L. Typically, as water temperatures increase, DO levels drop as a result of temperature's effect on oxygen's solubility properties in water. For this past season the overall DO average for all bays combined was 6.4mg/L which was not much different than the same measure for 2009

(6.8 mg/L). This metric does not vary much for the past five seasons with 2006 returning the highest overall average DO of 6.9 mg/L and the lowest belonging to 2005 at 6.2 mg/L (trawls). For seining the overall DO average levels ranged from 5.4 to 6.5 mg/L from 2005 to 2010. This past season returned 6.3 mg/L for that measure while the highest value belonged to 2006 at 6.5 mg/L.

In Assawoman Bay and Chincoteague Bay salinity rose until peaking in July, dipped in August and increased again for September. For Sinepuxent, salinity increased across the course of the field season, reaching its apex in September after a slight decline in August. St. Martin's and Newport experienced steady increases in salinity, returning their highest numbers in August and September, respectively. Salinity for Isle of Wight Bay rose to July, declined slightly and leveled off in August through September and continued down through the survey's end in October. (Table 11 and Figure 30). Salinity recorded in the bays varied from 15.7-34.1 ppt. through the year. Newport Bay had the lowest average salinity (25.6 ppt) and Sinepuxent Bay (30.0 ppt) yielded the highest. The overall salinity average for 2010 was 27.9 ppt. which was the fourth-highest value for that calculation compared with the previous five seasons. The sampling season with the highest overall salinity average was 2007 with a value of 29.3 ppt.

Results of Secchi analysis showed variations for turbidity levels from April to October for all systems (Figure 31 and Table 11). Turbidity was at its worst for Assawoman in August with an average visibility of 33.2 cm. In the St. Martins River, Secchi depth (turbidity) began very low with an average visibility of 117.8 cm and as it increased, average visibility fell to its lowest point (37.3 cm) in August. For Isle of Wight Bay, visibility actually increased from April to May, then declined until a slight rise in July. After declining again through September, visibility began to rise in this bay. Sinepuxent Bay experienced an overall decline in visibility throughout the summer despite a slight increase for August. Light began to penetrate to greater depths after September in Sinepuxent. Newport Bay experienced an increase in visibility from April to May, after which light penetration fell through July and leveled off. After September, visibility began to rise. Turbidity for Chincoteague Bay worsened from April until the poorest light penetration was reached in July.

Discussion

Differences in temperature, dissolved oxygen, salinity and turbidity are influenced by the flushing times of these systems. Lung (1994) presented data from two summers indicating flushing times of 21.1 to 21.3 days for Assawoman Bay and 8.0 to 15.8 days for the St. Martin's River. Flushing rates of the Isle of Wight Bay were reported to be 9.3 to 9.6 days. It was predicted by Prichard (1960) that Chincoteague Bay required 62 days to replace 99 percent of its water. Flushing rates for both Sinepuxent 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).

Some of the dissolved oxygen concentrations give rise to the concern of possible hypoxia 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 23 and Table 11). The average bottom DO for Assawoman Bay fell below 4.8 mg/L in August. Chincoteague Bay returned both surface and bottom average DOs below the chronic protective value in August. The St. Martin's River fell below 4.8 mg/L four times during the sampling months. The average surface DO was 4.2 mg/L in July and the average bottom DO's fell below 4.8 mg/L from June to August. In Newport Bay, the average bottom DO was 4.5 mg/L in September. The lowest DO (2.4 mg/L) of the season was recorded near the bottom of site T015 located in Chincoteague Bay on 6/22 (Table 11). Ayers Creek (S019) had the lowest recorded DO (2.1 mg/L) for the seine sites (Table 12). The lower DO may be a result of poor flushing as this site is extremely narrow and far up a tributary to Newport Bay.

The slight spike in DO for July witnessed for both Assawoman and Isle of Wight Bay could have resulted from algae growth. The average turbidity showed a decline for Isle of Wight Bay in July which indicates more light penetration and potential for an algal bloom leading to more oxygen by way of photosynthesis. Assawoman's turbidity continued to increase until August and experienced no decline for July.

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 (≤ 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.

Macroalgae
In the 2010 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 7). However, trawl and seine surveys were both primarily composed of red macroalgae, particularly *Agardhiella* and *Gracilaria* (Figures 32 and33). Green macroalgae was the second most abundant macroalgae captured by both gear types. Dominant genera of green macroalgae in the trawls were *Ulva* and *Chaetomorpha* (Figure 32), while *Cladophora*, *Enteromorpha* and *Ulva* dominated seines (Figure 33). For trawls occurring from 2006-2010, *Chaetomorpha* was primarily encountered in the southern bays, while all other dominant types of macroalgae were mostly found in the northern bays (Figure 34). For seines, all dominant genera of macroalgae were primarily found in the northern bays, specifically Isle of Wight Bay (Figure 35).

Of the 139 trawls in 2010, 15.1% had no macroalgae, 47.5% had light loads, and 37.4% had moderate or heavy loads (Figure 36). Sites with at least one heavy load of macroalgae were T001, T002, T004, T006, T009 and T011. For 2010, 38.5% of all *Agardhiella* was captured in one tow at T006 in April. Of the 37 seines, 24.3% had no macroalgae, 40.5% had light loads, and 35.1% had moderate or heavy loads (Figure 37). Sites with heavy densities of macroalgae were S001, S005, S006, S007 and S010.

Looking at red and green macroalgae data from 2006 through 2010, macroalgae were most abundant in northern regions, specifically Assawoman Bay and Isle of Wight Bay (Figure 38). Correspondingly, sites T006, T002 and T001 provided the highest percentages of total abundance of macroalgae over this time (Figure. 39). As with trawls, macroalgae in seines were most abundant in northern regions, specifically Isle of Wight Bay, the St. Martin River and Assawoman Bay (Figure 40). The three sites with the highest volumes of macroalgae were sites S007, S006 and S001 (Figure 41).

When considering all red and green macroalgae data from trawls, biomass significantly increased in 2008, but remained statistically the same from 2008 through 2010 (Figure 42). There was no significant difference in mean macroalgae volume by month (Figure 43). However, green macroalgae was present in greater abundances in April, May and June than for the rest of the sampling season (July through October; Figure 44). For seines, log mean volume of all macroalgae did not significantly differ by year or by month (Figures 45 and 46).

Discussion
Shifts in macroalgae composition can occur as different genera of macroalgae compete for dominance according to changing physical or biological conditions. 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, when *Gracilaria* was dominant (Bolinger et al. 2009). Seines were also primarily composed of red macroalgae, with the exception of 2008 when the seine survey was primarily

composed of green macroalgae (Bolinger et al. 2009). 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 2010, 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 2010. These northern regions are considered to be more impacted due to commercial and recreational development, harbors and marinas and a wastewater treatment facility. 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 2010 (T009, S010), as did a site in Newport Bay (T011). This survey has not detected 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. An increase in macroalgae was observed in 2008, but abundance has remained constant since then. 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 was present in greater abundances from April through June. 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. However, an increase in macroalgae abundance or change in composition may be indicative of eutrophication. Macroalgae abundance and composition could play an important role in species composition and diversity by providing habitat or creating inhospitable conditions for fish species. Therefore, continued monitoring is necessary to establish long term macroalgae trends in Maryland's Coastal Bays. Future analyses could also consider

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

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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 2010 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, 2010 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*	25621	154	25467	8.8	670.2
Bay Anchovy	*Anchoa mitchilli*	5526	4854	672	276.5	17.7
Spot	*Leiostomus xanthurus*	4502	2551	1951	145.3	51.3
Silver Perch	*Bairdiella chrysoura*	2124	412	1712	23.5	45.1
Atlantic Silverside	*Menidia menidia*	1861	35	1826	2.0	48.1
Mummichog	*Fundulus heteroclitus*	705	136	569	7.7	15.0
Atlantic Croaker	*Micropogonias undulatus*	643	643	0	36.6	0
Weakfish	*Cynoscion regalis*	628	623	5	35.5	0.1
Golden Shiner	*Notemigonus crysoleucas*	625	0	625	0	16.4
Rainwater Killifish	*Lucania parva*	509	28	481	1.6	12.7
Naked Goby	*Gobiosoma bosc*	349	305	44	17.4	1.2
Summer Flounder	*Paralichthys dentatus*	317	302	15	17.2	0.4
Striped Bass	*Morone saxatilis*	280	0	280	0	7.4
Hogchoker	*Trinectes maculatus*	262	152	110	8.7	2.9
Fourspine Stickleback	*Apeltes quadracus*	209	77	132	4.4	3.5
Striped Killifish	*Fundulus majalis*	145	0	145	0	3.8
White Mullet	*Mugil curema*	121	1	120	0.1	3.2
Oyster Toadfish	*Opsanus tau*	113	46	67	2.6	1.8
Black Sea Bass	*Centropristis striata*	90	82	8	4.7	0.2
Northern Searobin	*Prionotus carolinus*	76	76	0	4.3	0
American Eel	*Anguilla rostrata*	75	38	37	2.2	1.0
Smallmouth Flounder	*Etropus microstomus*	75	69	6	3.9	0.2
Green Goby	*Microgobius thalassinus*	70	69	1	3.9	<0.1
Bluefish	*Pomatomus saltatrix*	55	7	48	0.4	1.3
Atlantic Needlefish	*Strongylura marina*	54	0	54	0	1.4
Winter Flounder	*Pseudopleuronectes americanus*	46	21	25	1.2	0.7
Northern Pipefish	*Syngnathus fuscus*	46	33	13	1.9	0.3
Southern Kingfish	*Menticirrhus americanus*	42	34	8	1.9	0.2
Dusky Pipefish	*Syngnathus floridae*	40	29	11	1.7	0.3
Windowpane Flounder	*Scophthalmus aquosus*	21	21		1.2	
Striped Mullet	*Mugil cephalus*	17	0	17	0	0.4
Sheepshead Minnow	*Cyprindon variegatus*	13	1	12	0.1	0.3

Table 4. List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2010 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**
Pinfish	*Lagodon rhomboides*	11	0	11	0	0.3
Lined Seahorse	*Hippocampus erectus*	10	9	1	0.5	<0.1
Tautog	*Tautoga onitis*	9	1	8	0.1	0.2
Ballyhoo	*Hemiramphus brasiliensis*	8	0	8	0	0.2
Spotted Hake	*Urophycis regia*	8	8	0	0.5	0
Striped Searobin	*Prionotus evolans*	7	7	0	0.4	0
Bluefish	*Pomatomus saltatrix*	7	7	0	0.4	0
Striped Burrfish	*Chilomycterus schoepfii*	7	7	0	0.4	0
Smooth Butterfly Ray	*Gymnura micrura*	7	7	0	0.4	0
Striped Anchovy	*Anchoa hepsetus*	6	3	3	0.2	0.1
Bluegill	*Lepomis macrochirus*	6	0	6	0	0.2
Gizzard Shad	*Dorosoma cepedianum*	5	0	5	0	0.1
Southern Stingray	*Dasyatis americana*	5	3	2	0.2	0.1
Banded Killifish	*Fundulus diaphanus*	5	0	5	0	0.1
Seaweed Pipefishes	*Syngnathus*	5	0	5	0	0.1
Clearnose Skate	*Raja eglanteria*	4	4	0	0.2	0
Lookdown	*Selene vomer*	4	3	1	0.2	<0.1
Northern Kingfish	*Menticirrhus saxatilis*	4	4	0	0.2	0
Striped Cusk-Eel	*Ophidion marginatum*	4	3	1	0.2	<0.1
Spotted Seatrout	*Cynoscion nebulosus*	3	0	3	0	0.1
Black Drum	*Pogonias cromis*	2	0	2	0	0.1
Common Carp	*Cyprinus carpio*	2	0	2	0	0.1
Pumpkinseed	*Lepomis gibbosus*	2	0	2	0	0.1
Pigfish	*Orthopristis chrysoptera*	2	0	2	0	0.1
Blackcheek Tonguefish	*Symphurus plagiusa*	2	1	1	0.1	<0.1
Largemouth Bass	*Micropterus salmoides*	2	0	2	0	0.1
Inshore Lizardfish	*Synodus foetens*	2	2	0	0.1	0
Alewife	*Alosa pseudoharengus*	2	1	1	0.1	<0.1
Atlantic Moonfish	*Selene setapinnis*	2	2	0	0.1	0
Cobia	*Rachycentron canadum*	1	1	0	0.1	0
Blueback Herring	*Alosa aestivalis*	1	0	1	0	<0.1
Blue Runner	*Caranx crysos*	1	0	1	0	<0.1

Table 4. List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2010 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**
Cownose Ray	*Rhinoptera bonasus*	1	0	1	0	<0.1
White Mullet	*Mugil curema*	1	1	0	0.1	0
Crevalle Jack	*Caranx hippos*	1	0	1	0	<0.1
Inland Silverside	*Menidia beryllina*	1	0	1	0	<0.1
Skilletfish	*Gobiesox strumosus*	1	0	1	0	<0.1
Spotfin Butterflyfish	*Chaetodon ocellatus*	1	0	1	0	<0.1
White Perch	*Morone americana*	1	0	1	0	<0.1
Scup	*Stenotomus chrysops*	1	1	0	0.1	0
Conger Eel	*Conger oceanicus*	1	1	0	0.1	0
	Total Finfish	**45,439**	**10,887**	**34,552**		

Table 5. List of crustaceans and molluscs collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2010. 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*	18,372	14969	3403	0	0	852.5	89.6
Sand Shrimp	*Crangon septemspinosa*	16,910	180	4	16656	70	958.9	1.9
Grass Shrimp	*Palaemonetes spp.*	4,649	314	27	2410	1898	155.1	50.7
Say Mud Crab	*Dyspanopeus sayi*	280	264	4	12		15.7	0.1
Long-Clawed Hermit Crab	*Pagurus longicarpus*	129	109	20			6.2	0.5
Barnacle Infraclass	*Cirripedia*	53	17	0	36		3.0	
Lady Crab	*Ovalipes ocellatus*	46	37	9			2.1	0.2
Atlantic Rock Crab	*Cancer irroratus*	38	38	0			2.2	
White Shrimp	*Litopenaeus setiferus*	22	15	7			0.9	0.2
Flat-Clawed Hermit Crab	*Pagurus pollicaris*	19	18	1			1.0	<0.1
Atlantic Mud Crab	*Panopeus herbstii*	19	18	1			1.0	<0.1
Mantis Shrimp	*Squilla empusa*	17	17				1.0	
White Shrimp	*Litopenaeus setiferus*	15	15				0.9	
Brown Shrimp	*Farfantepenaeus aztecus*	8	8				0.5	
Nine-Spined Spider Crab	*Libinia emarginata*	6	6				0.3	
Bigclaw Snapping Shrimp	*Alpheus heterochaelis*	1	1				0.1	
Mud Crab	*Panopeus*	1	1				0.1	
Spider Crab	*Libinia*	2	2				0.1	
Green Crab	*Carcinus maenas*	1						<0.1
	Total Crustaceans	**40,588**	**16,029**	**3,477**	**19,114**	**1,968**		

Table 5 (con't). List of crustaceans and molluscs collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2010. 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
Mollusc Species**								
Blue Mussel	*Mytilus edulis*	2182	12		1570	600	90.1	15.8
Eastern Mud Snail	*Nassarius obsoletus*	717	65	22		630	3.7	17.2
Convex Slipper Shell	*Crepidula convexa*	213	38		175		12.1	
Common Jingle Shell	*Anomia simplex*	55	55				3.1	
Eastern White Slippersnail	*Crepidula plana*	29	24		5		1.7	
Solitary Glassy Bubble Snail	*Haminoea solitaria*	22	22				1.3	
Lemon Drop Nudibranch	*Doriopsilla pharpa*	18	18				1.0	
Atlantic Brief Squid	*Lolliguncula brevis*	10	10				0.6	
Bruised Nassa	*Nassarius vibex*	12	11	1			0.6	<0.1
Thick-Lipped Oyster Drill	*Eupleura caudata*	5	5				0.3	
Channeled Whelk	*Busycotypus canaliculatus*	4	4				0.2	
Northern Quahog	*Mercenaria mercenaria*	3	3				0.2	
Atlantic Oyster Drill	*Urosalpinx cinerea*	3	3				0.2	
Common Atlantic Slipper Shell	*Crepidula fornicata*	2	2				0.1	
Bay Scallop	*Argopecten irradians*	2	2				0.1	
Dwarf Surfclam	*Mulinia lateralis*	2	2				0.1	
False Angelwing	*Petricolaria pholadiformis*	2	2				0.1	
Blood Ark	*Anadara ovalis*	2	2				0.1	
Stout Tagelus	*Tagelus plebeius*	2	2				0.1	
Threeline Mudsnail	*Nassarius trivittatus*	2	2				0.1	
Atlantic Mud-piddock	*Barnea truncata*	1	1				0.1	
Purplish Tagelus	*Tagelus divisus*	1	1				0.1	
Ponderous Ark	*Noetia ponderosa*	1	1				0.1	
Eastern Oyster	*Crassostrea virginica*	1	1				0.1	
Transverse Ark	*Anadara transversa*	1	1				0.1	
	Total Molluscs	**3,292**	**289**	**23**	**1,750**	**1,230**		

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

Table 6. List of other species collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2010. 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)	Spec. Vol. (L) (T)	Spec. Vol. (L) (S)	Est. Vol. (L) (T)	Est. Vol. (L) (S)	CPUE (T) #/Hect.	CPUE (S) #/Haul
Sea Squirt	*Mogula manhattensis*	2886	13		2850	23					163.1	0.6
Sea Nettle	*Chrysaora quinquecirrha*	828	20		751	57	33.5		11.3		43.9	1.5
Comb Jelly	*Ctenophora sp.*	311	9	7	245	50	55.8	8.5	4.2	0.6	14.5	1.5
Forbes Asterias Star	*Asterias forbesi*	254	253	1							14.4	<0.1
Hairy Sea Cucumber	*Sclerodactyla briareus*	246	201	45							11.4	1.2
Sea Anemone Order	*Actiniaria*	105	5		100						6.0	
Horseshoe Crab	*Limulus polyphemus*	62	62								3.5	
Common Sea Cucumber	*Cucumaria pulcherrima*	44	44								2.5	
Moon Jelly	*Aurelia aurita*	4	3	1							0.2	<0.1
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	9	1	8							0.1	0.2
Sand Dollar	*Echinarachnius parma*	1	1								0.1	
Striped Anemone	*Haliplanella lineata*	1	1								0.1	
Bryzoans	*Ectoprocta*						1550.0	15.1	0.8			
Halichondria Sponge	*Halichondria*						404.3	2.0				
Detritus	*none*						188.6	54.3				
Rubbery Bryozoan	*Alcyonidium*						130.9	6.2				

Table 6. List of other species collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2010. 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)**	**Spec. Vol. (L) (T)**	**Spec. Vol. (L) (S)**	**Est. Vol. (L) (T)**	**Est. Vol. (L) (S)**	**CPUE (T) #/Hect.**	**CPUE (S) #/Haul**
Sulphur Sponge	*Cliona celata*						69.7					
Golden Star Tunicate	*Botryllus schlosseri*						53.6	0.3				
Sea Pork	*Aplidium*						43.6					
Red Beard Sponge	*Microciona prolifera*						20.8					
Fig Sponge	*Suberites ficus*						3.5					
Songes	*Porifera*						0.1					
	Total Other	**4,751**	**613**	**62**	**3946**	**130**	**2,554.4**	**86.4**	**15.5**	**0.6**		

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

Table 7. 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, 2010. Total trawl sites = 140, total seine sites = 38.

Common Name	Genus	Specific Volume (L) (T)	Specific Volume (L) (S)	Estimated Volume (L) (T)	Estimated Volume (L) (S)
SAV					
Eel Grass	*Zostera*	95.06	100.5		
Widgeon Grass	*Ruppia*	3.629	12.63		
	Total SAV	**98.69**	**113.1**		
Macroalgae					
Brown					
Rockweed	*Fucus*	1.774			
		1.774			
Green					
Sea Lettuce	*Ulva*	247.6	90.77	0.850	
Green Hair Algae	*Chaetomorpha*	262.4	3.670		
Hollow Green Weeds	*Enteromorpha.*	19.08	102.4		
Green Fleece	*Codium*	1.647			
Green Tufted Seaweed	*Cladophora*		195.7		
		530.7	*392.5*	*0.850*	
Red					
Agardh's Red Weed	*Agardhiella*	3200.1	1150.3	0.600	
Graceful Red Weed	*Gracilaria*	725.9	274.2		
Barrel Weed	*Champia*	5.769			
Banded Weeds	*Ceramium*	2.142			
Tubed Weeds	*Polysiphonia*	31.48	0.645		
	Spyridia	3.320	2.695		
		3968.7	*1427.8*	*0.600*	
Yellow-Green					
Water Felt	*Vaucheria*	12.42	22.7		
		12.42	*22.7*		
	Total Macroalgae	**4513.6**	**1843.0**	**1.45**	

Table 8. Coastal Bays Fisheries Investigations 1989-2010 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		2		2	1	1						2			2			2	2	
Atlantic Silverside		2			2	1	2		2	2		2	2		2			2	1	
Bay Anchovy	1	1	2	1	2						1	1	2	1		2		2		
Black Sea Bass	2		1	1			1	1	1			2				1				1
Bluefish	2	1	1	1	1		2	2												
Spot	1	1	2	2	1						1	1		2	2		2	2	2	
Summer Flounder	2	2				2						1								
Weakfish	1	1	1	1	2							1								

Table 9. Coastal Bays Fisheries Investigations 1989-2010 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 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	1	2	1	1	1		
Black Sea Bass		1	2	1	1	1				1							2	2	
Bluefish	1	1	1	1	1	1	2			2									
Spot	1	1	1		1	1	1	1	2	1	1	1	1	2	2		1	2	2
Summer Flounder	2	2	2		2	2				2		1	2	2	2		2		

Table 10. Summary of Maryland Recreational and Commercial Regulations for 2010

Recreational

Species	**Area**	**Minimum Size Limit (inches)**	**Creel (person/day)**	**Season**
American Eel	C	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
Bluefish	A	8	10	Open Year Round
Summer Flounder	A Emergency regulations effective 4/12	19	3	April 17 thru November 22
Weakfish	A	13	1	Open Year Round

Table 10 (con't). Summary of Maryland Recreational and Commercial Regulations for 2010

Commercial

Species	Area	Minimum Size Limit (inches)	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	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	Landing Permit Required	Individual IFQ issued. Individual without a landing permit: 50 lbs.
Bluefish	A	8	Quota: Open Year Round	
Summer Flounder	C	14 Hook & Line 19	4/12/10 to 12/09/2010 12/10--Closed	Individual IFQ issued. Individual with license: Bycatch of 100lbs./day unless possessing a MD summer flounder landing permit. Bycatch is reduced to 50 lbs. per day
Summer Flounder	B	14 Hook & Line 19	4/12/10 to 12/09/2010 12/10--Closed	Bycatch of 25lbs/day
Weakfish	B	12	Aug. 1 thru Sep. 30 50 lbs. trip or daily limit. No bycatch allowed.	Chesapeake Bay hook and line season closed Oct. 1. During a closed season, 100lbs/day of by-catch is permitted for any gear (not hook and line) provided that at least equal poundage of other species is landed.
Weakfish	C	12	Aug. 1 thru Sep. 30 100 lbs. trip of daily limit	During a closed season, 100lbs/day of by-catch is permitted for any gear (not hook and line) provided that at least equal poundage of other species is landed.

