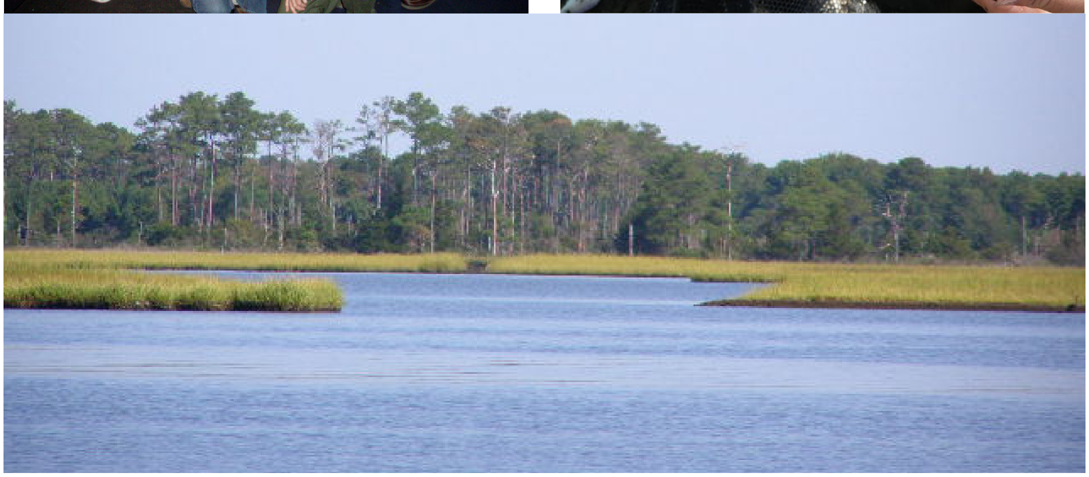
Investigation of
Maryland's Coastal Bays
and Atlantic Ocean Finfish Stocks

2012 Final Report



Prepared by:
Steve Doctor, Chris Jones, Carrie Kennedy,
Gary Tyler, and Angel Willey

Federal Aid Project No. F-50-R-21

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

Annual Report___X_____
Final Report (5-Year)_______
Proposal________

Grantee: Maryland Department of Natural Resources – Fisheries Service

Grant No.: F-50-R

Segment No.: 21

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

Period Covered: January 1, 2012 through December 31, 2012

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

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

Approved By: ____
Carl Simon, Appointing Authority Date

Date Submitted: March 29, 2013

Statutory Funding Authority:

Sport Fish Restoration __X__
CFDA #15.605

State Wildlife Grants (SWG) ______
Cooperative Management Act
CFDA #15.634

Acknowledgements

The Coastal Bays Fisheries Investigation celebrated its 40th Anniversary in 2012. This project began in 1972 and first received dedicated funding in 1989 which allowed staff to specifically dedicate time and make improvements to the prior sampling routine that resulted in significant beneficial contributions to the fisheries of the coastal bays. We would like to thank the past and present staff that dedicated their careers to the Coastal Bays Fisheries Investigation for having the knowledge, initiative, and dedication to get it started and maintained. Jim Casey, one of the retired founders of this project, is pictured on the cover of this report. Additionally, staff of the Coastal Fisheries Program would like to thank all of the Maryland Department of Natural Resources (MDNR) Fisheries Service employees who assisted with the operations, field work, and annual reports over the years whether it was for a day or a few months. We would also like to extend our gratitude to the numerous volunteers from outside MDNR who assisted with field collection work over the years.

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

Preface

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

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

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

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

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

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

Table of Contents

Table of Contents (con't.)

Chapter 1

Coastal Bays Fisheries Investigations: Trawl and Beach Seine Survey, and Pilot SAV Habitat Survey

Trawl and Beach Seine Survey

Introduction:

This survey was developed to characterize fishes and their abundances in Maryland's Coastal Bays, facilitate management decisions, and protect finfish habitats. The Maryland Department of Natural Resources (MDNR) Fisheries Service has conducted the Coastal Bays Fisheries Investigations (CBFI) Trawl and Beach Seine Survey in Maryland's Coastal Bays since 1972, sampling with a standardized protocol since 1989. These gears target finfish although bycatch of crustaceans, molluscs, sponges, and macroalgae are common. This report includes data from 1989 – 2012.

Over 130 adult and juvenile species of fishes, 26 molluscs, 20 macroalgae species, and 29 species of arthropods 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; and
3. delineate and monitor areas of high value as spawning, nursery and/or forage locations for finfish in order to protect against habitat loss or degradation.

Methods:

Study Area

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

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

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

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

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

Data Collection

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

Gears

<u>Trawl</u>

Trawl sampling was conducted at 20 fixed sites throughout Maryland's Coastal Bays on a monthly basis from April through October (Table 1, Figures 1-3). With the exception of June and September, samples were taken beginning the third week of the month. Sampling began the second week in June and September in order to allow enough time to incorporate beach seine collections. Two trawls were modified in tow time to accommodate increased macroalgae volume at the site. T002 in Assawoman Bay was reduced to 3 minutes (reduced by half) in the months of May and August because of large amounts of macroalgae.

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, Figures 1-3).

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

Water Quality and Physical Characteristics

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

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

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

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

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

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

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

Data Analysis
Statistical analyses were conducted on species that historically are most abundant in the trawl and beach seine catch data. Additional species were added to the analyses dependant on their recreational importance and biological significance as forage for adult game fish and indicators of water quality. Species rarely encountered and not considered recreationally important, including forage significance, were not included in the analyses.