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

Table 11. Coastal Bays Fisheries Investigations 2010 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:	16.7	16.6	26.7	27.9	26.4	22.1	14.9
		(16.5-17.0)	(16.4-16.8)	(25.9-28.2)	(27.6-28.1)	(26.1-26.8)	(21.8-22.4)	(14.8-15.0)
	Bottom:	16.6	16.6	26.4	27.6	26.1	22.1	14.9
		(16.2-17.0)	(15.9-17.0)	(25.9-27.2)	(27.4-27.8)	(25.9-26.3)	(21.7-22.5)	(14.8-15.0)
DO (mg/L)	Surface:	8.1	7.0	5.5	5.8	5.0	6.1	7.3
		(7.9-8.2)	(6.9-7.3)	(5.2-5.6)	(5.6-6.1)	(4.9-5.2)	(5.4-6.5)	(7.0-7.6)
	Bottom:	8.0	6.3	5.3	5.6	3.9	6.0	7.1
		(7.9-8.1)	(5.7-6.9)	(4.6-5.7)	(5.3-5.9)	(3.4-4.9)	(5.2-6.7)	(6.8-7.4)
Salinity (ppt)	Surface:	23.0	24.4	27.8	30.0	28.4	29.5	28.2
		(21.7-25.0)	(23.3-26.6)	(27.1-28.8)	(29.4-30.8)	(27.7-29.3)	(28.7-30.4)	(27.5-29.4)
	Bottom:	23.1	25.1	28.2	30.0	29.3	29.7	26.8
		(21.7-25.2)	(23.4-26.5)	(27.1-29.8)	(29.4-30.8)	(28.8-30.0)	(29.2-30.4)	(24.0-29.7)
Secchi (cm)		155.3	145	78.7	70.7	33.2	70.7	116.5
		(146.0-165.0)	(125.0-174.0)	(52.0-99.0)	(61.0-90.0)	(26.5-38.0)	(44.0-97.0)	(101.0-133.0)
Saint Martins River (Sites: T004 and T005)								
Temp (°C)	Surface:	17.3	17.3	28.6	28.3	27.0	24.1	16.0
		(16.4-18.2)	(16.9-17.6)	(28.1-29.0)	(27.8-28.7)	(26.8-27.2)	(23.8-24.4)	(15.4-16.5)
	Bottom:	16.5	17.1	28.3	28.1	26.5	24.0	15.9
		(16.2-16.8)	(16.1-18.0)	(27.8-28.8)	(27.7-28.5)	(26.2-26.8)	(23.6-24.3)	(15.4-16.4)
DO (mg/L)	Surface:	9.7	6.8	6.4	4.2	5.6	5.7	7.2
		(7.7-11.6)	(6.8-6.9)	(6.4-6.4)	(4.1-4.4)	(5.2-6.1)	(5.7-5.8)	(7.2-7.2)
	Bottom:	8.2	5.0	4.5	3.3	3.5	5.2	6.9
		(7.8-8.6)	(3.5-6.6)	(3.5-5.6)	(2.7-4.0)	(3.1-3.9)	(5.0-5.4)	(6.6-7.3)
Salinity (ppt)	Surface:	20.6	23.6	26.4	28.3	28.4	28.3	27.6
		(15.7-25.4)	(19.6-27.5)	(24.7-28.1)	(26.4-30.1)	(26.6-30.2)	(27.0-29.6)	(26.2-28.9)
	Bottom:	22.3	27.0	27.1	28.4	29.7	28.3	27.3
		(19.1-25.5)	(25.1-28.8)	(25.9-28.3)	(26.6-30.1)	(28.6-30.7)	(27.1-29.4)	(25.5-29.0)
Secchi (cm)		117.8	104.0	42.3	57.5	37.3	43.0	109.5
		(71.5-164)	(89.0-119.0)	(31.5-53.0)	(39.0-76.0)	(37.0-37.5)	(22.0-64.0)	(94.0-125.0)

Table 11 (con't). Coastal Bays Fisheries Investigations 2010 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:	15.3	16.6	27.2	27.5	26.7	23.3	16.6
		(14.3-16.2)	(15.7-17.5)	(25.8-28.5)	(26.0-29.0)	(24.7-28.6)	(22.4-24.2)	(16.4-16.8)
	Bottom:	15.3	16.4	26.0	25.7	24.8	23.2	16.4
		(14.9-15.7)	(15.4-17.4)	(23.8-28.2)	--- [A]	--- [A]	(22.4-24.0)	(16.3-16.4)
DO (mg/L)	Surface:	7.7	7.5	5.7	5.8	5.8	6.0	7.6
		(7.4-8.0)	(7.5-7.6)	(4.3-7.0)	(4.5-7.2)	(5.7-5.8)	(4.8-7.2)	(7.5-7.8)
	Bottom:	7.7	7.2	5.2	7.1	5.1	5.6	7.9
		(7.6-7.9)	(6.8-7.6)	(4.4-5.9)	--- [A]	--- [A]	(4.2-7.1)	(7.6-8.1)
Salinity (ppt)	Surface:	21.8	25.1	29.0	30.5	29.9	30.1	28.1
		(17.0-26.6)	(20.7-29.5)	(28.2-29.7)	(29.6-31.4)	(29.7-30.1)	(28.9-31.0)	(24.8-31.4)
	Bottom:	25.0	27.0	29.1	31.0	30.1	29.8	28.3
		(22.9-27.1)	(24.6-29.3)	(28.6-29.6)	--- [A]	--- [A]	(28.7-30.9)	(25.2-31.4)
Secchi (cm)		99.0	119.5	42.3	74.0	39.3	30.3	123.5
		(88.0-110.0)	(100.0-139.0)	(31.5-53.0)	(44.0-104.0)	(32.0-46.5)	(27.5-33.0)	(84.0-163.0)
Sinepuxent Bay (Sites: T008, T009, and T010)								
Temp (°C)	Surface:	13.6	17.2	23.4	26.5	23.4	22.3	16.5
		(13.5-13.9)	(16.3-18.1)	(20.8-27.0)	(24.2-30.1)	(22.3-24.5)	(21.9-22.5)	(16.2-16.9)
	Bottom:	13.6	17.0	23.2	26.4	23.2	22.2	16.5
		(13.4-13.8)	(16.1-17.9)	(20.4-26.9)	(24.3-30.1)	(22.4-23.7)	(21.8-22.5)	(16.1-16.9)
DO (mg/L)	Surface:	8.3	8.0	6.8	6.6	6.3	6.2	6.8
		(7.9-9.0)	(7.8-8.4)	(6.6-7.1)	(6.0-7.1)	(6.1-6.6)	(5.0-6.9)	(6.5-7.0)
	Bottom:	8.1	8.1	6.9	7.0	6.4	6.0	7.1
		(7.6-8.5)	(7.8-8.4)	(6.8-7.1)	(6.2-7.8)	(6.2-6.5)	(4.6-6.7)	(6.9-7.4)
Salinity (ppt)	Surface:	27.9	28.3	29.2	30.9	30.6	31.5	31.5
		(25.6-29.4)	(25.8-29.7)	(26.6-30.6)	(30.2-31.5)	(30.2-31.1)	(31.3-31.9)	(31.4-31.5)
	Bottom:	28.0	28.6	29.0	30.8	30.5	31.5	31.4
		(25.9-29.4)	(26.6-29.8)	(26.7-30.2)	(30.3-31.2)	(30.2-31.0)	(31.3-31.9)	(31.3-31.5)
Secchi (cm)		190.3	166.7	97.0	52.3	60.2	47.7	120.3
		(185.0-200.0)	(154.0-175.0)	(56.0-125.0)	(39.0-63.0)	(39.5-76.0)	(27.0-66.0)	(96.0-150.0)

Table 11 (con't). Coastal Bays Fisheries Investigations 2010 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:	13.8	17.5	27.3	29.6	25.0	21.7	15.3
		(13.5-14.1)	(17.0-17.9)	(27.1-27.4)	(29.5-29.7)	(24.4-25.5)	(21.2-22.1)	(15.3-15.3)
	Bottom:	13.8	17.6	27.2	29.1	24.3	21.5	15.6
		(13.5-14.1)	(17.6-17.6)	(27.1-27.2)	(28.7-29.4)	(24.1-24.5)	(21.3-21.7)	(15.5-15.7)
DO (mg/L)	Surface:	7.6	7.3	7.2	6.1	6.2	5.0	7.0
		(7.3-7.8)	(7.0-7.7)	(6.6-7.9)	(5.9-6.2)	(5.0-7.4)	(4.5-5.5)	(7.0-7.1)
	Bottom:	7.5	6.9	7.1	4.9	4.9	4.5	5.8
		(7.2-7.8)	(6.8-7.0)	(6.4-7.8)	(3.6-6.2)	(4.5-5.3)	(3.9-5.1)	(5.5-6.1)
Salinity (ppt)	Surface:	19.2	20.0	23.6	26.9	28.5	30.1	29.0
		(16.4-22.0)	(18.4-21.5)	(21.5-25.6)	(24.5-29.2)	(27.0-29.9)	(28.7-31.5)	(27.2-30.8)
	Bottom:	19.2	23.1	23.9	27.0	28.6	30.3	28.4
		(16.4-21.9)	(18.4-27.8)	(22.1-25.7)	(24.4-29.5)	(27.1-30.0)	(29.0-31.5)	(25.7-31.0)
Secchi (cm)		57.5	79.0	50.5	40.0	38.0	42.0	95.0
		(53.0-62.0)	(63.0-95.0)	(50.0-51.0)	(33.0-47.0)	(24.0-52.0)	(36.0-48.0)	(72.0-118.0)
				Chincoteague Bay (Sites: T013, T014, T015, T016, T017, T018, T019 and T020)				
Temp (°C)	Surface:	16.4	20.3	27.7	29.3	24.4	23.1	15.6
		(15.6-17.2)	(17.5-21.5)	(26.0-29.5)	(28.6-30.2)	(23.0-24.8)	(20.8-25.4)	(15.0-16.3)
	Bottom:	16.2^{B}	19.3^{B}	27.4^{B}	28.9^{B}	24.4^{B}	22.8	15.4
		(15.6-16.9)	(17.4-20.2)	(25.8-29.1)	(28.2-29.5)	(23.3-24.9)	(20.8-25.3)	(15.0-15.8)
DO (mg/L)	Surface:	7.7	7.3	6.0	5.3	4.3	6.1	8.5
		(7.3-8.0)	(6.0-8.3)	(4.7-7.2)	(3.8-6.5)	(3.4-6.5)	(5.0-6.8)	(8.0-9.2)
	Bottom:	8.1^{B}	7.4^{B}	5.2^{B}	4.9^{B}	4.2^{B}	5.7	8.6
		(7.6-8.5)	(6.1-8.3)	(2.4-6.8)	(3.8-5.7)	(3.4-5.5)	(3.6-6.8)	(7.7-9.8)
Salinity (ppt)	Surface:	23.7	25.5	29.5	31.9	31.5	33.1	31.1
		(22.1-26.1)	(22.4-28.7)	(25.3-31.8)	(28.6-34.0)	(30.5-33.2)	(32.2-34.1)	(29.7-31.8)
	Bottom:	23.4^{B}	25.2^{B}	29.4^{B}	31.7^{B}	31.6^{B}	33.0	31.3
		(22.4-26.0)	(22.6-28.8)	(25.4-31.6)	(29.0-34.0)	(30.5-33.2)	(32.2-33.5)	(30.4-31.8)
Secchi (cm)		145.8	75.1	61.9	49.2	61.3	63.8	136.4
		(97.0-192.5)	(56.0-115.0)	(49.5-84.0)	(37.2-76.0)	(30.0-75.0)	(33.0-79.0)	(94.0-278.0)

Table 11. Coastal Bays Fisheries Investigations 2010 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:	26.9 (26.2-27.5)	22.5 (21.4-23.0)
DO (mg/L)	Surface:	6.6 (5.6-8.5)	6.2 (5.4-7.3)
Salinity (ppt)	Surface:	29.3 (27.9-30.5)	30.1 (29.8-30.5)
Secchi (cm)		61.1 (30.5-121.9)	56.3 (47.0-63.0)
		Saint Martins River (Sites: S006)	
Temp (°C)	Surface:	28.2^{C}	28.2^{C}
DO (mg/L)	Surface:	7.3^{C}	7.3^{C}
Salinity (ppt)	Surface:	29.4^{C}	29.4^{C}
Secchi (cm)		58.0^{C}	58.0^{C}

Table 11 (con't). Coastal Bays Fisheries Investigations 2010 water quality data collected during seine sampling. Mean values are reported with the range in parentheses.

Parameter	Location	June	September
		Isle Of Wight Bay (Sites: S004, S005, and S007)	
Temp (°C)	Surface:	26.9 (22.8-29.1)	22.2 (21.3-22.7)
DO (mg/L)	Surface:	5.6 (4.9-6.3)	5.2 (5.0-5.4)
Salinity (ppt)	Surface:	29.8 (29.2-30.2)	30.9 (30.8-31.0)
Secchi (cm)		64.3 (38.0-115.0)	37.0 (28.0-53.0)
		Sinepuxent Bay (Sites: S008, S009, and S010)	
Temp (°C)	Surface:	24.7 (22.2-29.1)	23.6 (23.4-23.9)
DO (mg/L)	Surface:	8.3 (6.9-10.7)	8.0 (6.1-9.7)
Salinity (ppt)	Surface:	29.7 (27.9-30.8)	31.9 (31.7-32.3)
Secchi (cm)		75.5 (61.0-91.4)	52.5 (38.5-74.0)

Table 11 (con't). Coastal Bays Fisheries Investigations 2010 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:	27.5 (27.0-27.9)	21.6 (21.0-22.2)
DO (mg/L)	Surface:	6.9 (6.3-7.4)	4.9 (3.7-6.1)
Salinity (ppt)	Surface:	24.7 (24.2-25.1)	31.6 (31.1-32.0)
Secchi (cm)		38.0 (29.0-47.0)	34.5 (34.0-35.0)
		Chincoteague Bay (Sites: S013, S014, S015, S016, S017, S018, S019)	
Temp (°C)	Surface:	29.3 (26.5-31.3)	23.3 (20.9-24.9)
DO (mg/L)	Surface:	5.3 (2.1-6.8)	3.1 (4.5-7.8)
Salinity (ppt)	Surface:	26.7 (8.7-31.8)	31.2 (19.2-33.8)
Secchi (cm)		51.4 (13.5-82.0)	47.3 (22.0-66.0)

A-Conditions too shallow at site T006 for bottom water quality to be taken, but surface measurements were collected. Surface and bottom measurements were recorded from T007.
B-Conditions too shallow at site T019 for bottom water quality to be taken, but surface measurements were collected. Surface and bottom measurements are from seven sites instead of eight.
C-One site sampled.

Table 12. Coastal Bays Fisheries Investigations 2009 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:	23.3 (22.0-25.0)	22.3 (22.0-23.0)
DO (mg/L)	Surface:	5.8 (5.4-6.2)	8.0 (7.5-8.6)
Salinity (ppt)	Surface:	24.7 (23.0-26.0)	25.3 (24.0-27.0)
Secchi (cm)		58.0 (32.0-80.0)	85.5 (85.0-86.0)
		Saint Martins River (Sites: S006)	
Temp (°C)	Surface:	24.0	23.0
DO (mg/L)	Surface:	5.5	4.5
Salinity (ppt)	Surface:	26.0	26.0
Secchi (cm)		82.0	77.0

Table 12 (con't). Coastal Bays Fisheries Investigations 2009 water quality data collected during seine sampling. Mean values are reported with the range in parentheses.

Parameter	Location	June	September
		Isle Of Wight Bay (Sites: S004, S005, and S007)	
Temp (°C)	Surface:	24.0 (23.0-25.0)	22.0 (22.0-22.0)
DO (mg/L)	Surface:	6.1 (5.2-6.5)	6.0 (3.9-7.9)
Salinity (ppt)	Surface:	27.3 (26.0-29.0)	26.3 (26.0-27.0)
Secchi (cm)		98.0 (68.0-118.0)	71.0 (40.0-87.0)
		Sinepuxent Bay (Sites: S008, S009, and S010)	
Temp (°C)	Surface:	21.7 (21.0-23.0)	22.7 (22.0-24.0)
DO (mg/L)	Surface:	6.1 (5.9-6.3)	7.6 (6.4-8.8)
Salinity (ppt)	Surface:	29.7 (29.0-30.0)	26.7 (24.0-28.0)
Secchi (cm)		279.7 (82.0-660.0)	70.0 (50.0-90.0)

Table 12 (con't). Coastal Bays Fisheries Investigations 2009 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:	23.0 (22.0-24.0)	24.0 (24.0-24.0)
DO (mg/L)	Surface:	4.9 (4.4-5.4)	5.2 (4.6-5.8)
Salinity (ppt)	Surface:	23.5 (23.0-24.0)	24.5 (24.0-25.0)
Secchi (cm)		36.0 (35.0-37.0)	32.0 (22.0-42.0)
		Chincoteague Bay (Sites: S013, S014, S015, S016, S017, S018, S019)	
Temp (°C)	Surface:	24.0 (23.0-25.0)	21.7 (20.0-25.0)
DO (mg/L)	Surface:	5.2 (3.1-6.9)	6.2 (4.5-7.5)
Salinity (ppt)	Surface:	23.0 (1.0-29.0)	20.9 (0.0-25.0)
Secchi (cm)		47.6 (26.0-73.0)	63.8 (20.0-105.0)

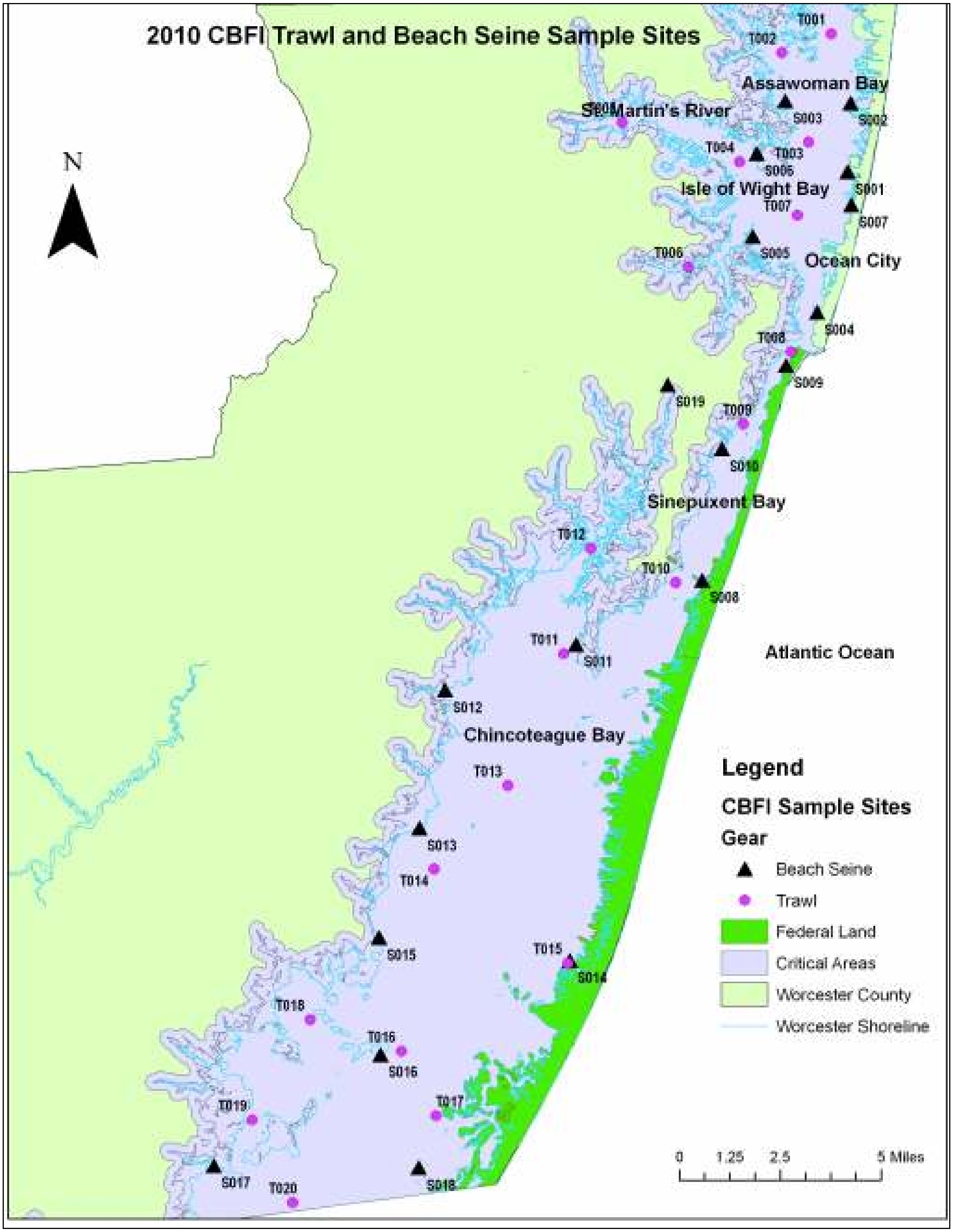

Figure 1. Site locations for the 2010 Coastal Bays Fishery Investigations Trawl and Beach Seine Survey.

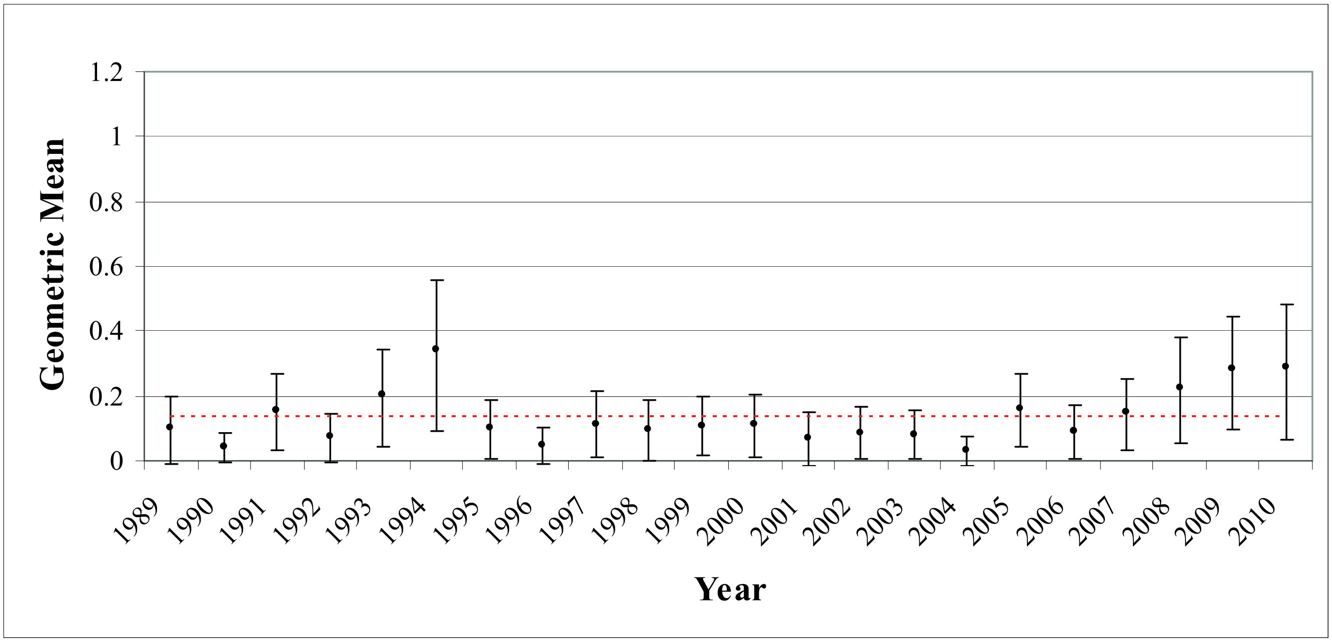

Figure 2. American Eel (*Anguilla rostrata)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

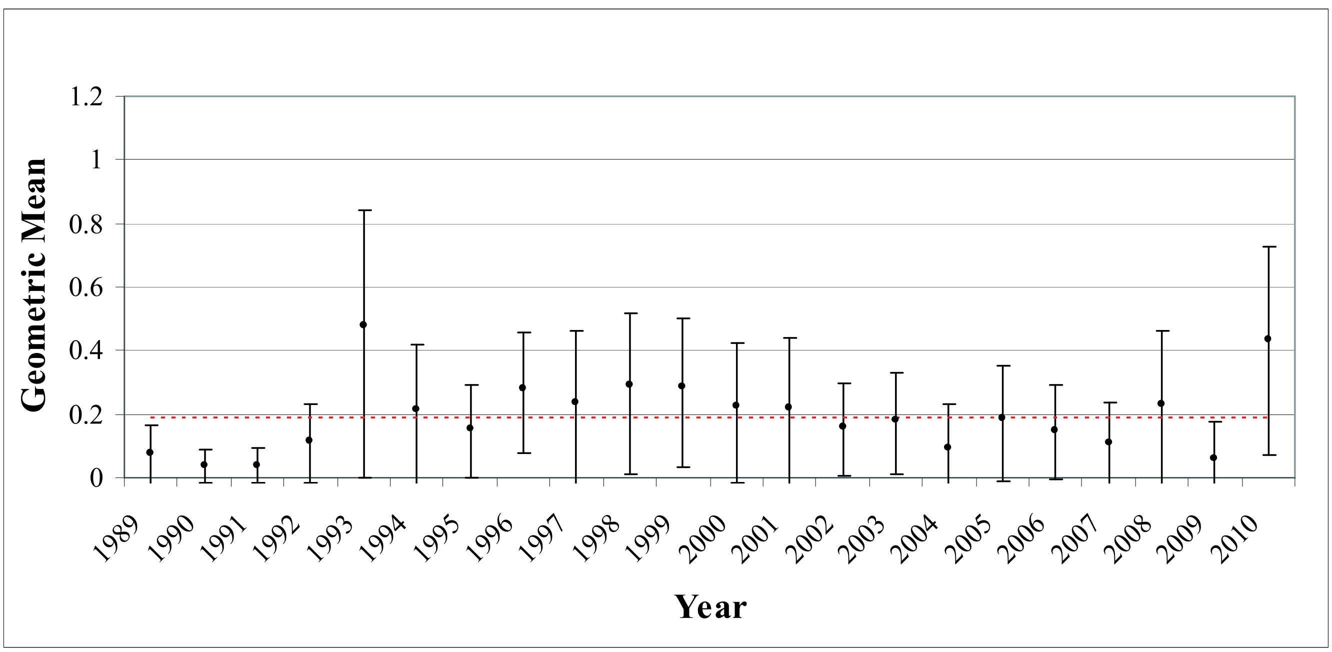

Figure 3. American Eel (*Anguilla rostrata)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

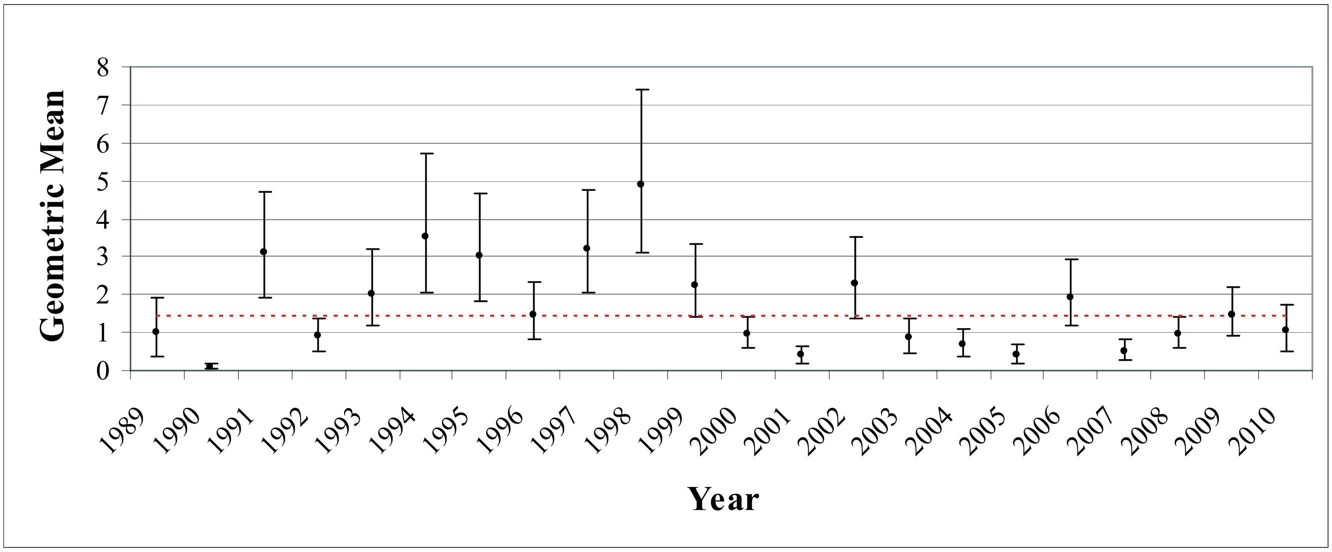

Figure 4. Atlantic Croaker (*Micropogonias undulates*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

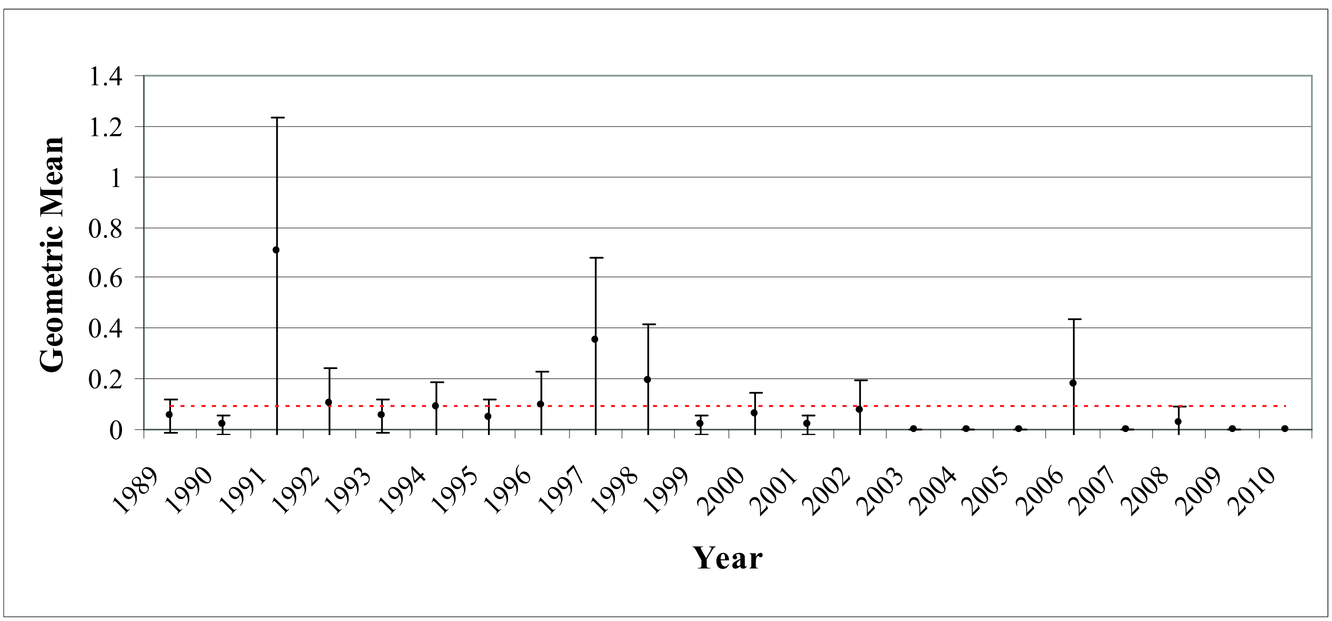

Figure 5. Atlantic Croaker (*Micropogonias undulates*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

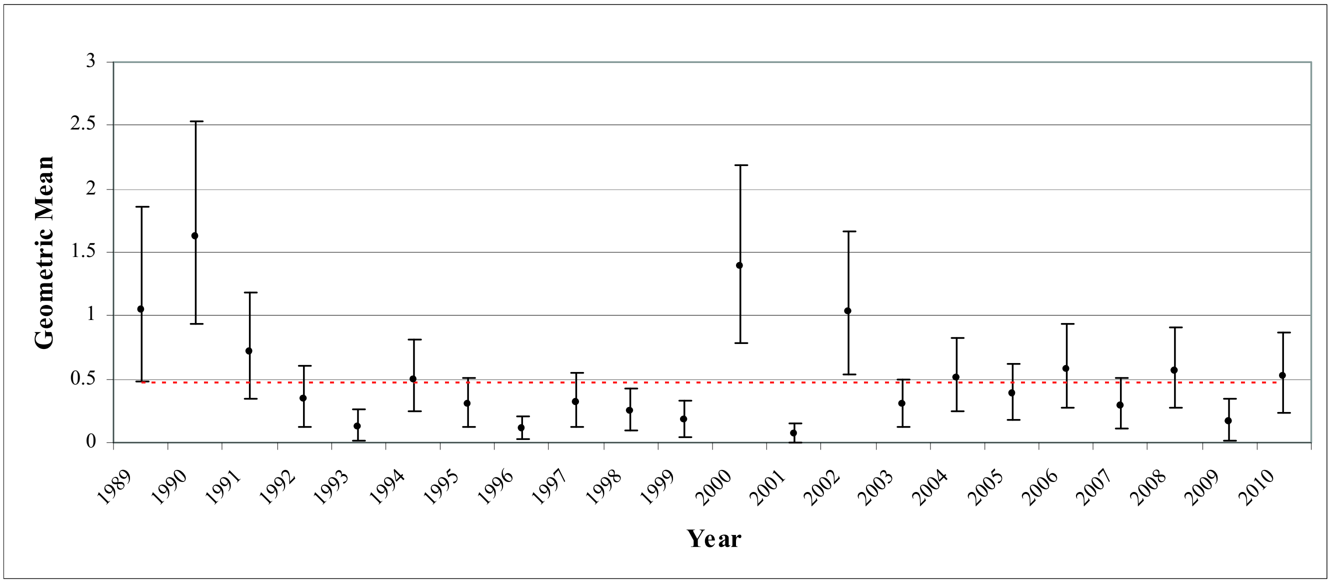

Figure 6. Atlantic Menhaden (*Brevoortia tyrannus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

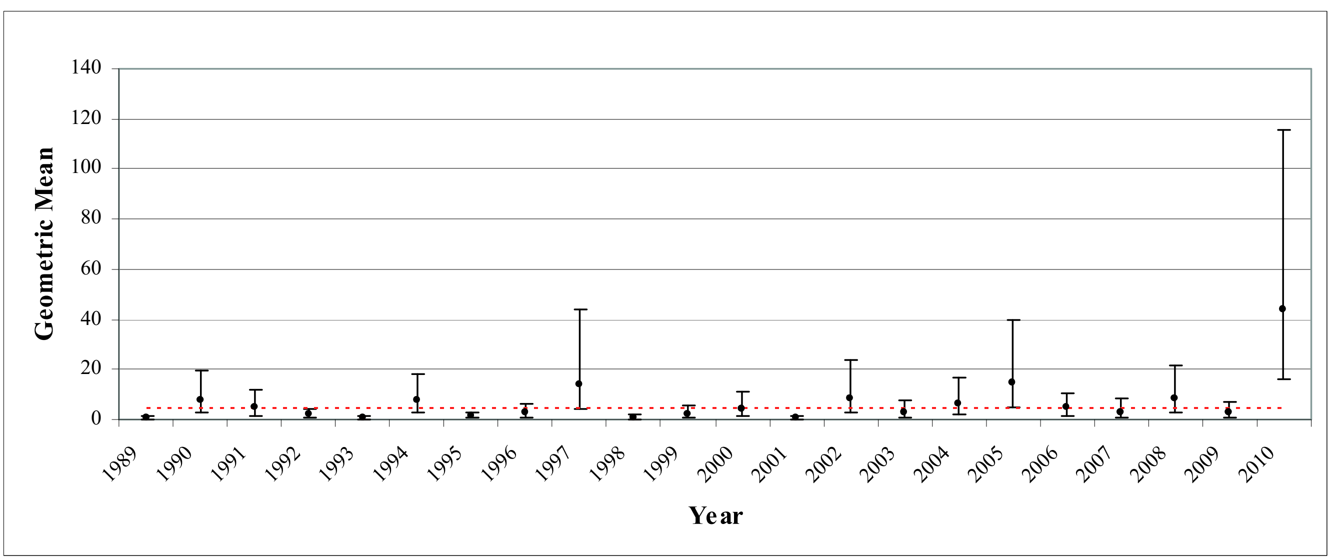

Figure 7. Atlantic Menhaden (*Brevoortia tyrannus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

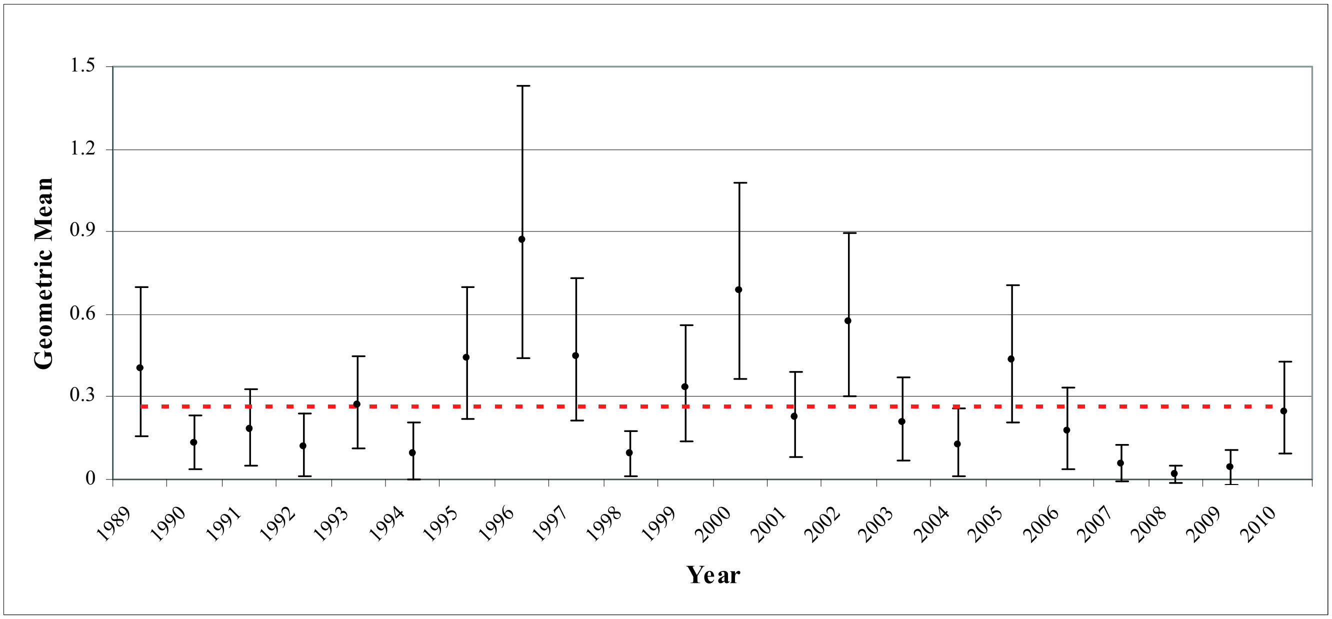

Figure 8. Atlantic Silverside (*Menidia menidia*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

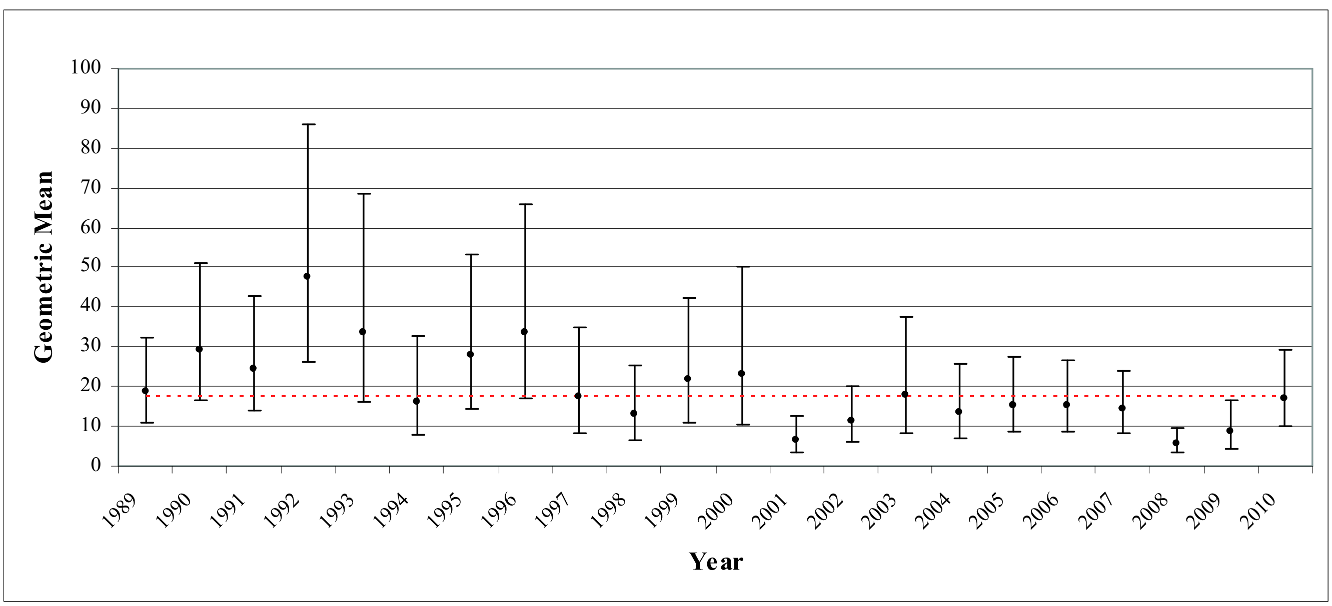

Figure 9. Atlantic Silverside (*Menidia menidia*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

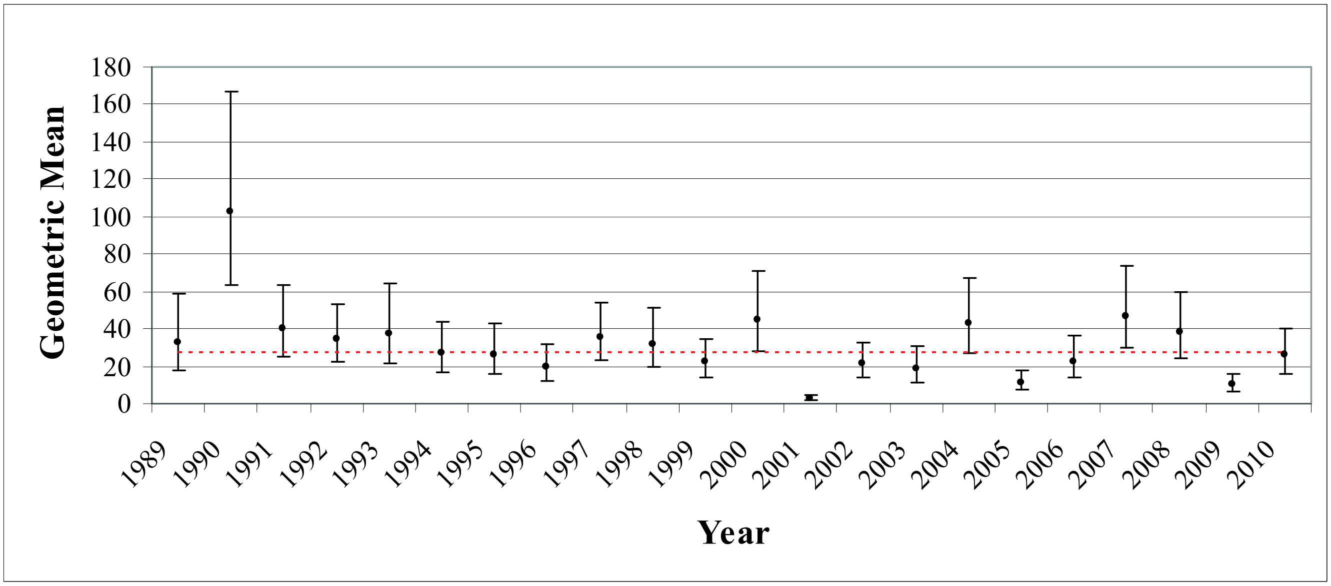

Figure 10. Bay Anchovy (*Anchoa mitchilli*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