The Geometric Mean (GM) was calculated to develop species specific annual trawl and beach seine indices of relative abundance (1989-2012). That method was adopted by the Atlantic States Marine Fisheries Commission (ASMFC) Striped Bass Technical Committee as the preferred index of relative abundance to model stock status. The mean was calculated using catch per area covered for trawl and catch per haul for seine. The GM was calculated from the $\log_e(x+1)$ transformation of the catch data and presented with 95% Confidence Intervals (CIs; Ricker 1975). The GM and CIs were calculated as the antilog [$\log_e$-mean(x+1)] and antilog [$\log_e$-mean(x+1) $\pm$ standard error * (t value: α=0.05, n-1)], respectively. A geometric grand mean was calculated for the time series (1989-2012) and used as a point estimate for comparison to the annual (2012) estimate of relative abundance.

To investigate species-specific habitat preference for 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 2012. A subsequent multiple pairwise comparison of means test (Duncan's Multiple Range Test) was performed to determine differences among sites in

2012. Those results are reported for each species in this chapter. The site or group of sites most abundant were classified as primary sites. Secondary sites were second most abundant.

Results and Discussion:

Finfish were the most abundant taxa captured in the survey. Specifically, they accounted for 47,291 fish caught trawling (36,002 fish) and beach seining (11,289 fish; Table 4) in 2012**.** The fish catch is almost double the catch in 2011, with most of the increase coming from increased numbers for Spot and Bay Anchovies accompanied by reduced numbers of Atlantic Menhaden. Collected fishes represented 71 species which is a normal representation of species in a year.

Above average indices were produced in 2012 for Spot and Bay Anchovy in the trawl. Above average indices were produced for Spot and Pinfish in the seine. It was the highest catch we have ever recorded for Pinfish caught by seine in the Coastal Bays. Below average indices were produced for Weakfish, Atlantic Silversides, and Atlantic Menhaden in trawl and Weakfish, Atlantic Croakers, and Atlantic Silversides in the seine. It is not unusual for below average seine indices for Weakfish and Atlantic Croakers as the shallow water habitat is not their preferred habitat. Above average indices are usually observed only in years with significant increases in the trawl indices. Nearly all other species of recreational and commercial interest had average indices of abundance.

Spot and Pinfish were both observed frequently in 2012. Pinfish spawning, like that of Spot, occurs in the fall through the spring in offshore waters. The winter of 2011-2012 was warmer than average as was the summer of 2012. Pinfish are on the northern end of their range in Maryland and the high abundance seen during 2012 may also be related to many southern species range expansion as part of climate change. Red Drum were also more abundant than usual in 2012 recreational catches which supports this hypothesis. Pinfish were found at many seine sites throughout the bays which is unusual. The Pinfish increase may have been a unique experience in 2012 and will be followed next year to see if it is repeated and part of a trend.

Crustaceans were the second most abundant taxa captured in this survey. Specifically, they accounted for 18,397 specimens caught trawling (14,716 crustaceans) and beach seining (3,681 crustaceans; Table 5); estimates of these counts are included in the total numbers reported here. Fifteen crustacean species were identified, which is similar to the numbers of crustaceans found between 1989 and 2011.

The third most abundant taxa captured in the survey were molluscs. Specifically, they accounted for 3,791 specimens caught trawling (3,442 molluscs) and beach seining (349 molluscs; Table 6). Molluscs were represented by 22 different species.

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

Species Results: American Eel (*Anguilla rostrata*)
American Eel were captured in nine of 140 trawls (6.4%) and in three of 38 beach seines (7.9%). A total of 26 American Eel were collected in trawl (17 fish) and seine (9 fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). American Eel ranked 28th out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 1.0 fish/hectare and 0.2 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl and seine were both equal to the grand means (Figures 4 and 5). Since 1989, the trawl relative abundance index rarely (three years) varied from the grand mean, and the seine index also rarely (four years) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl site T002 had the highest level of abundance (CPUE) and this location was classified as a primary site (Figure 6, Table 9). Secondary trawl sites included T001, T006, T011 and T015. Beach seine sites S007, S012, and S017 were determined to be a primary location and no sites were classified as secondary sites (Figure 7, Table 10).

Discussion
The abundance index for trawl and seine were both equivalent to the grand mean (1989-2012). Since American Eel spawn in an area north of the Bahamas known as the Sargasso Sea, environmental conditions and ocean currents may be a factor influencing relative abundance (Murdy *et al.* 1997).

American Eel were most frequently caught in the trawls at site T002 and seine sites S007, S012, and S017. T006, a secondary trawl site, is in Turville Creek where MDNR Fisheries Service's Eel Project does an annual elver survey further up the creek from our sampling site. The elver sampling site is located at a fish ladder and prodigious numbers of elvers are captured at this site every year. We attribute the large numbers of elvers being captured at this site to a moderately sized freshwater source close to the ocean inlet. The elvers are probably drawn to this area in search of fresh water in which to grow to adulthood. The scattered range of preferred seine sites for American Eels is due to their preference for near shore shallow weedy areas.

Management
American Eel are managed by the State of Maryland in cooperation with Atlantic States Marine Fisheries Commission (ASMFC). The data collected through this survey were a secondary source of data used in the most recent stock assessment for American Eels. Maryland's 2012 recreational American Eel regulations were comprised of a 25 fish creel and a 6 inch minimum size limit (Table 11). Commercial restrictions included a six inch minimum size (Table 12). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Croaker (*Micropogonias undulatus*)
Atlantic Croakers were captured in 43 of 140 trawls (30.7%) and in one of 38 beach seines (2.6%). A total of 219 juvenile Atlantic Croakers were collected in trawl (218) and seine (1) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Atlantic Croakers ranked 11th out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 12.4 fish/hectare and <0.1 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl index was equal to the grand mean and the seine index was below the grand mean (Figures 8 and 9). Since 1989, the trawl relative abundance indices frequently (12 years) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl site T001, T002, T003, T004, T005, T006, T011, and T014 had the highest level of abundance (CPUE) and these locations were classified as a primary sites (Figure 6, Table 9). Secondary trawl sites included T007, T013, T015, T017 and T018. Seine sites are not included in this discussion because Atlantic Croakers are seldom caught in beach seines.