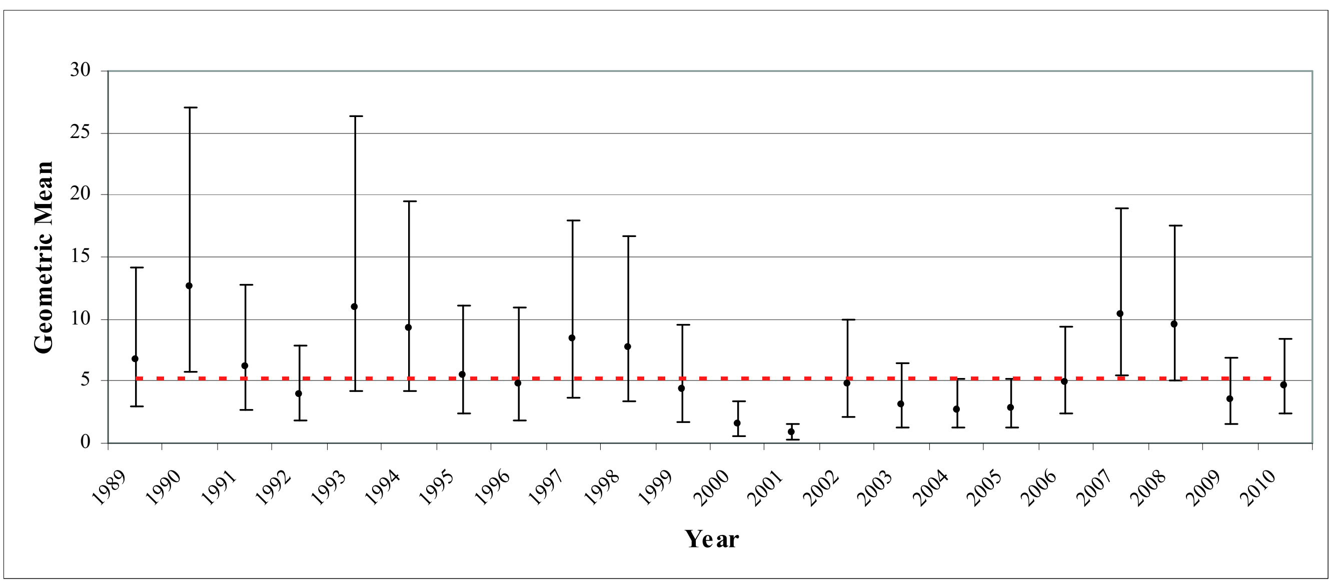

Figure 11. Bay Anchovy (*Anchoa mitchilli*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

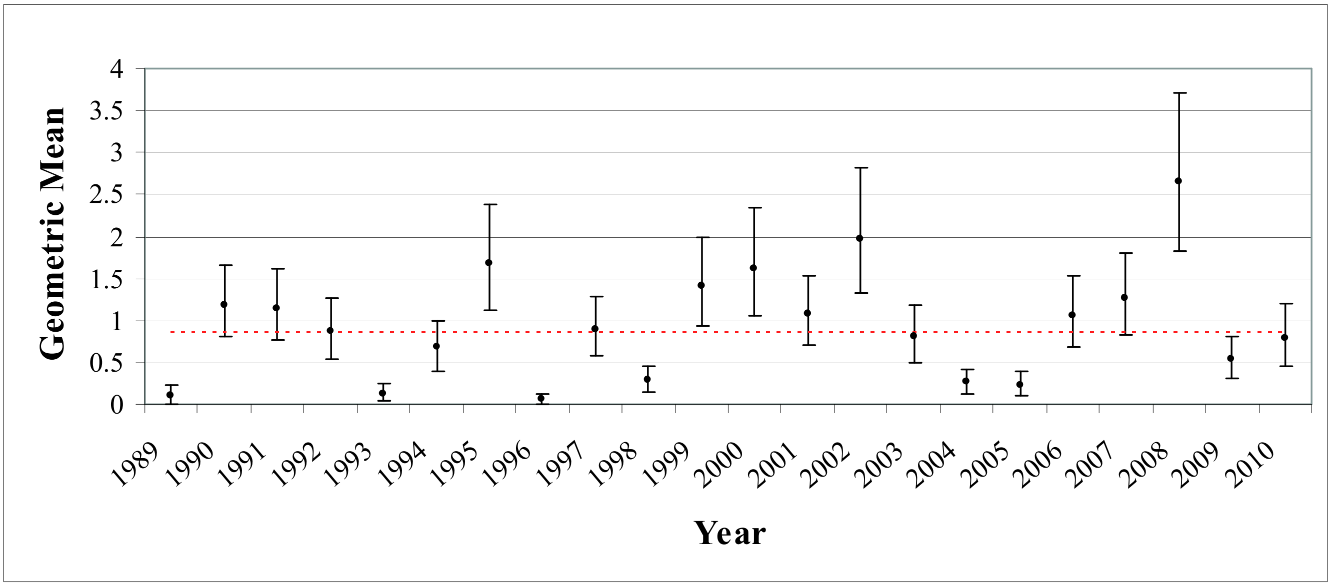

Figure 12. Black Sea Bass (*Centropristis* striata) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

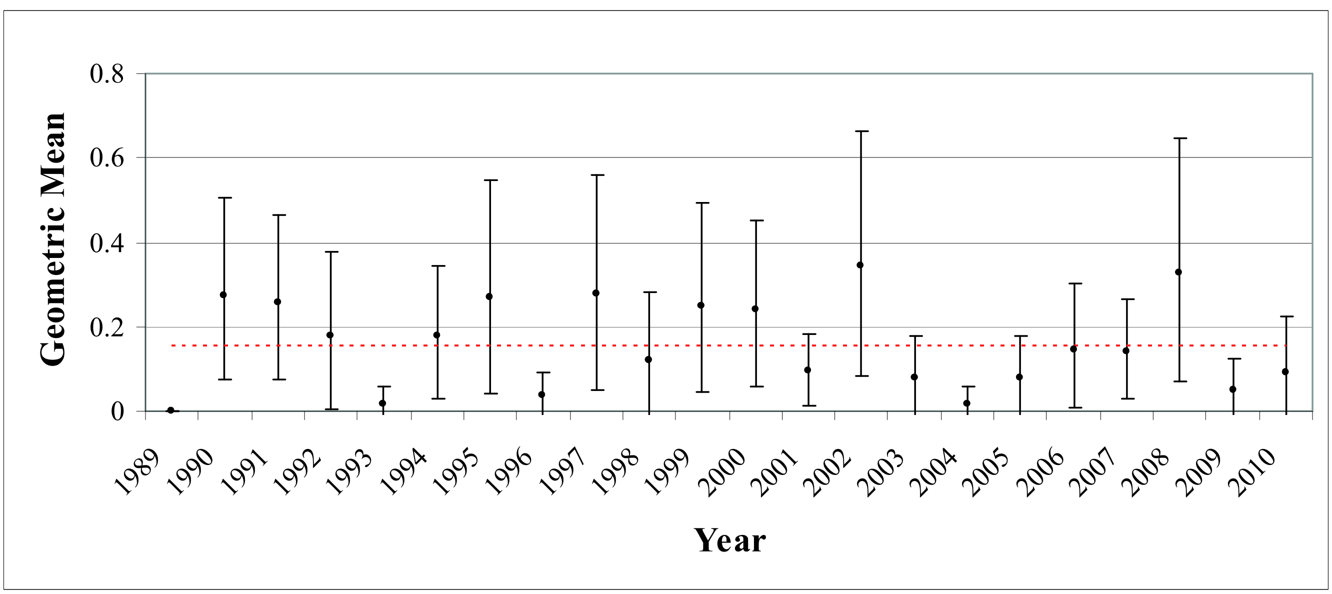

Figure 13. Black Sea Bass (*Centropristis* striata) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

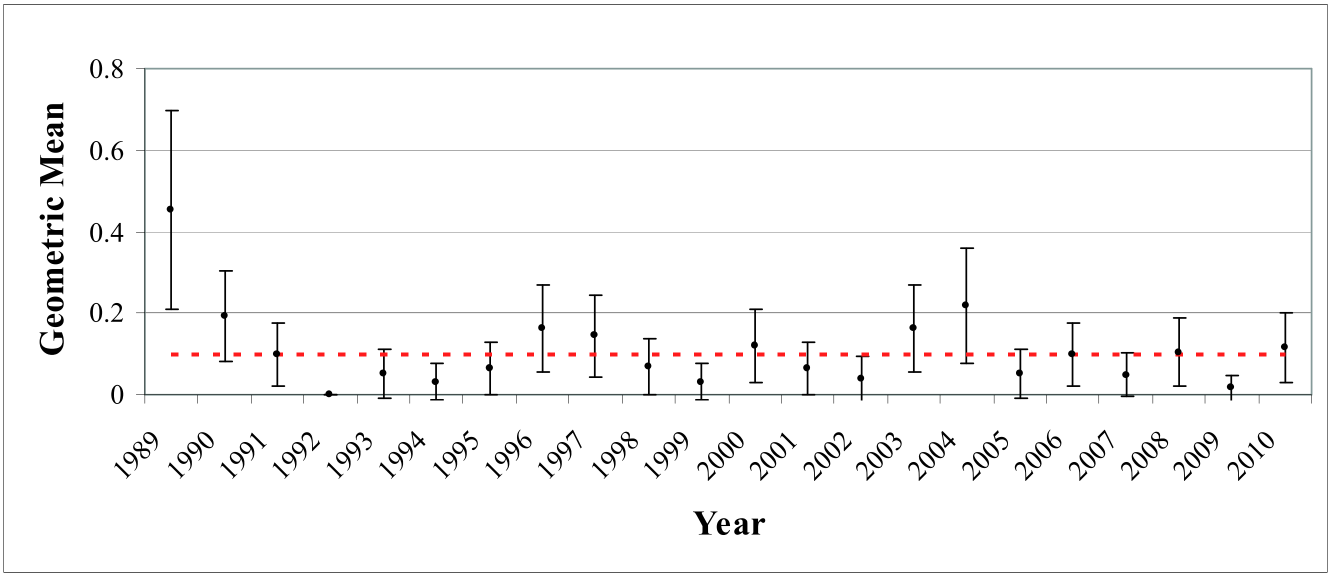

Figure 14. Bluefish (*Pomatomus saltatrix*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

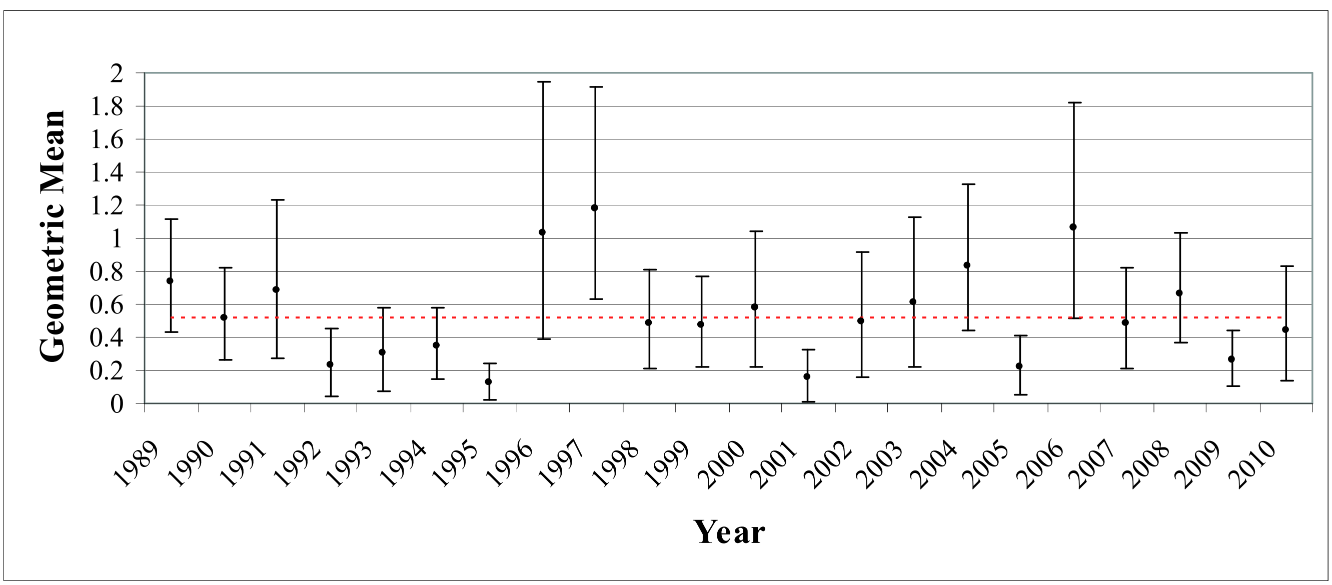

Figure 15. Bluefish (*Pomatomus saltatrix*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

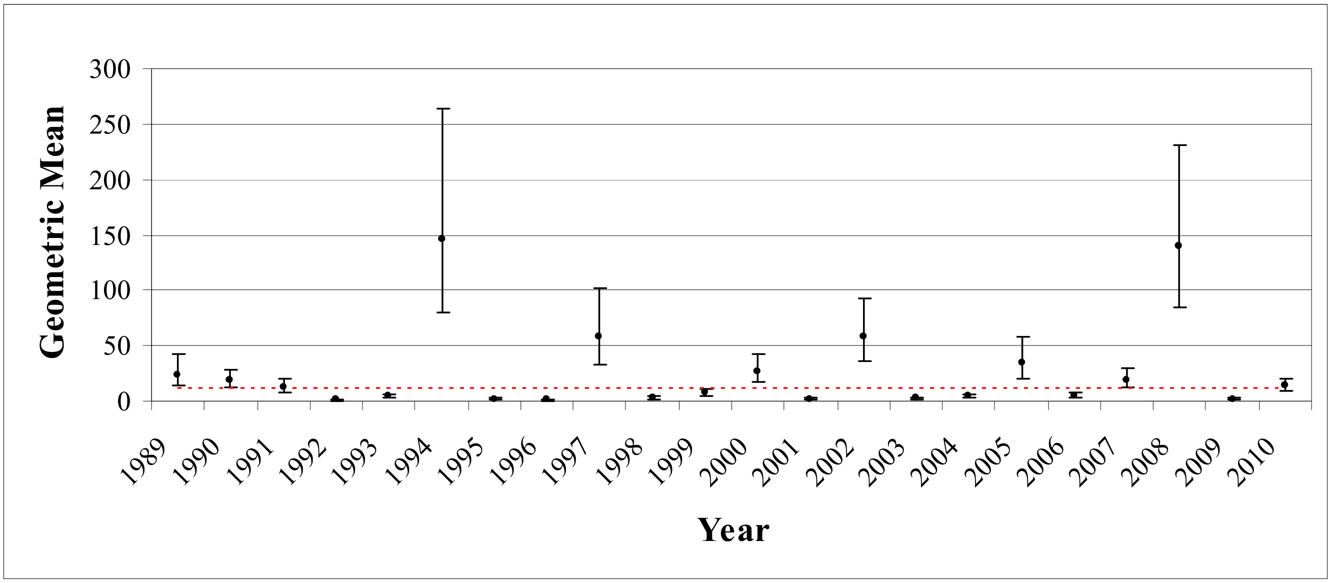

Figure 16. Spot (*Leiostomus xanthurus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

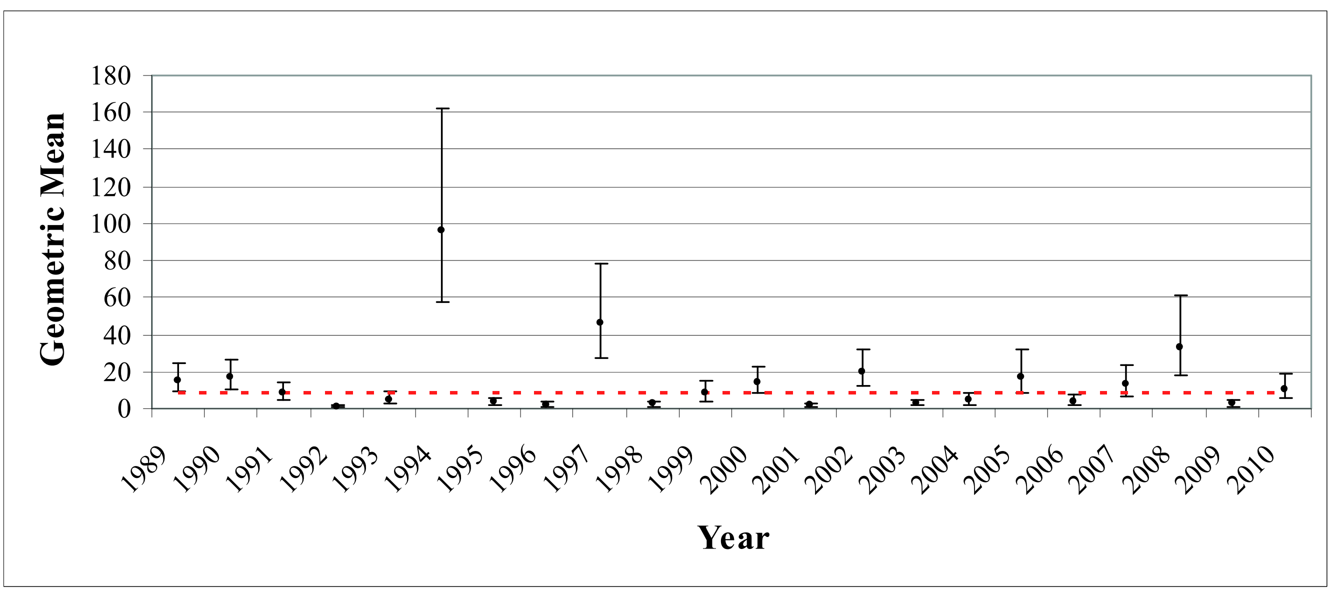

Figure 17. Spot (*Leiostomus xanthurus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

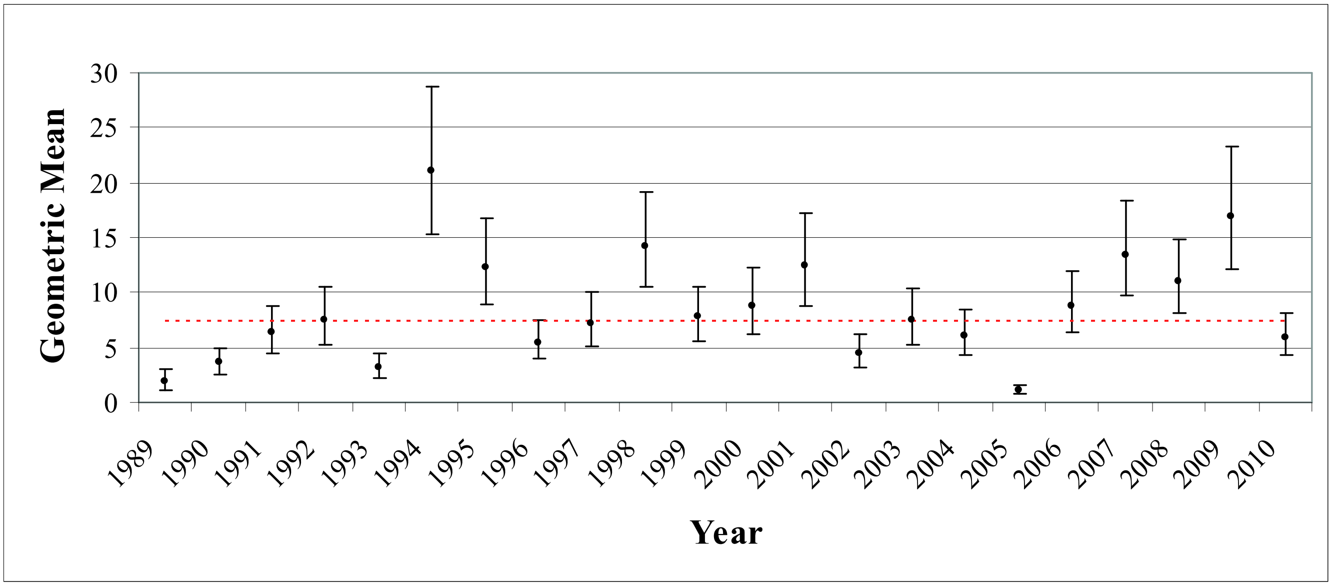

Figure 18. Summer Flounder (*Paralichthys dentatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

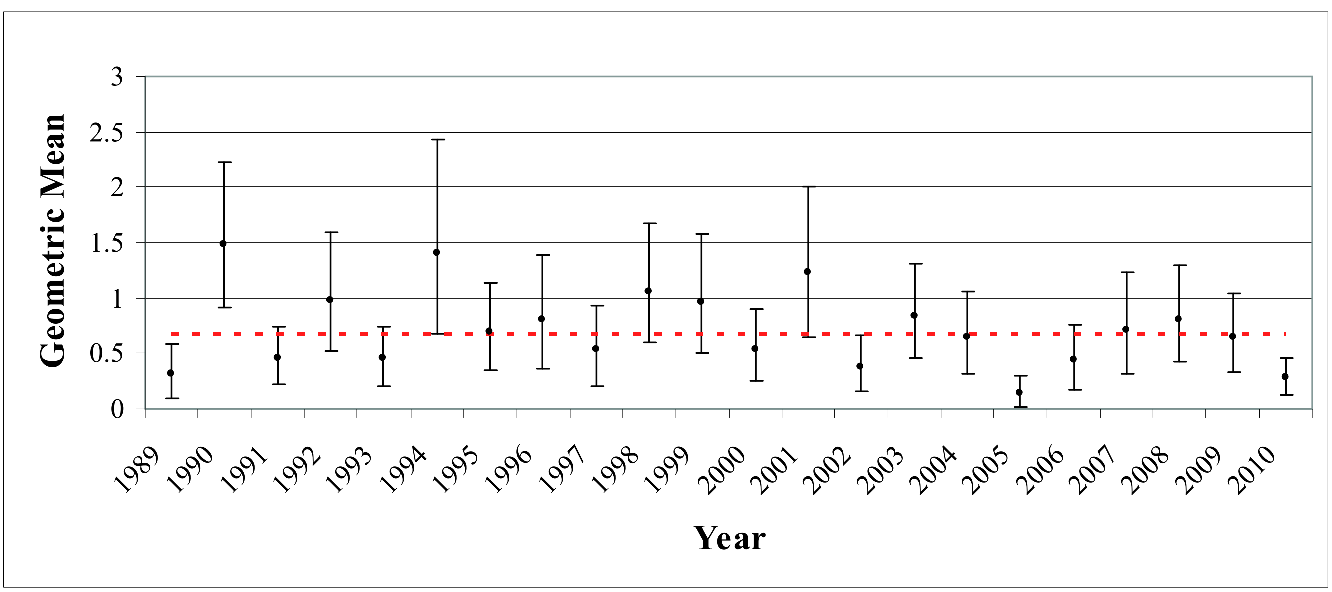

Figure 19. Summer Flounder (*Paralichthys dentatus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

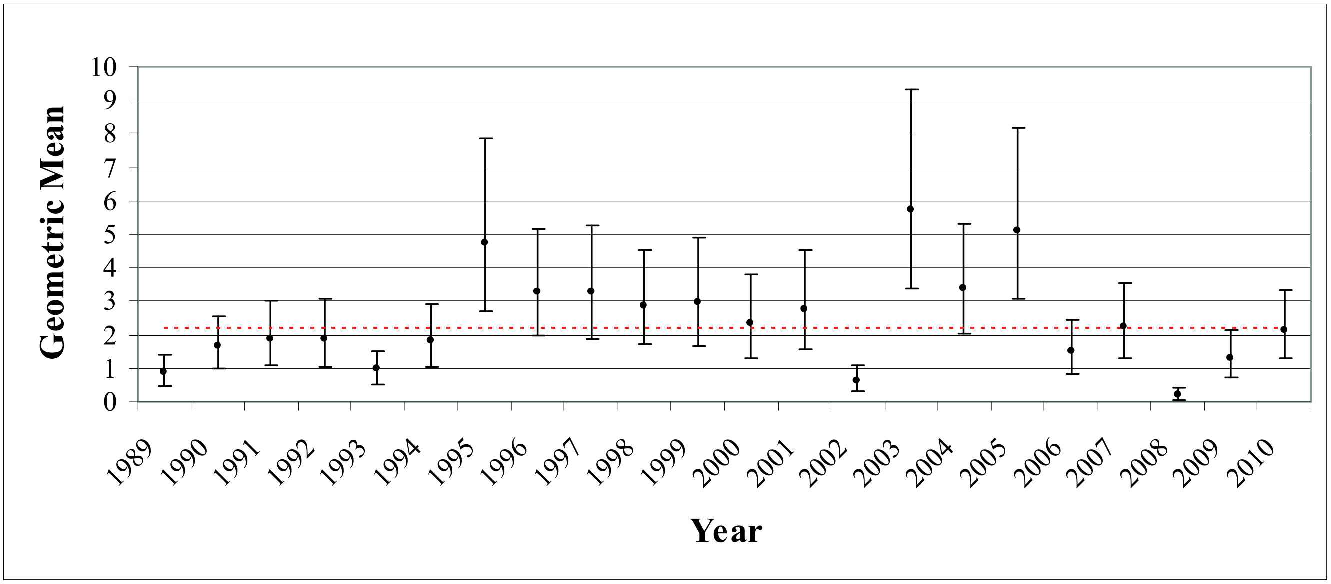

Figure 20. Weakfish (*Cynoscion regalis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

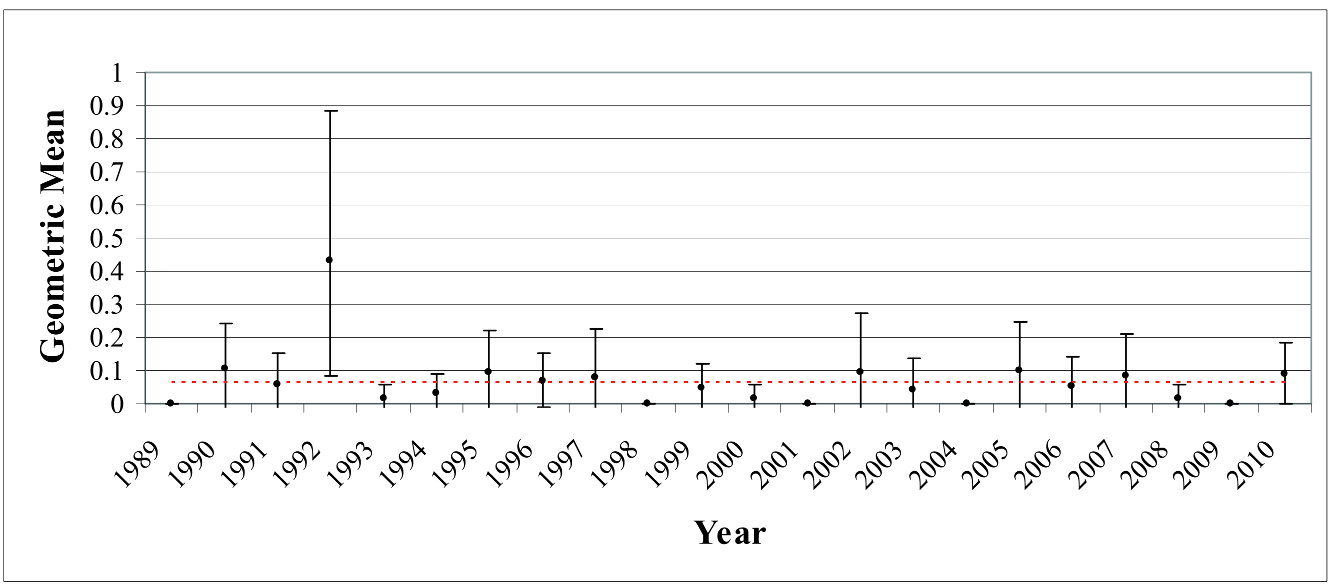

Figure 21. Weakfish (*Cynoscion regalis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2010). Dotted line represents the 1989-2010 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

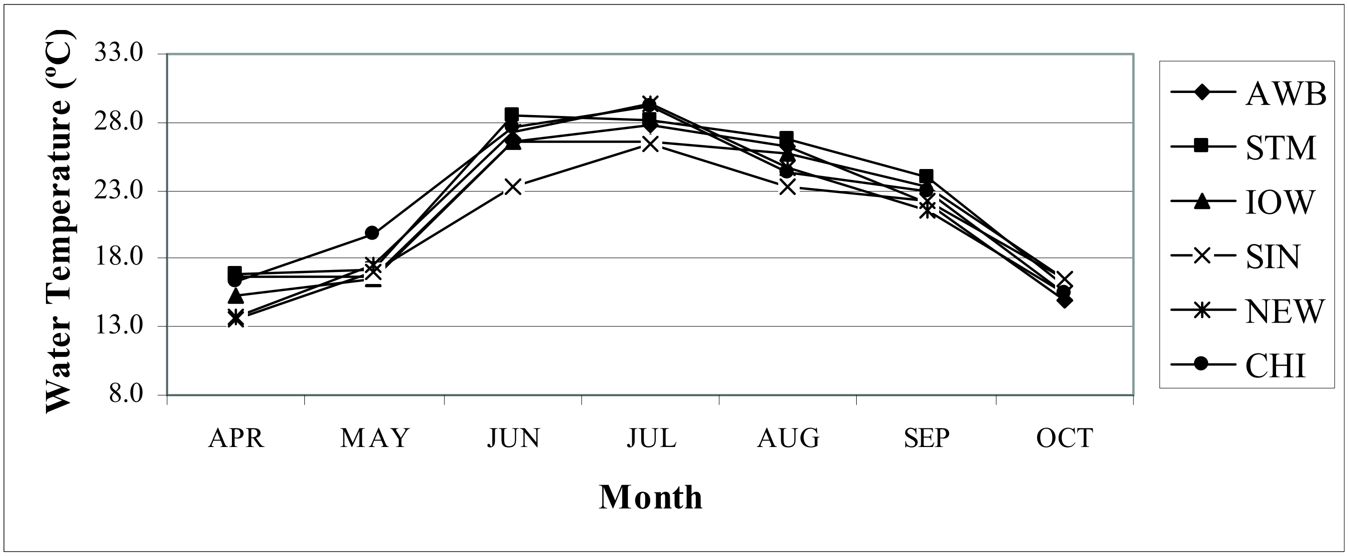

Figure 22. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

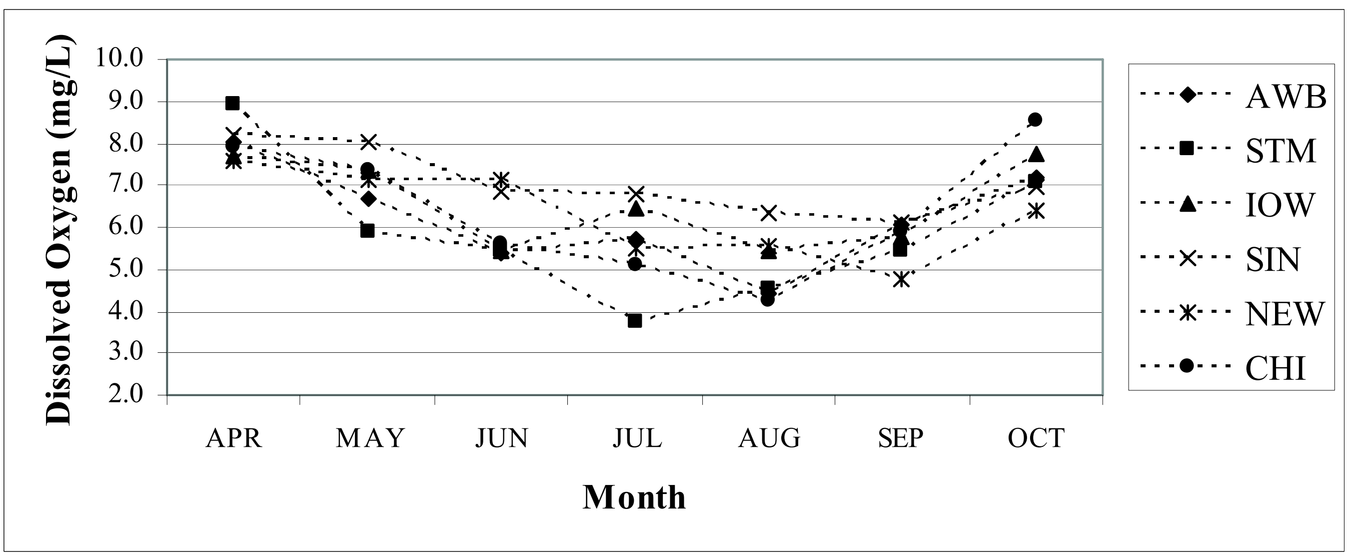

Figure 23. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

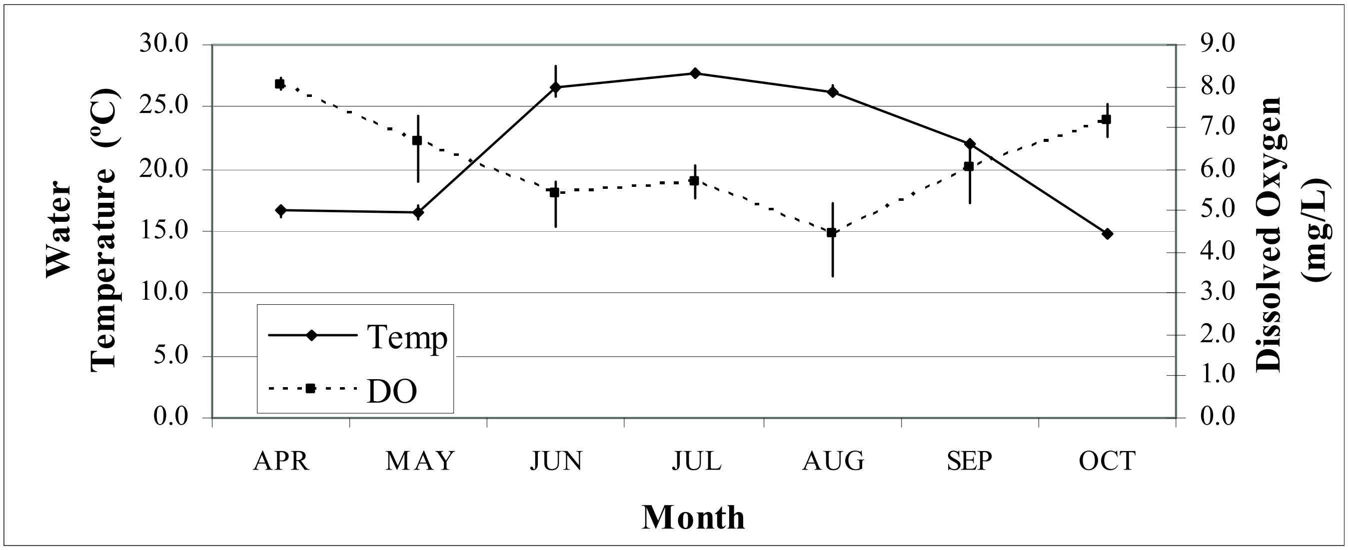

Figure 24. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Assawoman Bay. Error bars represent the range of values collected.

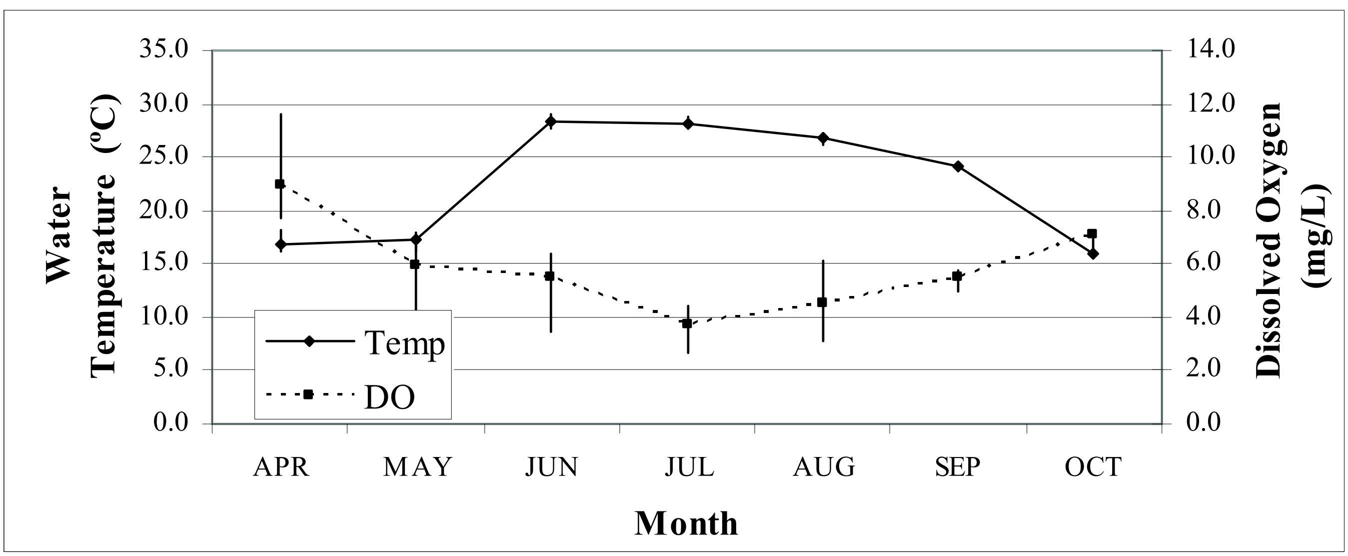

Figure 25. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in St. Martins River. Error bars represent the range of values collected.

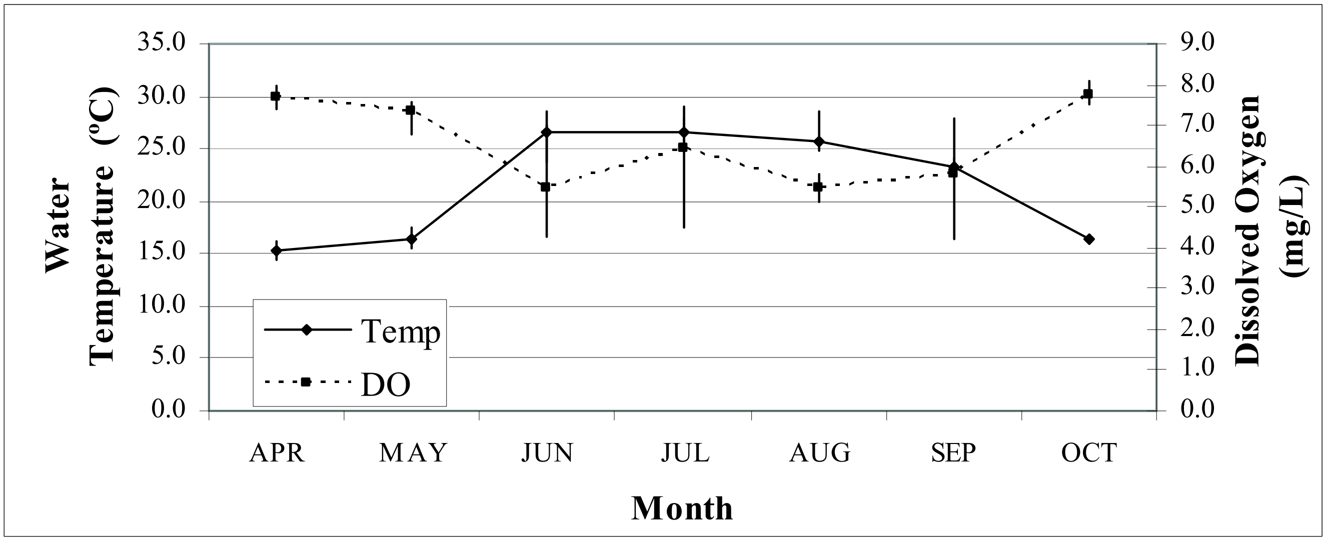

Figure 26. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Isle of Wight Bay. Error bars represent the range of values collected.

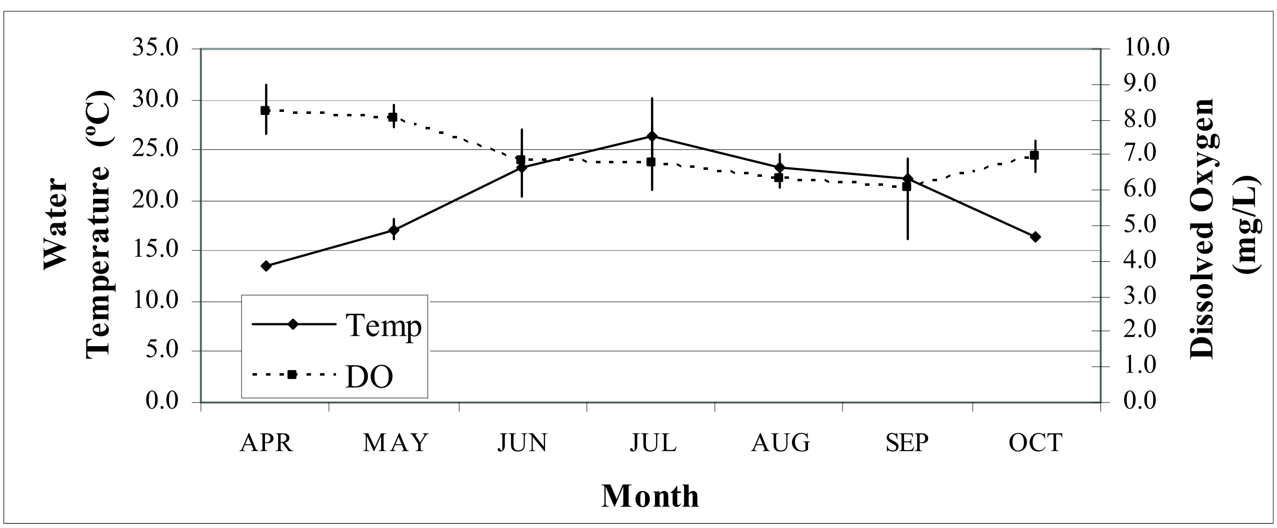

Figure 27. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Sinepuxent Bay. Error bars represent the range of values collected.

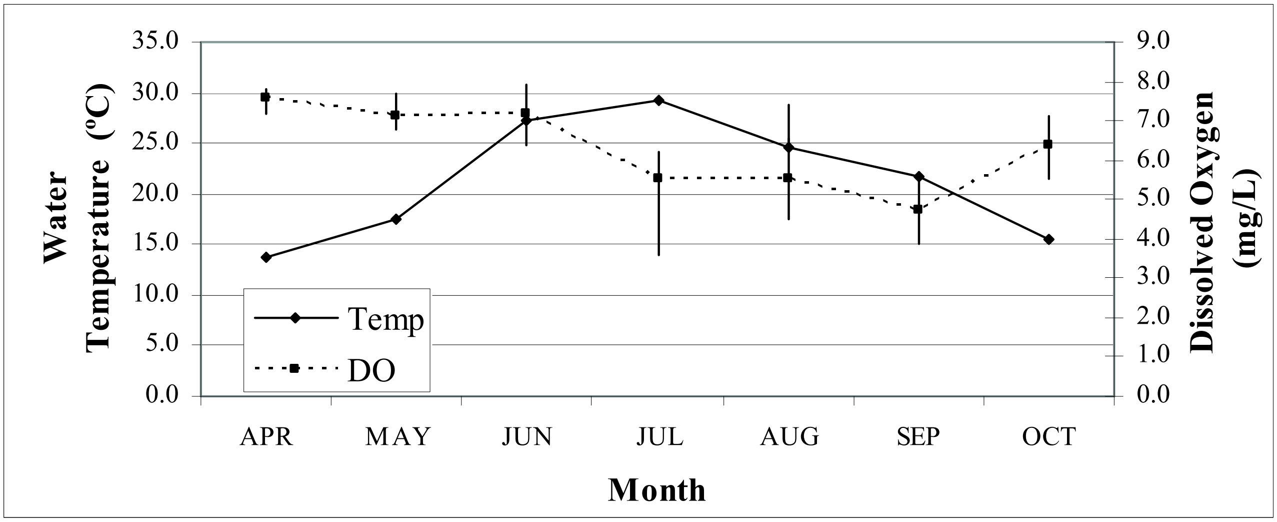

Figure 28. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Newport Bay. Error bars represent the range of values collected.

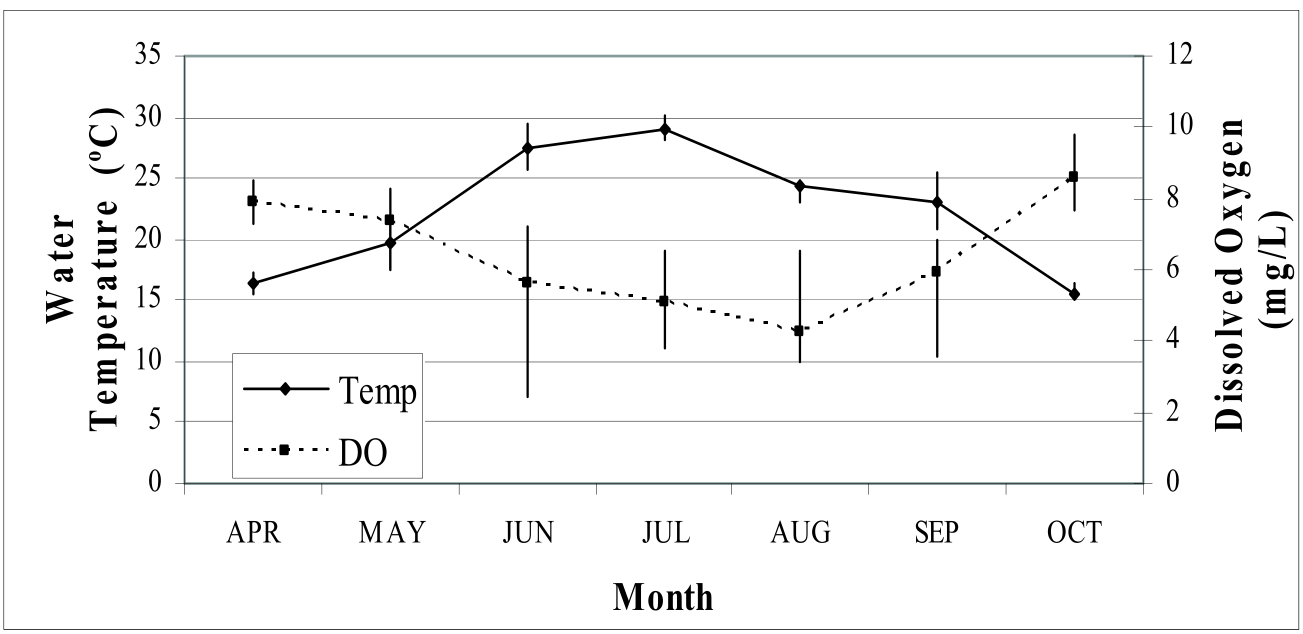

Figure 29. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Chincoteague Bay. Error bars represent the range of values collected.