Discussion
The abundance index for trawl was equal to the grand mean. Since Atlantic Croakers spawn on the continental shelf, environmental conditions and ocean currents may be a factor influencing relative abundance. Winter weather conditions appear to heavily influence abundance by impacting overwintering young of the year more significantly and pushing spawning activity further south on the Atlantic Coast (Murdy *et al.* 1997).

Juvenile Atlantic Croakers were more frequently caught in deeper water (trawl). Therefore, trawl indices better represent a more accurate picture of changes in relative abundance when compared to beach seine indices.

Primary and secondary trawl and sites for Atlantic Croakers were located in the relatively protected areas of Assawoman Bay, the St. Martins River, and Newport Bay. Most of the Atlantic Croakers caught by the survey were very small and probably avoided stronger currents found in Sinepuxent 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 Croakers are a known prey item for Summer Flounder, and may explain the co-occurrence of these species (Latour 2008).

Management
Atlantic Croakers are managed by the State of Maryland in cooperation with ASMFC. The data collected through this survey are a supplementary source of juvenile abundance data used in the regional stock assessment. Maryland's 2012 recreational Atlantic Croaker regulations were comprised of a 25 fish creel and a 9 inch minimum size limit (Table 11). Commercial restrictions included a 9 inch minimum size and an open season year round (Table 12). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Menhaden (*Brevoortia tyrannus*)
Atlantic Menhaden were captured in 7 of 140 trawls (5.0%) and in 14 of 38 beach seines (36.8%). A total of 2,186 Atlantic Menhaden were collected in trawl (124 fish) and beach seine (2,062 fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Atlantic Menhaden ranked third out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 7.1 fish/hectare and 54.3 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl index was below the standardized grand mean and the seine index was equal to the standardized grand mean (Figures 10 and 11). Since 1989, the trawl index occasionally (ten years) varied from the grand mean and beach seine index has varied nine times from the grand mean.

Duncan's Multiple Range Test indicated that trawl sites T005 and T006 had the highest level of abundance (CPUE) and were classified as a primary sites (Figure 6, Table 9). There were no secondary trawl sites for Atlantic Menhaden. Beach seine site S010 was determined to be a primary location and seine sites S001, S002, S003, S005, S006, S007, S008, S012, S013, S018, and S019 were classified as secondary sites (Figure 7, Table 10).

Discussion
The abundance index for trawl was below the grand mean and the index for seines 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. Significant changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and/or overfishing.

The primary trawl sites were in protected areas at the head of Turville Creek (T006) and the St. Martins River (T005). Turville Creek is known to have high nutrient levels and may attract the prey sources of Atlantic Menhaden (Maryland Department of the Environment, 2001). Trawl primary sites are up at the head of creeks and are likely to have high chlorophyll concentrations, a desirable characteristic for a filter feeder (Wazniak *et al.* 2004). The beach seine primary site (S010) for Atlantic Menhaden was located in Grey's creek off Sinepuxent Bay, a muddy protected bay. Primary and 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. The data collected through this survey are a supplementary source of juvenile abundance data used in the regional stock assessment. There was no recreational creel or size limits for this species in 2012. There are no harvest limits for Atlantic Menhaden in the waters of the Atlantic Ocean or Maryland's Coastal Bays; however, a Chesapeake Bay-wide commercial harvest cap of 109,020 metric-tons was implemented in 2006 (Table 12; ASMFC 2006).

Recent action by ASMFC will reduce menhaden commercial harvest by 20% in coming years. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Atlantic Silverside (*Menidia menidia*)
Atlantic Silversides were captured in 5 of 140 (3.6%) trawls and in 32 of 38 beach seines (84.2%). A total of 879 Atlantic Silversides were collected in trawl (5 fish) and beach seine (874 fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Atlantic Silversides ranked 4th out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.3 fish/hectare and 23 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl and seine indices were both below the grand means (Figures 12 and 13). Since 1989, the trawl and seine relative indices seldom (one year trawl, five years seine) varied from the grand means.

Duncan's Multiple Range Test indicated that trawl site T005, T015, T017, and T019 had the highest level of abundance (CPUE) and that locations were classified as a primary sites (Figure 6, Table 9). Beach seine sites S001, S002, S003, S005, S006, S007, S008, S009, S010, S011, S012, S014, S015, S016, S017, S018, S019 were determined to be primary locations and S004 was classified as a secondary site (Figure 7, Table 10).

Discussion
The abundance indices for trawl and seine were both below the grand means. 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 nearshore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices. It is unusual for Atlantic Silversides to be below average in abundance for both trawl and seine and is something that we need to examine if the trend continues. This is a major forage species for many other juvenile finfish that use Maryland's Coastal Bays has habitat. Since they are often found in shallow water their abundance may be an early indicator of a water quality changes due to land use or other disturbances, but predation could also be a factor.

Primary and secondary trawl and beach seine sites for Atlantic Silversides were located in the shallow, protected areas of Assawoman Bay, Isle of Wight Bay and its tributaries, Sinepuxent Bay, and Chincoteague Bay. Similar characteristics of primary and secondary trawl and seine sites were their proximity to land and inlets. They do not seem to prefer large expanses of exposed open water. Atlantic Silversides are known to be a preferred forage species for larger game fish and have been found co-occurring with Spot and Summer Flounder at multiple sites in this survey.

Management
No management plan exists for 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 115 of 140 trawls (82.1%) and in 31 of 38 beach seines (81.6%). A total of 11,472 Bay Anchovies were collected in trawl (10,925 fish) and (547 fish) beach seine samples collected in Maryland's Coastal Bays in 2012 (Table 4). Bay anchovies ranked 2nd out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 622.2 fish/hectare and 14.4 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl index was above the grand mean and the seine index was equal to the grand mean (Figures 14 and 15). Since 1989, the relative abundance estimates seldom (six years trawl, four years beach seine) varied from the grand means.

Duncan's Multiple Range Test indicated that trawl site T001, T002, T003, T004, T005, T006, T007, T010, T011, T012, T013, T014, T015, T016 T017, and T019 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 6, Table 9). T020 was classified as a secondary trawl site. Beach seine sites S001, S002, S003, S005, S006, S007, S010, S011, S012, S014, S015, S016, and S019 were determined to be primary locations and S013, and S018 were classified as secondary sites (Figure 7, Table 10).

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

Bay anchovies were caught in both near-shore and open water locations indicating a wide distribution. Therefore, both indices represent an accurate picture of changes in relative abundance.

Primary and secondary trawl and beach seine sites for bay anchovies were located in all bays and abundance was above average in 2012. Bay Anchovies are known to be a preferred forage species for larger game fish and have been found co-occurring with Spot and Summer Flounder at multiple sites in this survey. Additional review of Atlantic Silverside indices compared with Bay Anchovy indices indicate a trend of higher Bay Anchovy indices in years with low Atlantic Silverside indices. This may be due to niche overlap, with expanded opportunities for Bay Anchovies in poor Atlantic Silverside years.

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 31 of 140 trawls (22.1%) and four of 38 seines (10.5%). A total of 125 juvenile Black Sea Bass were collected in trawl (92 fish) and beach seine (33 fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Black Sea Bass were ranked 16th out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 5.2 fish/hectare and 0.9 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl and beach seine indices were both equal to the standardized grand means (Figures 16 and 17). Since 1989, the trawl and seine indices frequently (13 years trawl, nine years beach seine) varied from the grand means.

Duncan's Multiple Range Test indicated that trawl sites T001, T002, T003, T007, T009, T010, T011. T015, and T017 had the highest level of abundance (CPUE) and these location were classified as a primary sites (Figure 6, Table 9). Secondary trawl sites included T004 and T020. Beach seine sites S001, S002, S004, and S005 were determined to be primary locations and no sites were classified as secondary sites (Figure 7, Table 10).

Discussion
The 2012 trawl and beach seine indices were both equal to the standardized grand means. Indices were greatly improved from the previous year which was an unusually low year of abundance. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in species composition and habitat type.

Black Sea Bass were caught in all bays by trawl, and in the northern bays by seine reflecting a wide range of preferred habitats. As natural and artificial reef structure necessary for Black Sea Bass habitat increases, there may be an increase in Black Sea Bass recruitment to Maryland waters. However, because Black Sea Bass do prefer reef habitat, trawls and seines are not ideal gears to sample Black Sea Bass.

Trawl and seine sites of primary and secondary preference were locations with or near structure such as channels, drop offs, rip rap, or crab pots. Many of the preferred sites have a hard shell bottom that provided the needed habitat structure that Black Sea Bass desire (Murdy *et al.* 1997).

Management
Black Sea Bass are managed by the State of Maryland in cooperation with ASMFC and the Mid-Atlantic Fishery Management Council (MAFMC). The data collected through this survey are a supplementary source of juvenile abundance data used in the coast wide stock assessment. Maryland's recreational Black Sea Bass regulations for 2012 included a 12.5 inch total length minimum size limit, 25 fish/day creel limit, and an open season from May 19 until October 14th, and November 1 through December 31st or as determined by NMFS (Table 11). The federal waters were closed to harvest by NMFS for the November and December season in 2012. Commercial restrictions included an 11 inch minimum size and required a landing permit with an associated individual fishing quota issued by the State (Table 12). Commercially licensed fishermen without a landing permit were allowed to land 50 pounds per day as bycatch. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Bluefish (*Pomatomus saltatrix*)
Bluefish were collected in three of 140 trawls (2.1%) and in 14 of 38 beach seines (36.8%). A total of 33 juvenile Bluefish were collected in trawl (five fish) and beach seine (28 fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Bluefish ranked 24th out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.3 fish/hectare and 0.7 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl and beach seine indices were both equal to the grand means (Figures 18 and 19, respectively). Since 1989, the indices occasionally (five years trawl, six years beach seine) varied from the grand means.

Duncan's Multiple Range Test indicated that trawl sites T003, T007, T011, had the highest level of abundance (CPUE) and those locations were classified as a primary sites (Figure 6, Table 9). There were no secondary trawl sites. Beach seine sites S001, S003, S005, S006, S007, S008, S009, S010, S011, S012, S017, and S018 were determined to be primary locations and no sites were classified as secondary sites (Figure 7, Table 10).

Discussion
The 2012 trawl and beach seine indices were both equal to the grand means. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type.

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

Primary trawl sites were all located north of the Ocean City Inlet with the exception of site T011. Primary beach seine sites for Bluefish were located in all bays. Bluefish may be drawn to the abundance of forage and the higher flushing rates of the areas closer to the inlets as shown by the lack of primary or secondary sites in upper and middle Chincoteague Bay.

Management
Bluefish are managed by the State of Maryland in cooperation with ASMFC and MAFMC. The data collected through this survey are a supplementary source of juvenile abundance data used in the coastal stock assessment. Maryland's 2012 recreational Bluefish regulations were comprised of a 10 fish creel and an 8 inch minimum size limit (Table 11). Commercial restrictions included an eight inch minimum size and no seasonal closures (Table 12). Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Spot (*Leiostomus xanthurus*)
Spot were collected in 123 of 140 trawls (87.9.9%) and 36 of 38 seines (94.7%). A total of 22,763 Spot were collected in trawl (22,597 fish) and beach seine (5,166 fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Spot ranked 1st out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 1287.0 fish/hectare and 135.9 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl and beach seine indices were both above the grand means (Figures 20 and 21). Since 1989, the indices frequently (18 years trawl, 13 years beach seine) varied from the grand means, indicating variability in abundance over the time period.

Duncan's Multiple Range Test indicated that trawl sites T001, T002, T003, T004, T005, T006, T007, T011, T012, T013, T014, T015, T017, and T019 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 6, Table 9). Secondary trawl sites included: T009, T010, T016, and T018. All the beach seine sites were determined to be primary locations except for S004 and S019 which were classified as secondary sites (Figure 7, Table 10).