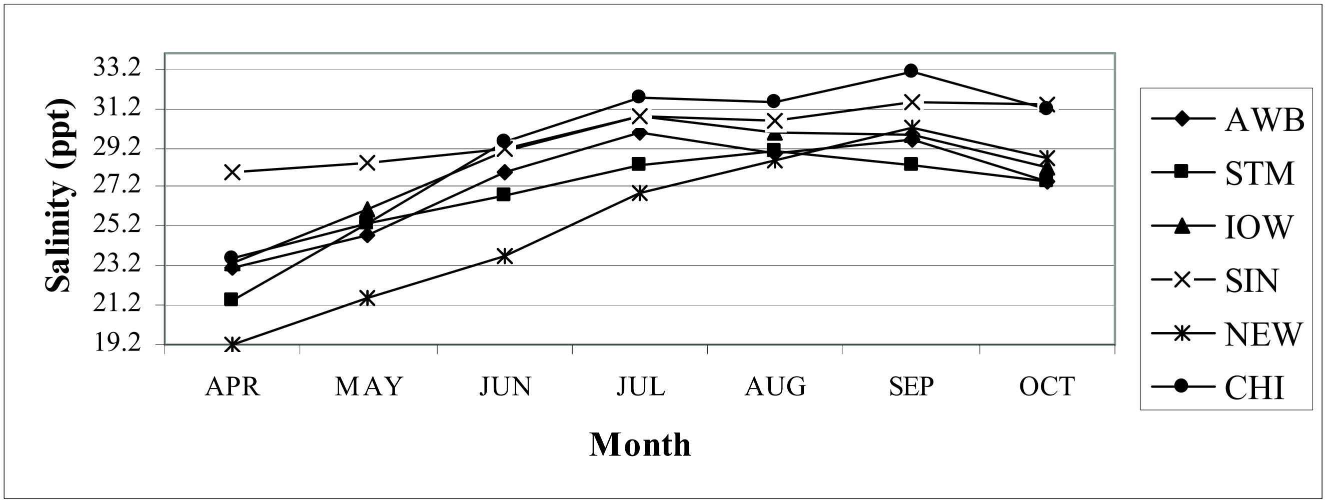

Figure 30. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

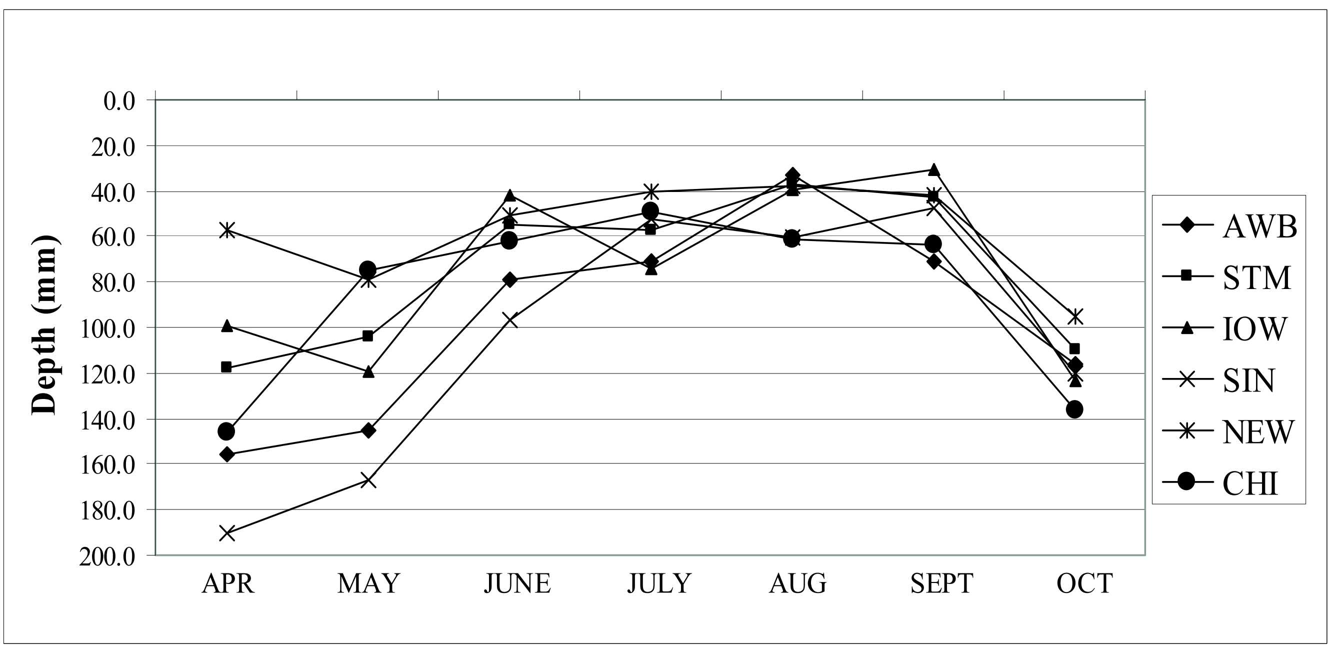

Figure 31. 2010 Coastal Bays Fisheries Investigations Trawl Survey mean turbidity (cm) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

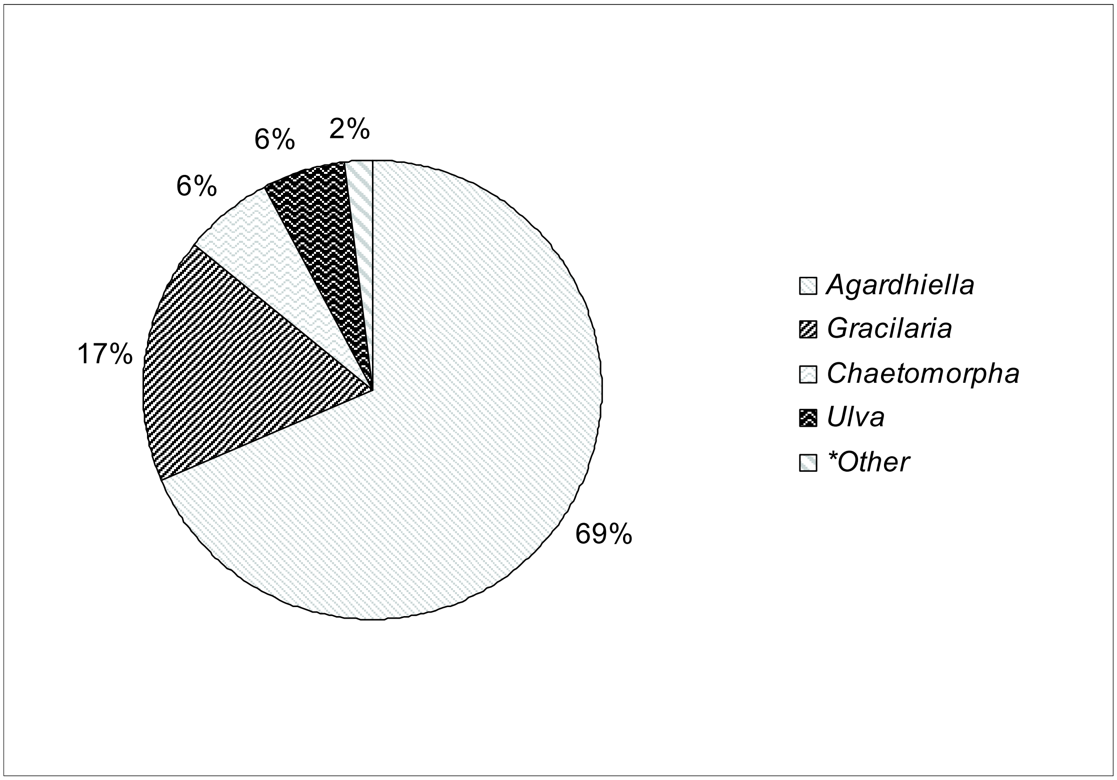

Figure 32. Percentages of macroalgae biomass collected in 2010 Coastal Bays Fisheries Investigation Trawl Survey. *Other consisted of macroalgae genera that were 2% or less of the total volume: *Polysiphonia*, *Enteromorpha*, *Vaucheria*, *Champia*, *Spyridia*, *Ceramium*, *Fucus* and *Codium*.

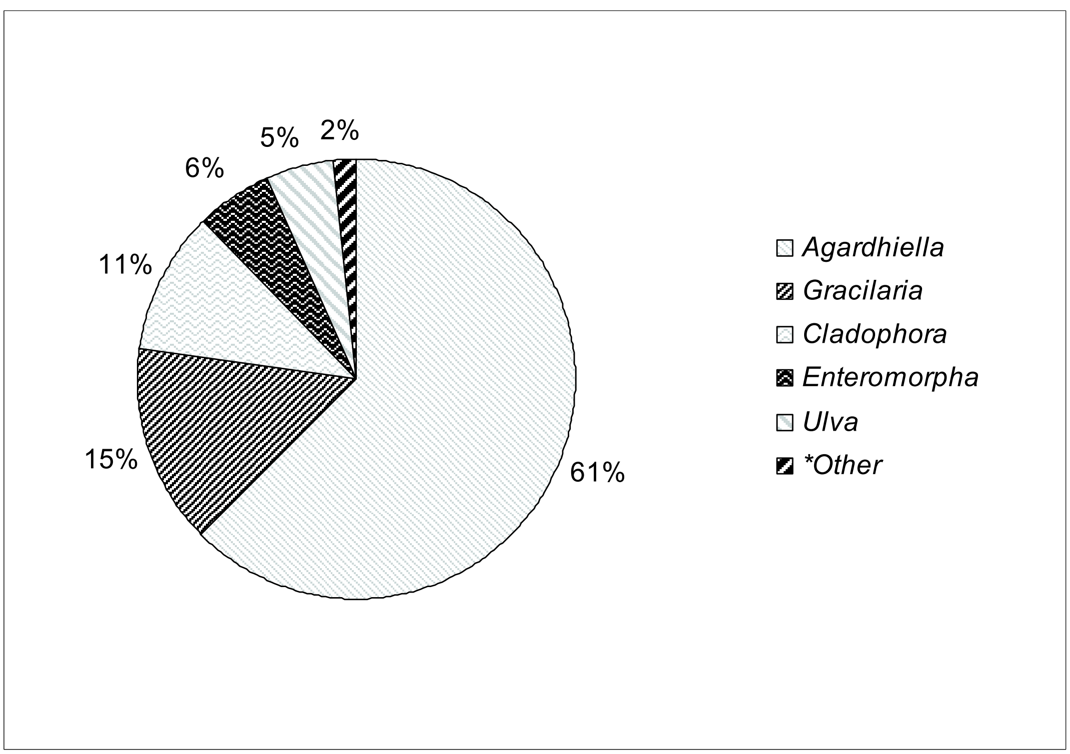

Figure 33. Percentages of macroalgae biomass collected in 2010 Coastal Bays Fisheries Investigation Beach Seine Survey. *Other consisted of macroalgae species that were 2% or less of the total volume: *Vaucheria*, *Chaetomorpha*, *Spyridia* and *Polysiphonia*.

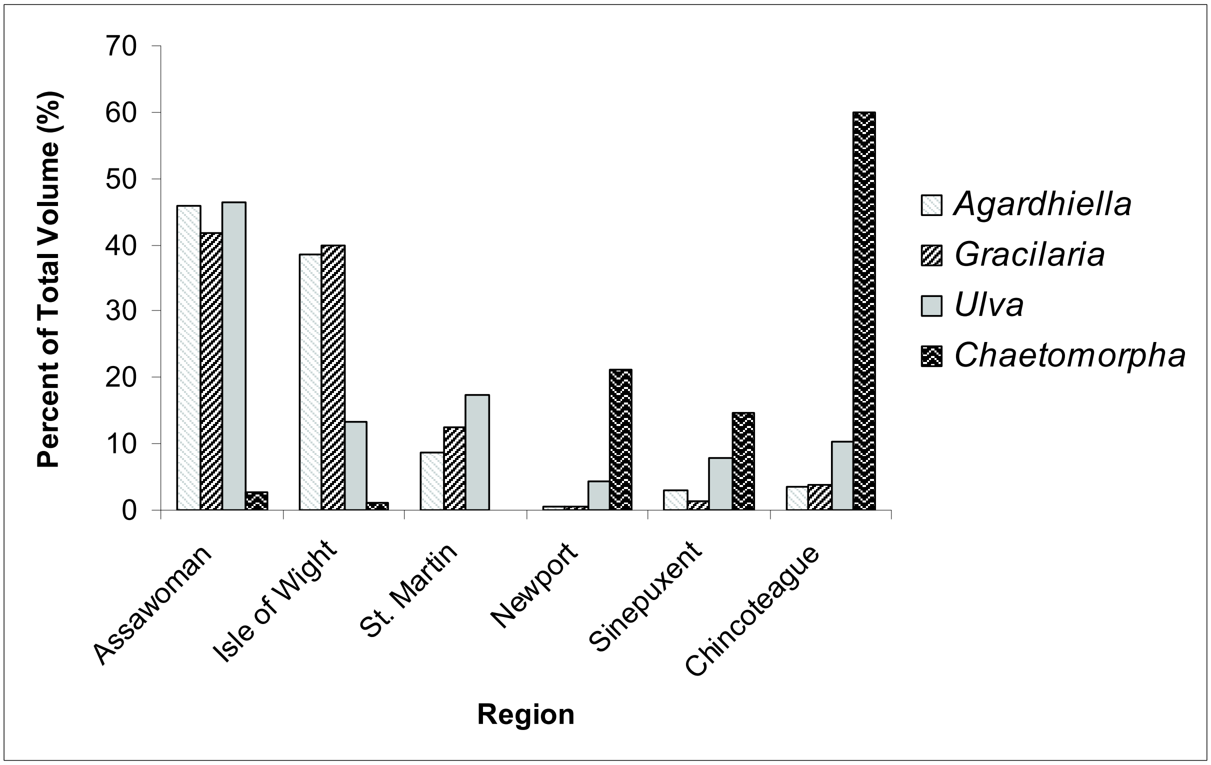

Figure 34. Percent of total volume of each dominant genus (*Agardhiella, Gracilaria, Chaetomorpha* and *Ulva*) by region from 2006-2010 in the Coastal Bays Fisheries Investigation Trawl Survey.

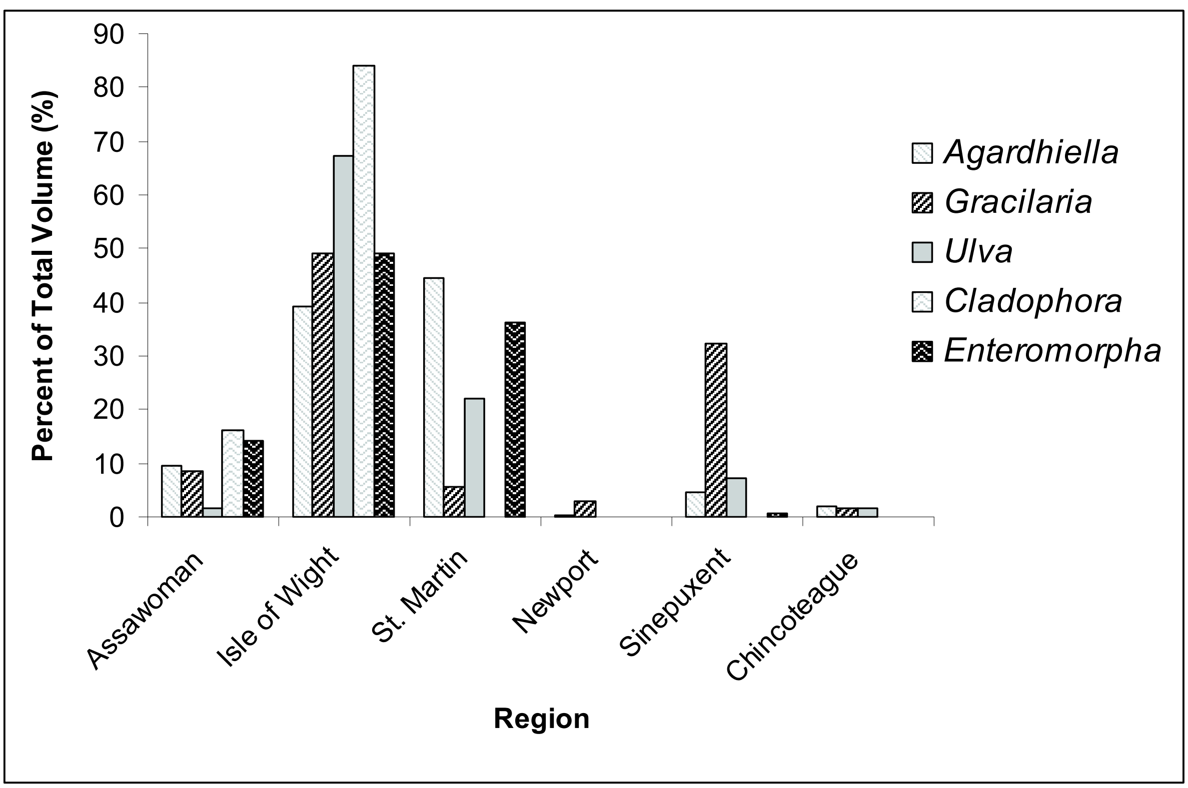

Figure 35. Percent of total volume of each dominant genus (*Agardhiella, Gracilaria, Ulva, Cladophora* and *Enteromorpha*) by region from 2006-2010 in the Coastal Bays Fisheries Investigation Beach Seine Survey.

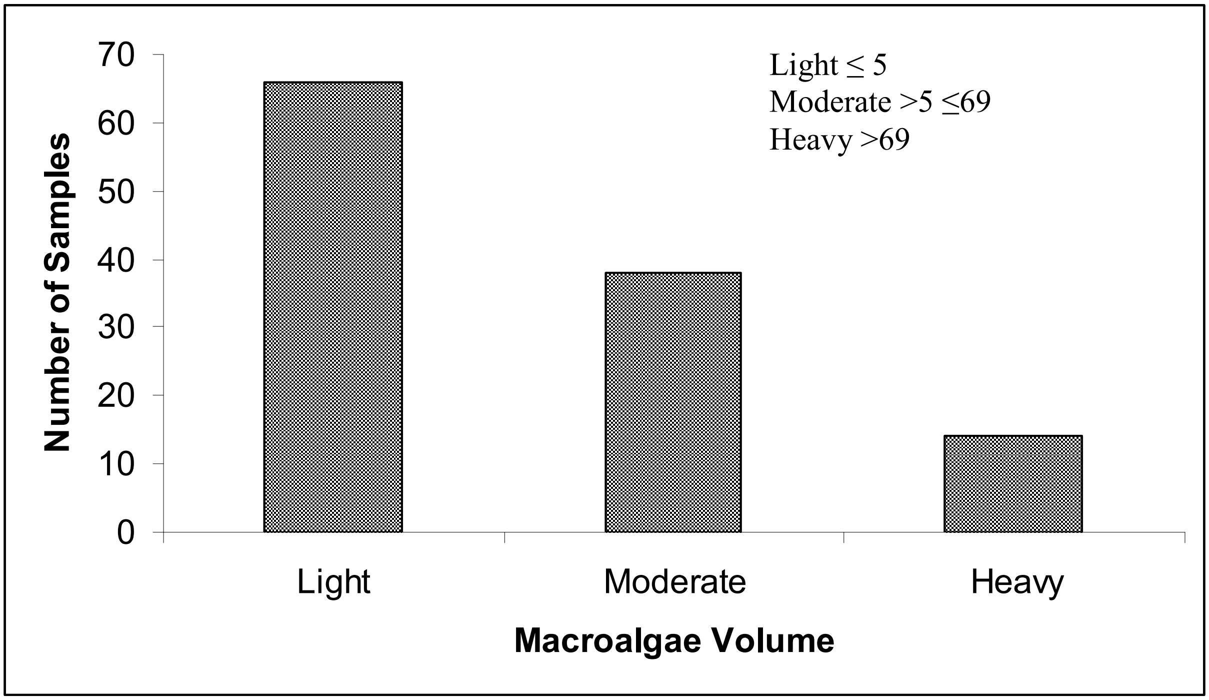

Figure 36. Volume categories of all 2010 Coastal Bays Fisheries Investigation Trawl Survey macroalgae samples (n=139) collected from Maryland's Coastal Bays.

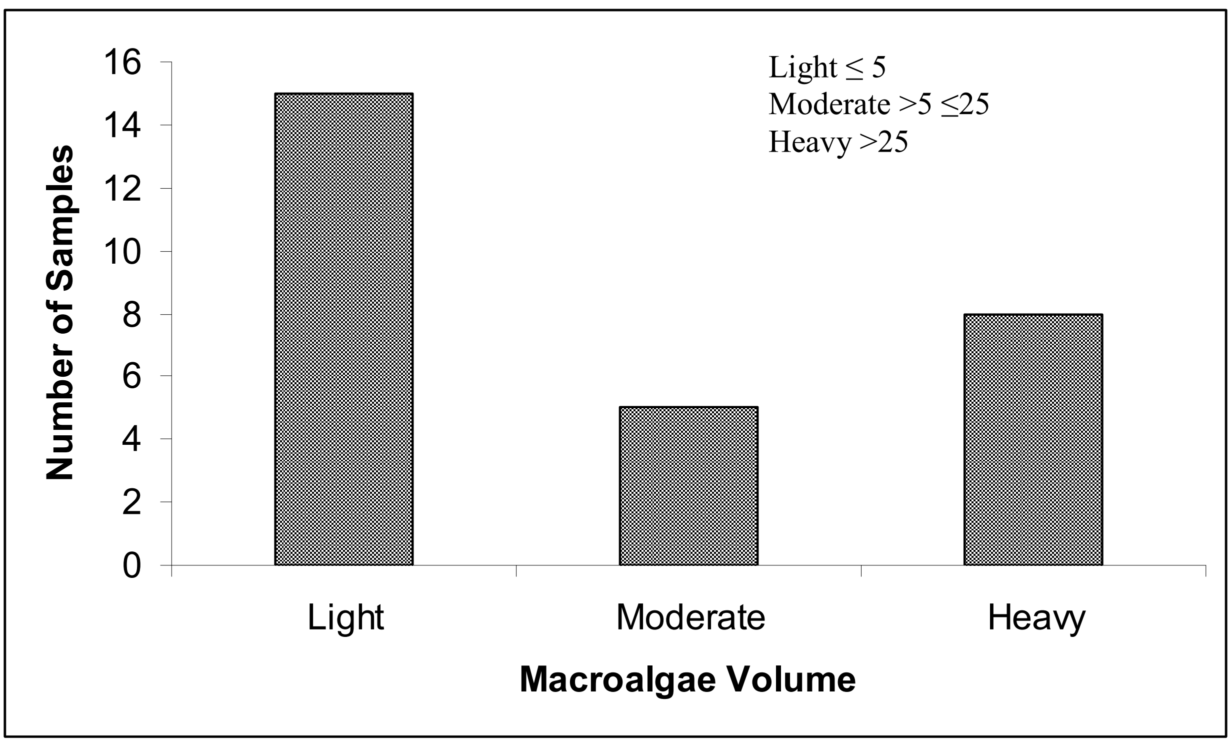

Figure 37. Volume categories of all 2010 Coastal Bays Fisheries Investigation Beach Seine Survey macroalgae samples (n=37) collected from Maryland's Coastal Bays.