Discussion
The 2012 trawl index and the beach seine indices of Spot were both above the grand mean. Since Spot spawn offshore, environmental conditions including global weather patterns, and ocean currents may be a factor influencing relative abundance (Murdy *et al.* 1997). In 2012 there was very poor reproduction of Striped Bass in the Chesapeake Bay. At the same time 2012 was the best year for Spot trawl and seine indices since 2008 in the Maryland Coastal Bays. It has been proposed that in years of poor anadromous fish reproduction those offshore spawners such as Spot have better reproduction due to environmental conditions that favor one type of species over another (Nye *et al*. In Press).

Spot were caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance.

Primary and secondary trawl and beach seine sites for Spot were located in Assawoman Bay, Isle of Wight Bay (tributaries), Sinepuxent Bay, Newport Bay, and Chincoteague Bay. Spot were widely dispersed in the Coastal Bays as exhibited by a large number of primary and secondary preference sites. This indicates that most of the habitat of the Maryland Coastal Bays is favorable nursery habitat for this species.

Management

In the mid-Atlantic, Spot were managed by the State of Maryland in cooperation with ASMFC. The data collected through this survey are a supplementary source of juvenile abundance data used in the regional stock assessment. There were no recreational or commercial fishing regulations for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Summer Flounder (*Paralichthys dentatus*)

Summer Flounder were collected in 91 of 140 trawls (65.0%) and 19 of 38 seines (50.0%). A total of 400 Summer Flounder collected in trawl (353 fish) and beach seine (47 fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Summer Flounder ranked 7th out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 20.1 fish/hectare and 1.2 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl and beach seine indices were both equal to the grand means (Figures 22 and 23, respectively). Since 1989, the trawl index frequently (13 years) varied from the grand mean and the seine index rarely (four years) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl sites T002, T004, T005, T006, T007, T009, T010, T011, T012, T013, T014, T015, T017, T018, and T019 had the highest level of abundance (CPUE) and those locations were classified as primary sites (Figure 6, Table 9). Secondary trawl sites included: T001, T003, and T008. Beach seine sites S005, S006, S009, S010, S012, S013, S015, S016, and S017 were primary locations and S002, S003, and S011 were classified as secondary sites (Figure 7, Table 10).

Discussion

The 2012 trawl and beach seine indices were both equal the grand means. There was considerable improvement over the prior two years in the Summer Flounder indices in 2012. Like Spot, Summer Flounder are pelagic spawners, so they were probably subject to similar environmental conditions that may have affected spawning and juvenile distribution. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including shifts in forage species composition and habitat type.

Summer Flounder were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data, although not to the extent of some other species like Atlantic Croakers and Weakfish.

Primary and secondary trawl and beach seine sites were located in all bays and at most sites. There were many secondary trawl and seine sites which illustrated the quality of the Coastal Bays as habitat for Summer Flounder.

Management

Summer Flounder are managed by the State of Maryland in cooperation with ASMFC and MAFMC. The data collected through this survey are a primary source of juvenile abundance data used in the coastal stock assessment. Maryland's 2012 recreational Summer Flounder regulations were comprised of a 3 fish creel and 17.0 inch minimum size limit. The open season was April 14th through December 16th (Table 11). Commercial restrictions included a 14 inch minimum size for all gears with the exception of hook-and-line which had size regulations consistent with recreational measures (Table 12). Permitted fishermen in the Atlantic Ocean and Coastal Bays can harvest 5,000 pounds per day while non-permitted fishermen can land 100 or 50 pounds per day in the Atlantic/Coastal Bays and Chesapeake Bay, respectively. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species Results: Tautog (*Tautoga onitis*)

Tautogs were captured in zero of 140 trawls (0%) and in zero of 38 beach seines (0%) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Tautogs were not ranked out of 71 species in overall finfish abundance.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 trawl and seine indices for 2012 were both below the grand means (Figures 24 and 25).

Due to the absence of Tautogs in the 2012 survey, Duncan's Multiple Range Test indicated no trawl or seine sites had the highest level of abundance (CPUE) and no sites were classified as a primary or secondary sites (Figure 6, Table 9), (Figure 7, Table 10).

Discussion

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

Management
Tautogs are managed by the State of Maryland in cooperation with ASMFC. The data collected through this survey are a supplementary source of juvenile abundance data used in the coastal stock assessment. Maryland's 2012 recreational Tautog regulations were comprised of a 16 inch minimum size limit and a 4 fish creel from January 1st to May 15th and November 1 through November 30, and a two fish creel from May 16th to October 31st. Tautog fishing is closed in Maryland for the month of December (Table 11). Commercial restrictions are consistent with recreational regulations (Table 12).

In 2011, an update stock assessment was performed that indicated the Tautog stock is overfished and overfishing is occurring. The model used for stock assessment was largely based on recreational harvests and does not account for recent increases in Tautog habitat along the Mid-Atlantic. However, there are no independent biological surveys currently being conducted in our region targeting Tautogs, although there is age sampling from the commercial and recreational party boats to meet ASMFC compliance requirements. In 2013, a benchmark stock assessment will be completed for Tautog, which we hope will give a more accurate picture of the stocks.

Species Results: Weakfish (*Cynoscion regalis*)
Weakfish were collected in 15 of 140 trawls (10.70%) and zero of 38 seines (0%). A total of 201 juvenile Weakfish were collected in trawl (201 fish) and beach seine (zero fish) samples conducted on Maryland's Coastal Bays in 2012 (Table 4). Weakfish ranked 11th out of 71 species in overall finfish abundance. The trawl and beach seine CPUEs were 11.4 fish/hectare and 0 fish/haul, respectively.

GM indices of relative abundance were calculated and compared with the 1989-2012 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 2012 trawl and seine indices were both below the grand means (Figures 26 and 27, respectively). Since 1989, the relative abundance trawl estimates occasionally (eight years) varied from the grand mean.

Duncan's Multiple Range Test indicated that trawl sites T003 and T004 had the highest level of abundance (CPUE) and these locations were classified as primary sites (Figure 6, Table 9). The secondary trawl sites of greatest abundance were T011, T012, T014, and T016. No beach seine sites were determined to be primary or secondary sites in 2012 (Figure 7, Table 10).

Discussion
The 2012 seine and trawl indices were below 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. Weakfish were considered depleted but not overfished. The recent declines appear to be due to natural mortality (NEFSC 2009).

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

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

Management

Weakfish are managed by the State of Maryland in cooperation with ASMFC. The data collected through this survey are a supplementary source of juvenile abundance data used in the coastal stock assessment. Maryland's 2012 recreational Weakfish regulations were comprised of a one fish creel and a 13 inch minimum size limit (Table 11). Commercial regulations in 2012 restricted fisherman to a 12 inch minimum size and included an array of season closures dependant upon the type of gear used and body of water being fished (Table 12). The commercial fishery is managed as a bycatch fishery with a 100 pounds catch limit on the Atlantic coast and a 50 pound limit in the Chesapeake Bay. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Additional Discussion on Habitat Preference by Bay

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

Many species including Atlantic Menhaden, Atlantic Silversides, Bay Anchovy, Black Sea Bass, Spot, and Summer Flounder, showed a preference to the northern bays for both trawl and seine (Tables 9 and 10). American Eel and Atlantic Croakers preferred these areas in the trawls, but not the seines. Site T005, at the head of the St. Martins River, and site T006, high up Turville Creek, are two of the shallowest trawl sites. The shallow depths of these locations are probably responsible for the preference of these trawl sites for Atlantic Menhaden and Atlantic Silversides. They are high nutrient shallow areas. The combination of the habitat type, forage, tidal current, salinities, and dissolved oxygen make this area desirable for juvenile finfish production. Most sites in the northern bays for both trawl and seine showed site preferences for multiple species (Figures 6 and 7).

For trawl, all sites in the northern bays, except T001, were primary sites for five to six species and secondary for one species. Beach seine sites S001, S005, S006, and S007 were primary sites for five to six species and secondary sites for one species. The northern bays had more primary sites with five to six species preferring it than any other bay.

Sinepuxent Bay

Bay Anchovy, Black Sea Bass, Spot, and Summer Flounder dominated the trawl preferences for Sinepuxent Bay. In the seine samples Atlantic Menhaden, Atlantic Silversides, Bay Anchovy, Bluefish, Spot, and Summer Flounder had preferred sites in this bay (Tables 9 and

10). Seine sites in Sinepuxent Bay had a range of four to seven species that classified it as a primary or secondary site. Trawl sites in Sinepuxent Bay had a range of one to four species that classified it as a primary or secondary site. Seine site S010 had the greatest species diversity with primary or secondary classifications (seven; Figure 7). It is located in a shallow, muddy, protected cove which is an ideal habitat for juvenile finfish. High tidal velocities probably inhibit abundance of Atlantic Menhaden, Atlantic Silversides, Atlantic Croakers, and Weakfish, and are the reason that the seine sites have greater diversity than the trawl sites in this area.

Newport Bay and Chincoteague Bay
A wide variety of species had preferred trawl and seine sites in Newport and Chincoteague Bays. This is to be expected as this is a large area with a variety of habitats including protective seagrass beds and deep, swift-moving channels (Tables 9 and 10).

Seine site S012 and had the most diversity of the seine sites in these two bays, with seven species showing a preference for the site (Figure 7). It offers secure habitat for juvenile finfish: sand beach surrounded by marsh. Seine site S017 had the second greatest diversity of species that prefer this site. It is located in a shallow, muddy, protected cove which is ideal habitat for juvenile finfish and shellfish, which are a food source for many species. It is a location where southern stingrays can be often be found, in addition to black drum, red drum, and spotted sea trout.

Trawl sites T011, T015, and T017 showed the greatest site diversity in the southern bays (Figure 6). Site T011 is an open water site in the middle of Newport Bay, and T017 is relatively close to marsh. Site T015, is surrounded by marsh with some deep (6 feet) water. Spot, Summer Flounder and Bay Anchovy appear to be the species that most preferred use of Newport and Chincoteague Bays as they had the most preferred trawl and seine sites combined.

Macroalgae

Methods and Data Analysis

For each trawl or seine, macroalgae and bryozoans were combined for one total volume measurement (liters) and identified to genera (for example, *Agardhiella, Gracilaria, Ulva*). The percent composition by genera was estimated visually. To summarize macroalgae presence in the Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey (CBFI) for 2012, the number of samples with light, moderate and heavy macroalgae volume was identified. For trawls, ≤5 liters of macroalgae was considered a light load. Loads >5 and ≤69 liters of macroalgae were considered moderate, and loads <69 liters were considered heavy. For seines, ≤5 liters of macroalgae was also considered a light load. Loads >5 and ≤25 liters were considered moderate, and loads >25 liters were considered heavy.

To investigate changes in macroalgae volume over time, analysis of variance (ANOVA) was used to compare total mean macroalgae volume from 2006-2012 by year and month. Duncan's Multiple Range Tests were used to identify years or months with significant differences in macroalgae abundance. Separate trends for red and green macroalgae were also examined using the same process. Significance was determined at $p=0.05$.