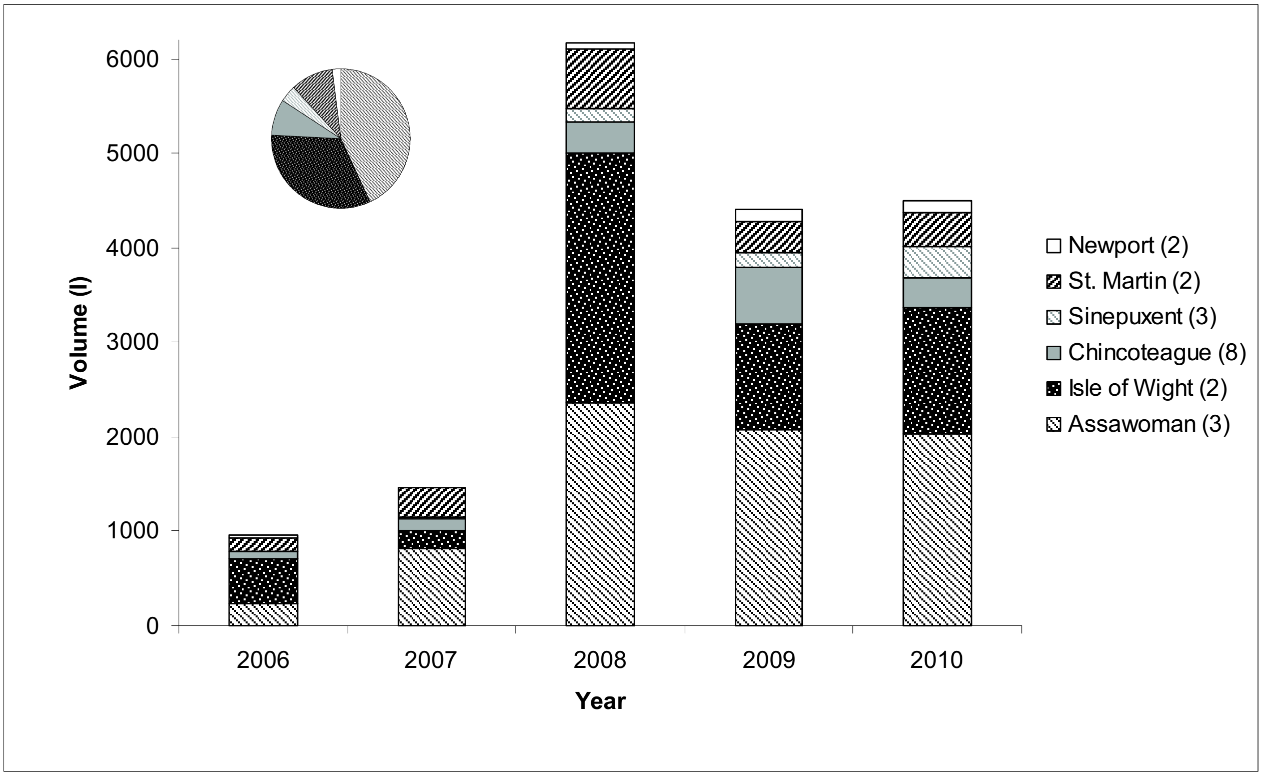

Figure 38. Total volume of (red and green) macroalgae by region for Coastal Bays Fisheries Investigation Trawl Survey. The number in parenthesis after the region name is the number of trawl sites in each region. The inserted pie chart shows the total volume of macroalgae by region from 2006-2010.

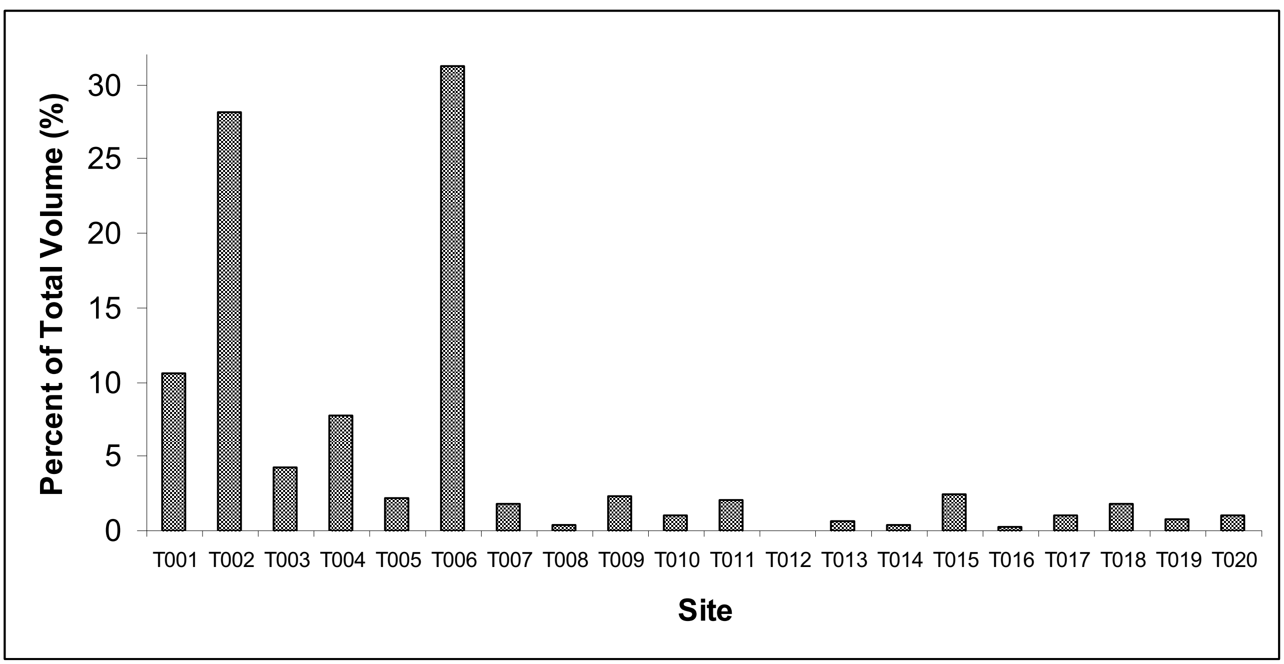

Figure 39. Percent of total volume of (red and green) macroalgae by site from 2006-2010 in the Coastal Bays Fisheries Investigation Trawl Survey. Macroalgae were present at all sites; no bar indicates total volume less than 0.1 liters.

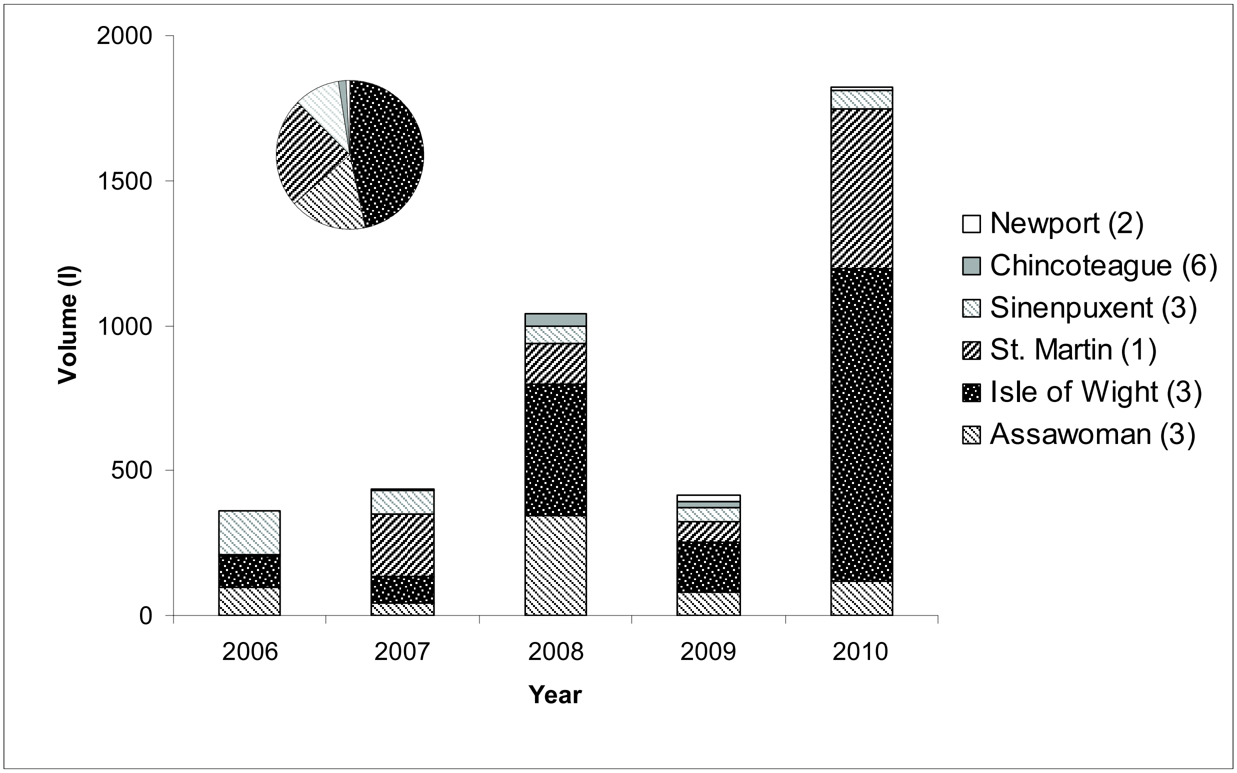

Figure 40. Total volume of (red and green) macroalgae by region for Coastal Bays Fisheries Investigation Beach Seine Survey. The number in parenthesis after the region name is the number of seine sites in each region. The inserted pie chart shows the total volume of macroalgae by region from 2006-2010.

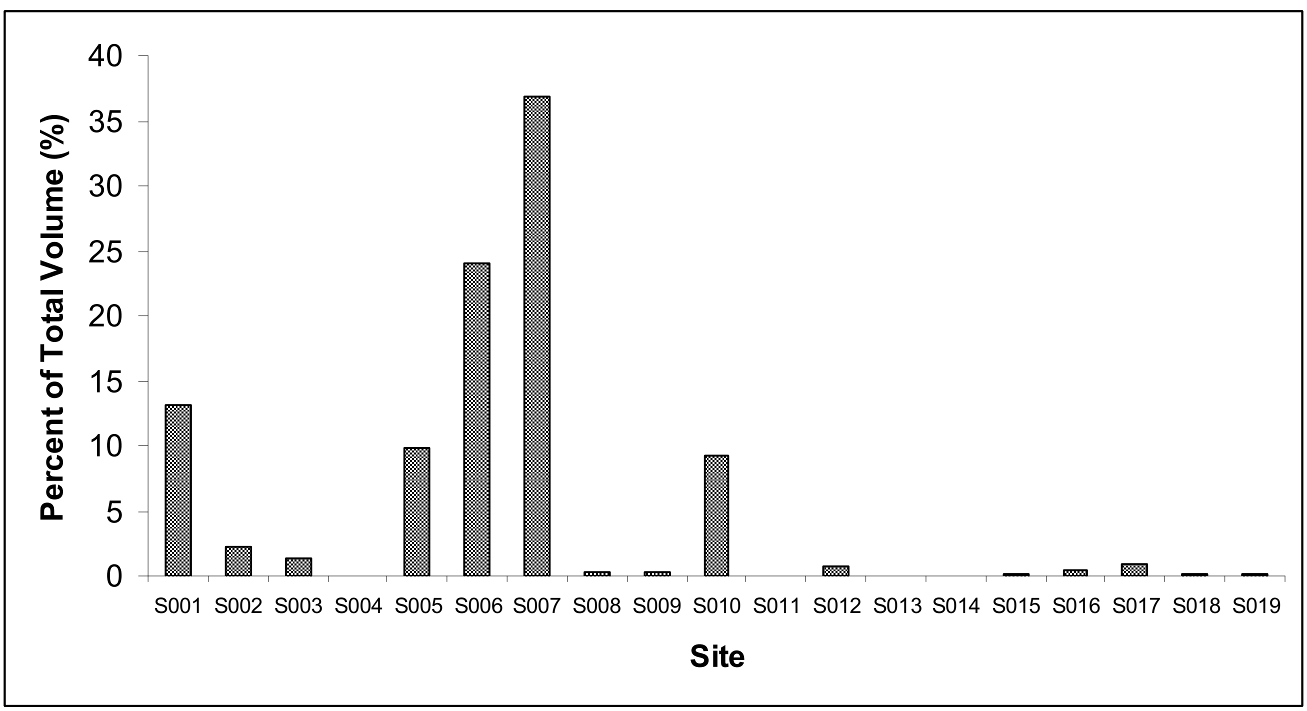

Figure 41. Percent of total (red and green) macroalgae by site from 2006-2010 in the Coastal Bays Fisheries Investigation Beach Seine Survey. Macroalgae were present at all sites; no bar indicates total volume less than 0.1 liters.

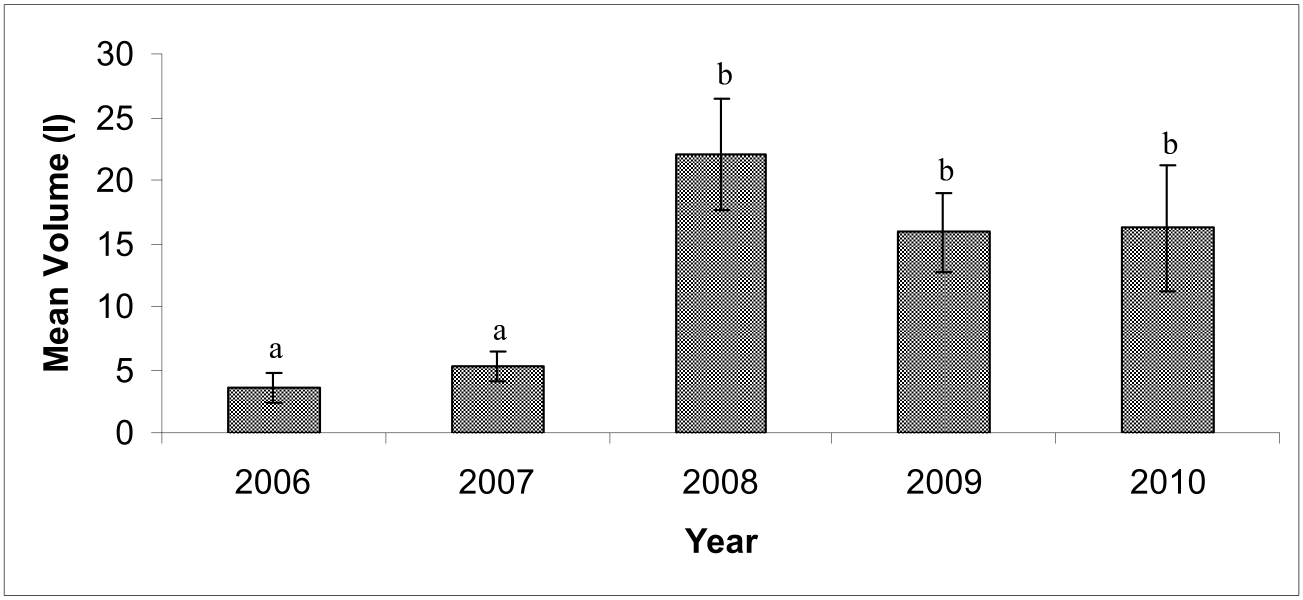

Figure 42. Mean volume ± standard error of total (red and green) macroalgae by year from 2006-2010 for the Coastal Bays Fisheries Investigation Trawl Survey. Years with different letters are significantly different from each other.

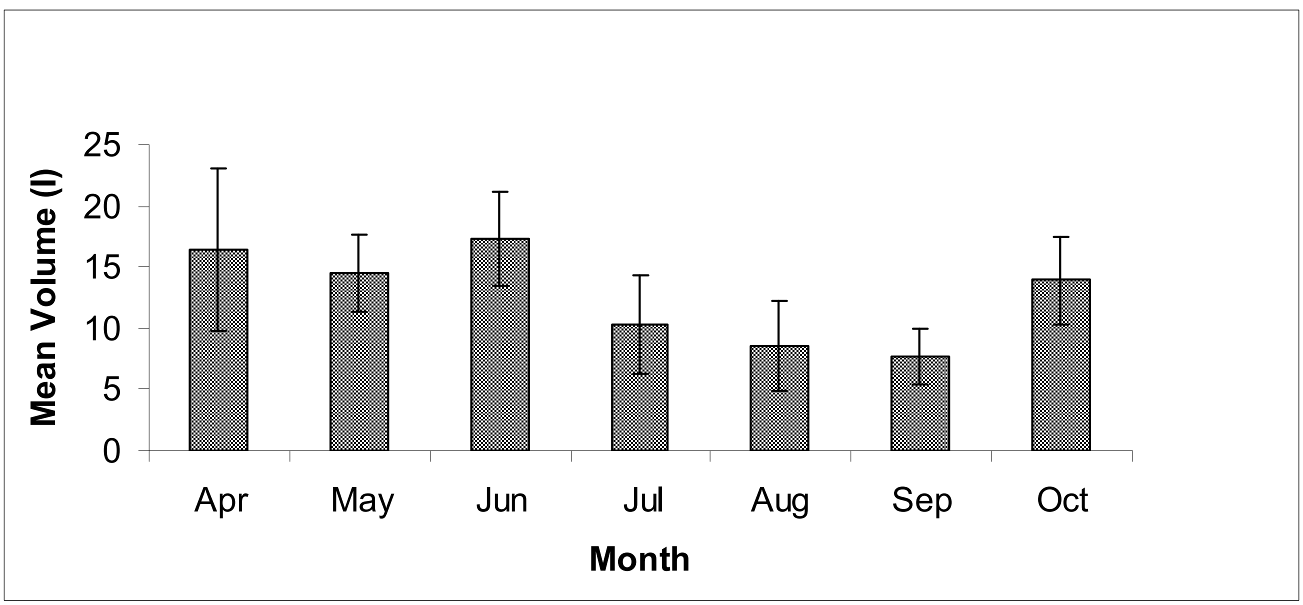

Figure 43. Mean volume ± standard error of total (red and green) macroalgae by month from 2006-2010 in the Coastal Bays Fisheries Investigation Trawl Survey.

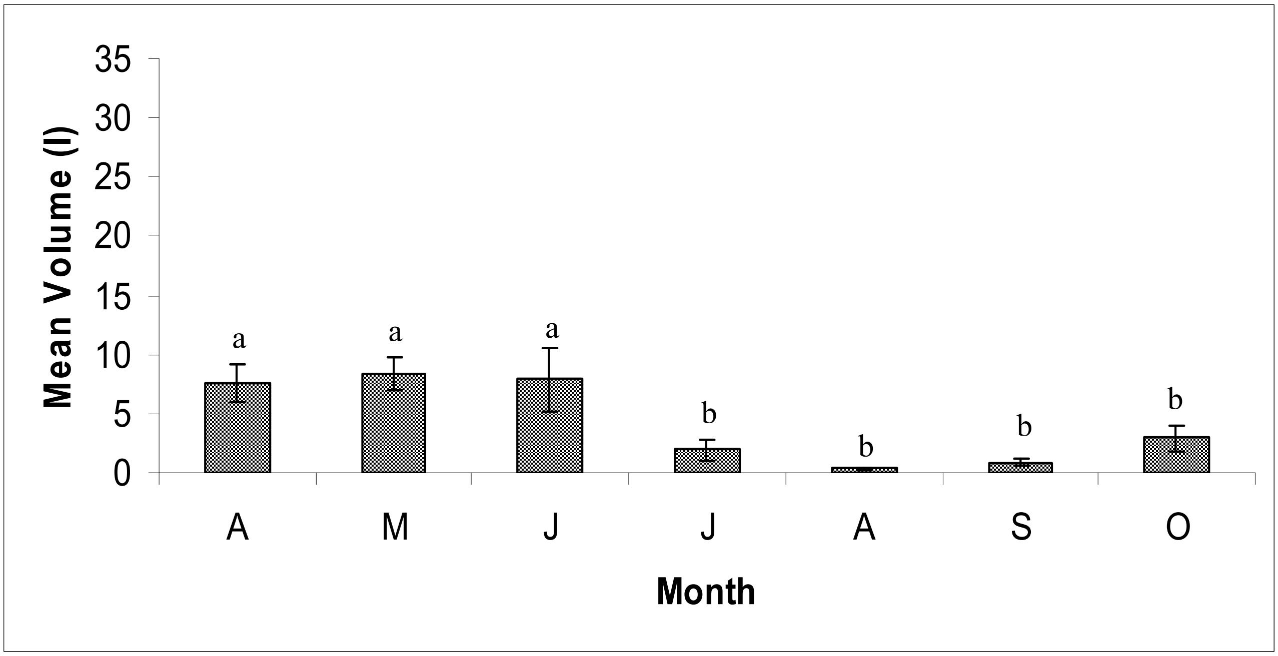

Figure 44. Mean volume ± standard error of green macroalgae by month from 2006-2010 in the Coastal Bays Fisheries Investigation Trawl Survey. Months with different letters are significantly different from each other.

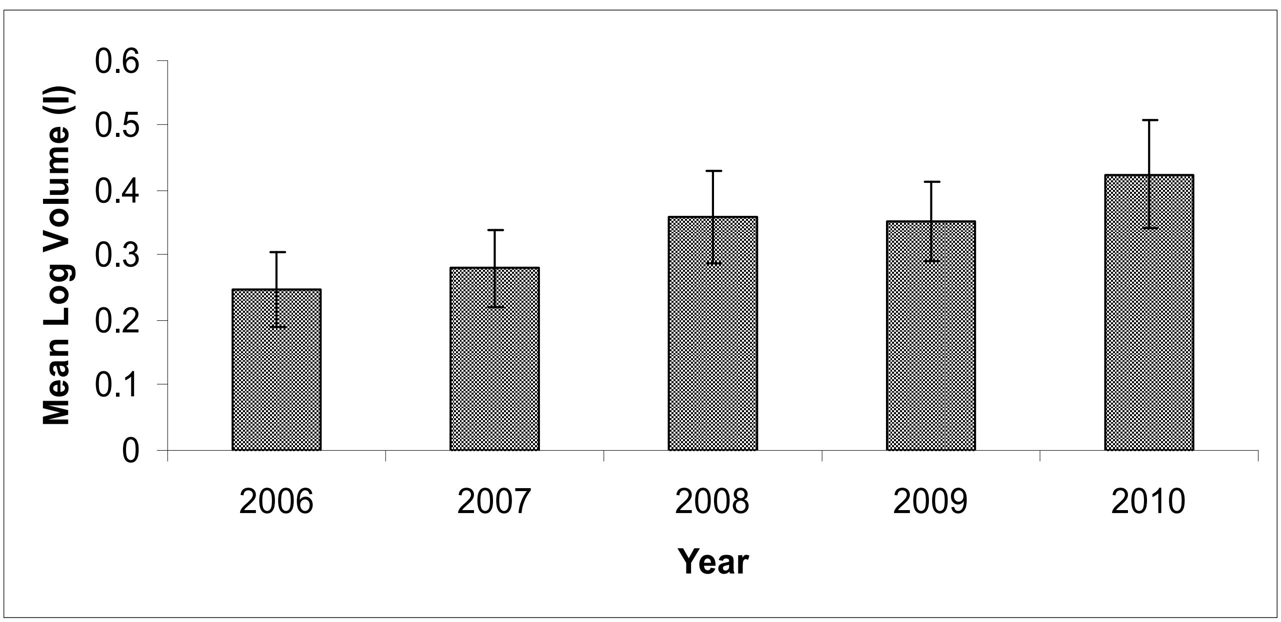

Figure 45. Mean log volume ± standard error of total (red and green) macroalgae by year from 2006-2010 in the Coastal Bays Fisheries Investigation Beach Seine Survey.