Because red and green macroalgae accounted for at least 97% of total macroalgae captured in trawls and seines from 2006-2012, 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

In the 2012 CBFI, four of the five taxonomic macroalgae divisions were represented in the catch: red, green, brown and yellow-green (Table 8). However, trawl and seine surveys were both primarily composed of red macroalgae, particularly *Agardhiella* and *Gracilaria* (Figures 28 and 29). Green macroalgae was the second most abundant macroalgae captured by both gear types. The dominant genus of green macroalgae in the trawls was *Cladophora* (Figure 28), while *Codium* dominated seines (Figure 29). Using the dominant genera of algae from 2012 compared to the time series 2006 – 2012, we see that *Gracilaria* and *Agardhiella* have dominated the northern bays, while the southern bays have been diverse in their macroalgal communities (Figure 30). For seines, the red algae genera dominate all regions, but green algae genera are present in low to moderate levels in all bays (Figure 31).

Of the 140 trawls conducted in 2012, 60.7% (85 samples) had light loads of macroalgae, 34.3% (48 samples) had moderate loads, and 5% (7 samples) had heavy loads (Figure 32). Trawl sites with at least one heavy load of macroalgae in 2012 were T001, T002, T006 and T011. For the 2012 trawl survey, 60.8% of all *Agardhiella* and 98.4% of all *Gracilaria* was captured in Assawoman Bay. Sites T002, T001 and T011 had the most macroalgae, respectively, in the entire 2012 trawl survey (Figure 33). T006 was moved slightly southwest due to the inability to accommodate for the extreme volumes of macroalgae encountered at the original site. This move resulted in a 22 percent reduction in macroalgae production based upon historical averages.

Of the 36 seine samples, 66.7% (24 samples) had light loads of macroalgae, 11.1% (4 samples) had moderate loads, and 22.2% (8 samples) had heavy loads (Figure 34). Seine sites with at least one heavy load of macroalgae in 2012 were S005, S007, S010, S012 and S017. In the 2012 beach seine survey, sites S007, S017 and S010 had the most macroalgae, respectively (Figure 35).

Looking at red and green macroalgae data from 2006 through 2012, macroalgae were most abundant in northern regions, specifically Assawoman Bay and Isle of Wight Bay (Figures 36 and 37). Correspondingly, sites T002, T006 and T001 provided the highest percentages of total abundance of macroalgae over this time, respectively (Figure 38). As with trawls, macroalgae in seines were most abundant in northern regions, specifically Isle of Wight Bay, Assawoman Bay and Sinepuxent Bay (Figures 39 and 40). The three sites with the highest percent of total volume of macroalgae were sites S007, S006 and S001, respectively (Figure 41).

When considering all red and green macroalgae data from trawls, biomass (volume) significantly increased in 2008, and has remained statistically the same from 2008 through 2012 (Figure 42). For the trawl survey, there was significantly less mean macroalgae volume by month for September and October over both the 2006 – 2012 time series (Figure 43) and the 2012 sampling season (Figure 44). From 2006 – 2012, 2010 is the only year that differs significantly in mean macroalgae volume by year for seine data (Figure 45). There was no significant difference in mean macroalgae volume by month for seine data from 2006-2012 (p>0.05; Figure 46) or for seine data from 2012 (p>0.05; Figure 47). For trawls from 2006 – 2012 there has been a significant drop off in green algae production after July (p=0.0017; Figure 48).

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 the CBFI in 2006. Trawls were primarily composed of red macroalgae; specifically, *Agardhiella* was the most abundant red macroalgae genera for all years except 2008, 2011 and 2012, when *Gracilaria* was dominant (Doctor *et al.* 2012). Seines were also primarily composed of red macroalgae, with the exception of 2008 when the seine survey was primarily composed of green macroalgae (Doctor *et al.* 2012). 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, 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 2012, 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 2012. These northern regions are considered to be more nutrient-impacted due to commercial and recreational development, harbors and marinas and a wastewater treatment facility. Although macroalgae production for Assawoman Bay in 2012 decreased by over 40% from 2011, Assawoman Bay was still responsible for 69% of overall macroalgae production in 2012. Isle of Wight Bay saw a large increase in macroalgae production for 2012. However, macroalgae production for Isle of Wight Bay is still considerably lower than pre-2011 levels, potentially due to a shift in the location of T006.

The southern regions (Sinepuxent Bay, Chincoteague Bay and Newport Bay) are surrounded by less development and are therefore considered more pristine. In the most recent Coastal Bays Report Card (2011), Sinepuxent Bay and Chincoteague Bay received the highest grades, respectively, based on four water quality indicators (total nitrogen, total phosphorous, chlorophyll *a* and dissolved oxygen) and two biotic indicators (seagrasses and hard clams) (IAN UMCES 2012). 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 Isle of Wight Bay did have heavy loads of macroalgae in 2012 (S005, S007), as did a site in Sinepuxent Bay (T010), and two sites in Chincoteague Bay (T012, T017). This survey has not detected unusually large amounts of *Chaetomorpha* in Chincoteague Bay.

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

Macroalgae has been observed as a refuge for several different species of fish (blennies, have been observed using macroalgae as refuge (Olla *et al.* 1979, Stoner and Livingston 1980, Gore *et al.* 1981, Wilson *et al*. 1990, Sogard and Able 1991, Raposa and Oviatt 2000, personal observations). However, there appears to be no direct relationship between site preference for finfish species of concern (species results presented earlier in this chapter) and macroalgae density in the CBFI Trawl and Beach Seine Surveys (Figures 49 and 50). Based on 2012 data, the average amount of macroalgae at any site did not correlate with how many finfish species of concern preferred that site. This suggests that, while macroalgae can provide opportunities for refuge, habitat, and foraging, finfish species of concern are not necessarily relying on macroalgae.