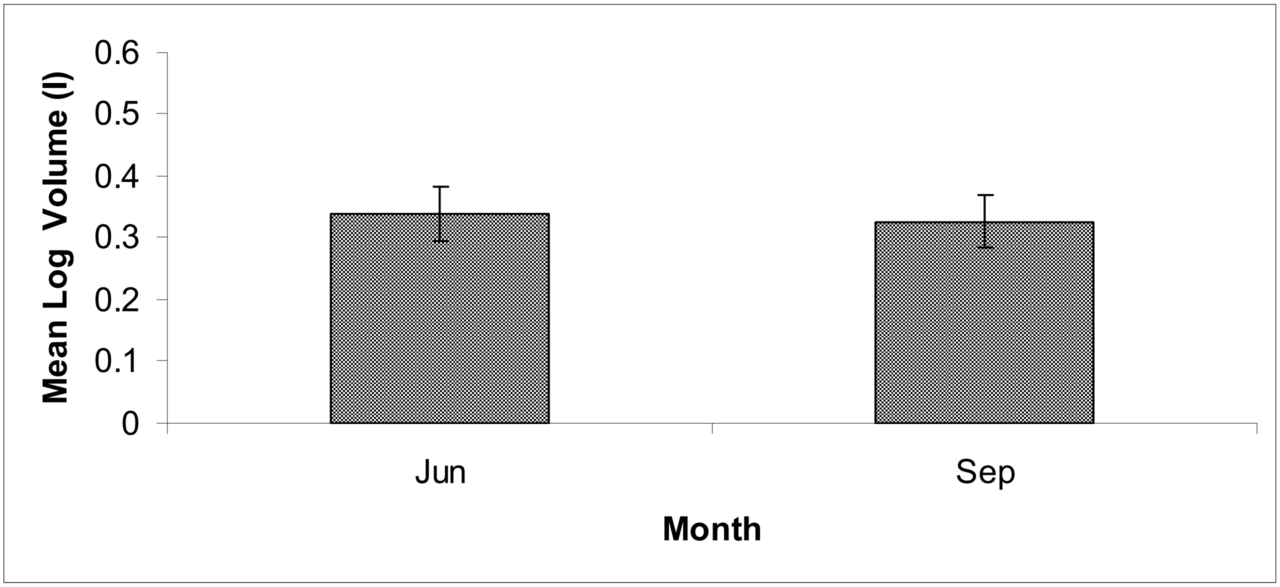

Figure 46. Mean log volume ± standard error of total (red and green) macroalgae by month from 2006-2010 in the Coastal Bays Fisheries Investigation Beach Seine Survey.

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 2010, commercial sampling trips were conducted on June 16-17, August 12, August 23, September 28, October 6 and November 2.

Gear and Location
Sampling was conducted on commercial trawlers targeting Summer Flounder and 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 November trip, also targeting the same species, employed a net with a 15.24 cm mesh net body and a 15.24 cm cod end. 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. 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 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 (C) was taken from shipboard transducer. Weather, wind direction and wind 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. Total catch was estimated by multiplying the number of fish in the sub-sample by the inverse of the proportion of catch the sample represented.

Results:

Trawl time varied, with times ranging between 20 and 120 minutes. Water Temperature ranged from a high of 25.5 C in August 2010 to a low of 17.3 C in November 2010. Depth over the course of the surveys varied and ranged from 9.1 m to 21.3 m. On the trip that occurred in June, the depth trawled ranged from 9.1 m to 12.3 m. The first August trip spanned depths of 15.2 m to 17.1 m. During the second August expedition, depths trawled ranged from 16.6 m to 21.3 m. The September trawl samples had a consistent depth of 19.8 m. Trawling effort in October spanned depths of 19.8 m to 20.1 m. Depths for November ranged from 20.4 m to 21.0 m (Table 1).

From the first sampling in June, 195 individual animals were counted and 169 were measured. Ten species were represented. On the first trawl date in August, 10 species and 460 individual animals were counted. This trip generated measurements for 98 animals. On the second trip in August, 527 animals were counted, representing 23 species. Measurements for 370 animals were collected. On September 28, 75 animals were counted from 11 species and 69 measurements were taken. October's trip generated measurements for 140 animals and counts for 203 animals. Eighteen species were represented. During the November trip, 15 species and 115 individual animals were sampled. Measurements were obtained for 105 specimens. Predominant species encountered from all the trawls were Horseshoe Crabs (*Limulus polyphemus*), Summer Flounder (*Paralichthys dentatus)* and Atlantic Croaker (*Micropogonias undulatus*) (Table 2).

From all trips combined, a total of 295 Summer Flounder were measured. Lengths ranged in size from 252 mm to 664 mm (Figure 1). The mode was 380.0 mm and the mean was 407.1 mm. From June to November, prosomal lengths were collected for 414 horseshoe crabs (Figure 2). There were 246 females with a mean carapace width 215.5 mm and 168 males with a mean carapace width of 192.5 mm.

Discussion:

Catches were typical of what has been captured and sampled on trawls in recent years. The mean length for Summer Flounder at 407.1 mm was smaller than the mean lengths in 2009 through 2006. This indicates that there may be a slight change in stock structure of the adult population sampled between years . A smaller mean size may result from the influx of recent Summer Flounder year classes. The length frequency plot for summer flounder shows balanced population structure with many age classes and a good number of adult fish in the population (Figure 1.).

Horseshoe Crabs continue to be a productive resource for both biomedical use and bait harvest in the state of Maryland. This survey indicates that the populations appear to be robust (they are easily captured), and supplies rare information to characterize the Horseshoe Crab fishery. The length-frequency data for Horseshoe Crabs shows a separation between a juvenile cohort and the adult population (Figure 2). The female to male ratio was determined to be 1.5 to 1.

References:

Gosner, Kenneth L. 1978. Peterson Field Guide-Atlantic Seashore. Boston. Houton Mifflin Company. 329 pp.

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 16 to June 17	9.1-12.3
August 12	15.2-17.1
August 23	16.6-21.3
September 28	19.8-19.8
October 6	19.8-20.1
November 2	20.4-21.0

Table 2. List of species collected in sub-sampled commercial offshore trawls from June through November 1, 2010 by the Maryland Department of Natural Resources, n= 1,575. Species grouped (Finfish, Crustaceans, Mollusks, Other) and listed by order of Extrapolated Total Number, n= 19,784 (number of individuals multiplied by sub-sample: total sample ratio. 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*	2300	169
Summer Flounder	*Paralichthys dentatus*	1134	648
Atlantic Croaker	*Micropogonias undulatus*	900	78
Spot	*Leiostomus xanthurus*	220	13
Weakfish	*Cynoscion regalis*	97	8
Southern Kingfish	*Menticirrhus americanus*	70	4
Bullnose Ray	*Myliobatis freminvilli*	56	11
Northern Puffer	*Sphoeroides maculatus*	51	4
Striped Burrfish	*Chilomycterus schoepfii*	38	3
Butterfish	*Peprilus triacanthus*	30	3
Atlantic Angel Shark	*Squatina dumeril*	21	21
Spotted Hake	*Urophycis regia*	20	2
Scup	*Stenotomus chrysops*	20	2
Red Hake	*Urophycis chuss*	15	1
Striped Searobin	*Prionotus evolans*	10	1
Smallmouth Flounder	*Etropus microstomus*	10	1
Southern Stingray	*Dasyatis americana*	5	5
Northern Searobin	*Prionotus carolinus*	2	2
Northern Kingfish	*Menticirrhus saxatilis*	2	2
Cownose Ray	*Rhinoptera bonasus*	1	1
Black drum	*Pogonias cromis*	1	1
	Total Finfish	**5,003**	**980**

Table 2. List of species collected in sub-sampled commercial offshore trawls from June through November 1, 2010 by the Maryland Department of Natural Resources, n= 1,575. Species grouped (Finfish, Crustaceans, Mollusks, Other) and listed by order of Extrapolated Total Number, n= 19,784 (number of individuals multiplied by sub-sample: total sample ratio). 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			
Nine-Spined Spider Crab	*Libinia emarginata*	941	41
Broad-Clawed Hermit Crab	*Pagurus pollicaris*	793	37
Long-Clawed Hermit Crab	*Pagurus longicarpus*	275	10
Rock Crab	*Cancer irroratus*	181	9
	Total Crustaceans	**2,190**	**97**
Mollusc Species			
Knobby Whelk	*Busycon carica*	1283	37
Channeled Whelk	*Busycotypus canaliculatus*	277	16
Ocean Quahog	*Arctica islandica*	54	4
Longfin Squid	*Loligo pealeii*	30	1
Brief Squid	*Lolliguncula brevis*	10	1
Common Atlantic Slippershell	*Crepidula fornicata*	2	2
	Total Molluscs	**1,656**	**61**
Other Species			
Horseshoe Crab	*Limulus polyphemus*	10,759	427
Sea Star	*Asterias forbesi*	156	9
Hairy Sea Cucumber	*Sclerodactyla briareus*	20	1
	Total Other	**10,935**	**437**

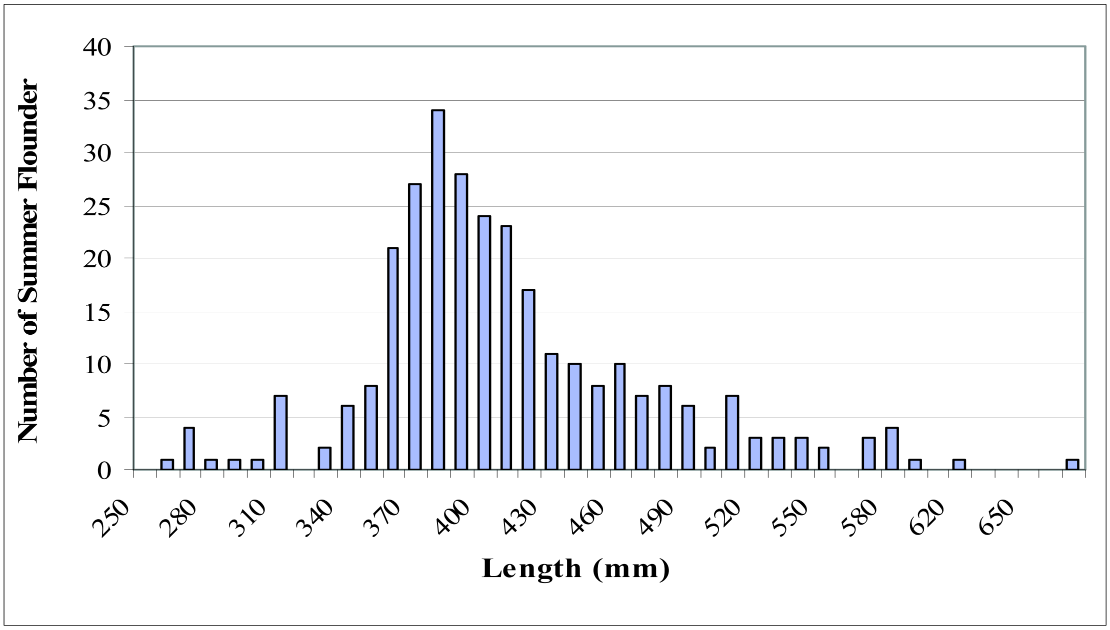

Figure 1. Summer Flounder (*Paralichthys dentatus)* length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources between June and November 2010 n=295. Data derived from six trawl trips taken at different water depths.

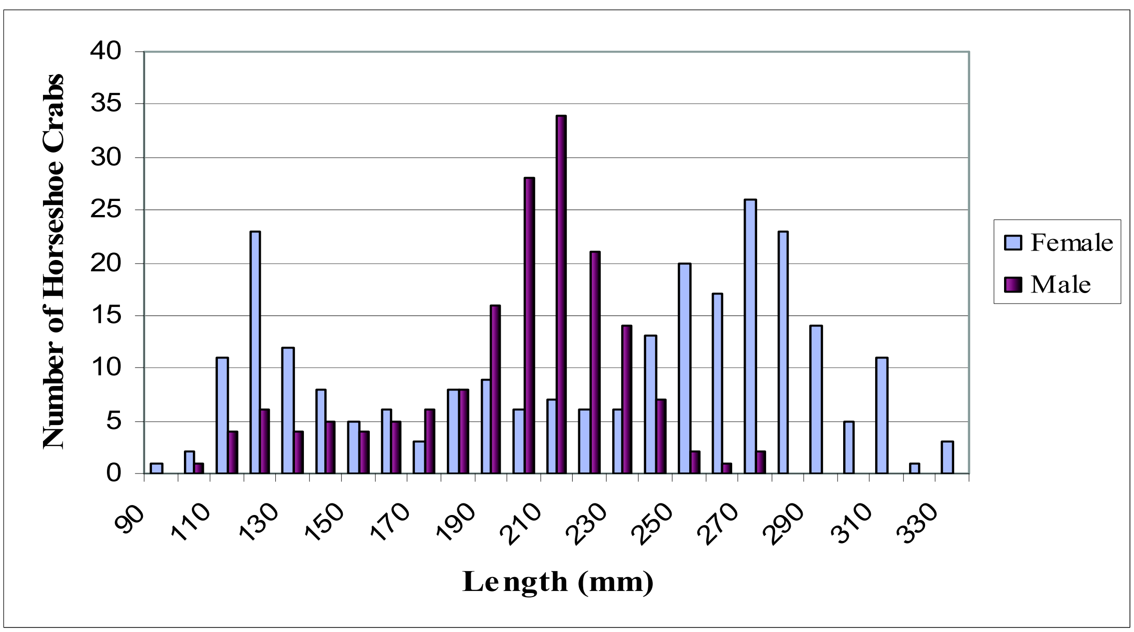

Figure 2. Horseshoe Crabs (*Limulus polyphemus*) length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources between June and November 2010 n= 414. Data derived from six trawl trips taken at different water depths.

Chapter 3

2009 and 2010 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 coastwise assessments for this species.

Methods:
Weakfish were purchased from a local seafood dealer on December 9th, 2009, October 6, 2010 and November 22, 2010. The weakfish were landed by bottom trawl for both years. These fish were measured for Total Length (TL) in millimeters (mm), weighed to the nearest gram (g), and sexed. Otoliths were extracted and sent to South Carolina Department of Natural Resources for ageing. Striped bass were also measured and scale samples were collected for ageing; those results are included in the federal aid report completed by that project (F-61-R-6).

Results and Discussion:
A review of results from 2009 is included because age data were not available by report submission date. A total of 41 weakfish were sampled from the commercial harvest in 2009. These fish had a mean length of 364.3 mm (ranges 330-392 mm, 95% CI: $\pm$ 4.84). Mean weight was 551.4 g (range 346-726 g; 95% CI: $\pm$ 24.95). Table 1 shows mean lengths, weights and ages by sex for 2009.

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: $\pm$ 3.69) and a mean weight of 365.2 g (range 243-580 g; 95%CI: $\pm$ 13.65). Table 2 shows mean lengths and weights for 2010. The ages for weakfish sampled during the fall of 2010 will not be available until later in 2011.

By comparing size distribution (i.e. length and weight) by sex, one can conclude that the size range of females harvested was larger than the males for 2009 and 2010 (Figure 1 and Figure 2). The average age (1.2 years) for 2009 was lower than that of 2008 (1.4 years) and 2007 (2.0 years).

Maryland commercial weakfish landings (Atlantic coast and Chesapeake Bay combined) 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 in 2009 may not be unexpected considering the reduction of total commercial landings over the previous few years.

References:

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. Average weights, lengths and ages (with ranges) for commercially caught weakfish with a bottom trawl out of Ocean City, Maryland in 2009, n= 41.

Gender (n)	Avg. Weight (g)	Avg. Length (mm)	Avg. Age (yrs.)
Male (10)	509.9 (387-654)	358 (330-378)	1.1 (1-2)
Female (31)	564.7 (346-726)	366.4 (330-392)	1.2 (1-2)

Table 2. Average weights and lengths (with ranges) for commercially caught weakfish with a bottom trawl out of Ocean City, Maryland in 2010, n= 115.

Gender (n)	Avg. Weight (g)	Avg. Length (mm)	Avg. Age (yrs.)
Male (24)	365 (243-490)	328.9 (304-360)	N/A
Female (91)	365.2 (260-580)	330.7 (297-385)	N/A

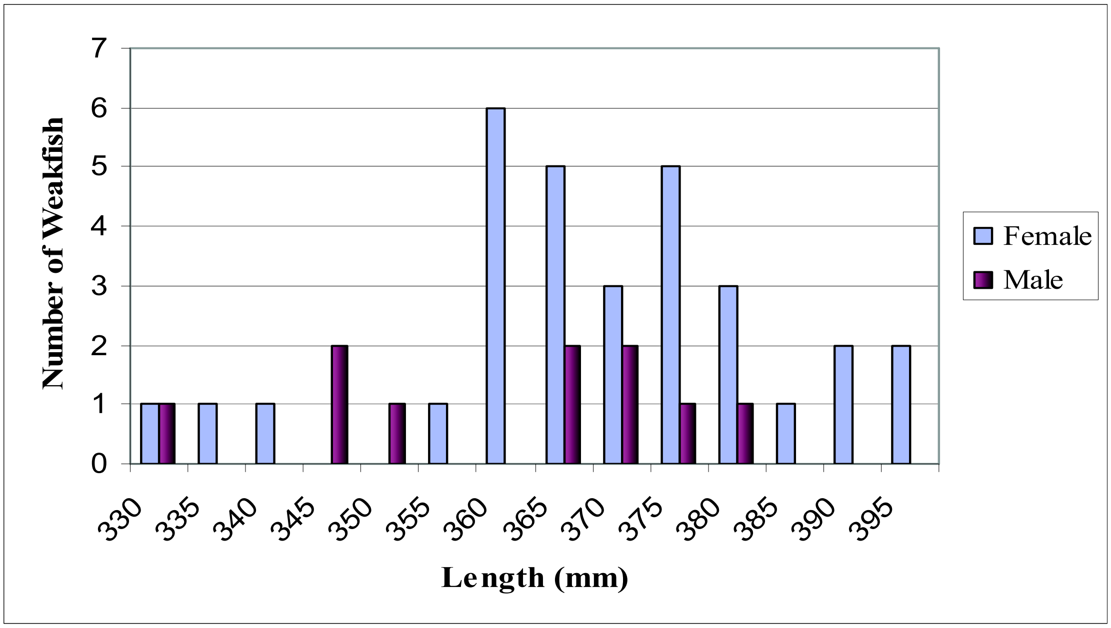

Figure 1. Weakfish (*Cynoscion regalis)* male versus female length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources in 2009, n=41.

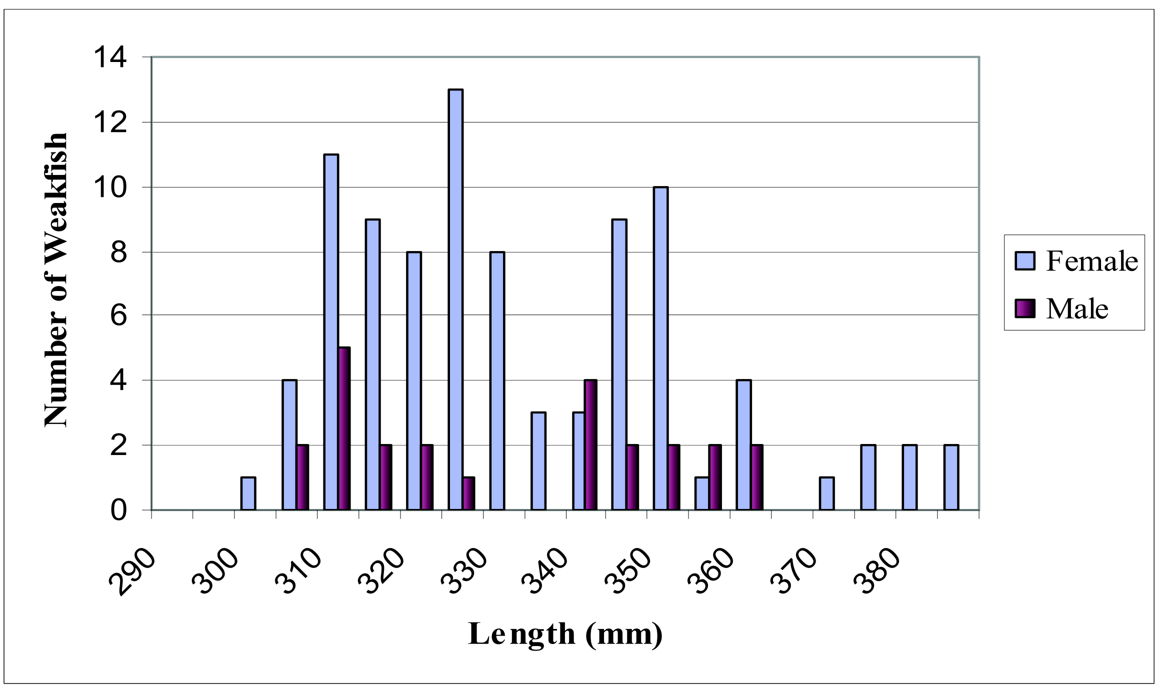

Figure 2. Weakfish (*Cynoscion regalis)* male versus female length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources in 2010, n=115.

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#
______/______/2010			

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

EstimateVol (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) ______/______/2010	**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 and 2009 Summary

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>Lat. 38°</td><td colspan="2">Long. 75°</td></tr>
<tr><td colspan="3">Collected By: MD DNR Fisheries Service Atlantic Program</td></tr>
<tr><td>Date Collected:</td><td colspan="2">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.
    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. 6th 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. 6th 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. In 2006, valid names are Angel Bolinger or Gary Tyler.
    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 in a dark and climate controlled (60-65F) location. Check jars for evaporation and lid backing off twice a year. 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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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