Future Goals

Macroalgae are a part of a healthy estuarine ecosystem, and variations in abundance, distribution or composition of macroalgae can be related to natural environmental changes. Macroalgae abundance and composition could play an important role in species composition and diversity. Several species of fish (blennies, gobies, sticklebacks, pipefishes and tautog) have been observed using macroalgae as refuge (Olla *et al.* 1979, Stoner and Livingston 1980, Gore *et al.* 1981, Wilson *et al*. 1990, Sogard and Able 1991, Raposa and Oviatt 2000, personal observations). Macroalgae also provides habitat and foraging opportunities for several species of decapods (Wilson *et al*. 1990, Sogard and Able 1991). However, macroalgae is not considered an essential habitat for fish because it is variable and ephemeral (Sogard and Able 1991). *Ulva* also produces exudates which can be toxic to winter flounder and a host of invertebrates (Sogard and Able 1991). An increase in macroalgae abundance or change in composition may also be indicative of eutrophication. The differing studies on the advantages and disadvantages of macroalgae for nekton warrant further research. Therefore, continued monitoring is necessary to establish long term macroalgae trends in Maryland's Coastal Bays. Future analyses could also consider

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

Water Quality and Physical Characteristics

Results

Temperature

Analysis of the 2012 CBFI Trawl Survey water quality data beginning in April showed increasing average water temperature through July for all bays (Table 13). The highest surface temperature (31.7 C) was recorded at site T012 in July. Examination of the past three years indicates that the combined average temperatures were highest in July. The highest bottom temperature (31.4 C) was observed during the same month at site T005. Both the lowest surface temperature (12.4 C) and lowest bottom temperature (12.3 C) for all bays were recorded in April at site T008.

The June 2012 seine sites had a temperature range of 7.6 C (21.7 C to 29.3 C; Table 14). Three months later in September of 2012, the range was slightly bigger at 8.9 C (18.2 C to 27.1 C). The combined average per bay was derived from the adding together of both the surface and bottom temperature averages, collected while trawling, from April to October for each water system, and calculating the average of this total. St. Martin's River system was the warmest with a combined average of 24.5 C and the system with the lowest combined average water temperature was Sinepuxent (21.9 C). Such averages take into account both bottom and surface temperatures for all sites in that bay/river. The overall average from all water systems was 22.9 C which was close to that number for 2011 (22.4 C). That measurement was 21.6 C in 2010. The overall average is the average of the combined averages from all of the coastal bays.

Dissolved Oxygen

As expected, dissolved oxygen (DO) levels generally decreased as water temperatures increased. Graphs were created combining both top and bottom DO averages from all sites per bay/river (Figures 51 - 58). The DO patterns for each system were assessed by graphing averages. In Assawoman, Isle of Wight, Sinepuxent, Newport and Chincoteague Bays DO decreased from April to July. The St. Martins River had its lowest DO in June, after which it increased by July. After remaining stable from July to September, DO for this system was in an upward trend by October. In Isle of Wight Bay, average DO decreased through July and then experienced a slight increase for August. In September the DO levels exhibited another decline with a measurement of 3.66 mg/L at the surface for site T006 (Figure 1). Water levels were too shallow for bottom water quality readings at site T006 in August and September. Sinepuxent, Newport and Chincoteague Bays followed a similar trend to Isle of Wight Bay (Table 13).

The range of DO across the water systems was 2.58 mg/L to 9.45 mg/L for the entire season. The DO of 2.58 mg/L was taken on May 14, 2012 at site T014 near bottom. There were no indications of a large bloom of algae at the DNR's monitoring station at Public Landing, the closest station, during May that could account for the low DOs (Eyes on the Bay 2013). Site T014 is one mile off of Public Landing. The highest DO (9.45 mg/L) came from the surface at site T014 in August (Figure 3). For 2012, the overall DO average for all bays combined was 6.8 mg/L which was notably close to the same measure for 2011 (6.7 mg/L).
The Ocean City area received a total of 3.04 inches (7.72 cm) of precipitation for June 2012 which was more than the previous year received that month. The June precipitation total for 2011 was 1.46 inches (3.71 cm; Wunderground, Inc. 2013b). Out of all the seine sites during 2012, Ayers Creek (S019) had the lowest recorded DO of 2.80 mg/L for June and was sampled on June 15. Up to this date, the Ocean City area received 1.57 inches (3.9 cm) of rain. When visited again on September 20, a DO of 8.75 mg/L was measured. This area had received no precipitation from the beginning of September up to this date. Runoff from precipitation could have contributed to the low DO level encountered in June. During 2011, this same site also had the lowest DO for seining on June 28 (3.48 mg/L). From early June through this date, Ocean City had received 1.35 inches (3.43 cm) of precipitation. Site S019 was sampled on September 20, 2011 and returned a DO of 3.16 mg/L. From the start of September 2011 to when S019 was sampled, the Ocean City area had received 0.86 inches (2.18 cm). The lower DO may be a result of poor flushing as this site is extremely narrow and far up a tributary to Newport Bay. If the site was in a more open area, precipitation may have had no impact.

Salinity

When all the salinity averages were analyzed for each bay, Sinepuxent had the highest combined average at 29.1 ppt and the St. Martin's River had the lowest (24.4 ppt). A phenomena common to all bays this season was a sharp decline in salinity from August to September. For Assawoman Bay, the average salinity dipped from April to May and began to ascend from June to its pinnacle in August. A similar pattern was observed for the St. Martin's River except that the highest average salinity was reached in July. Again, salinity fell noticeably for September. The salinity level changes in Isle of Wight and Sinepuxent Bays were not as dramatic as found in Assawoman Bay and St. Martin's River. Just as in Assawoman Bay and St. Martin's River, suspended salt levels in Isle of Wight Bay declined from April to May and began climbing in June. The highest average salinity occurred in August. Aside from a slight dip in June, salinity levels in Sinepuxent rose from April to July. Salinity increased for Newport from April to May, remained stable through June, and then continued rising until August. Chincoteague experienced a decline in salinity from April to May, but this measurement rose steeply through August. Average salinity across all bays increased from September to October (Figure 59).

Secchi

Results of Secchi analysis showed variations for turbidity levels from April to October for all systems (Figure 60, Table 13). For Assawoman Bay, visibility actually increased from April to May, then declined. Turbidity was at its worst for this bay in June with an average visibility of 24.0 cm. In the St. Martin's River, turbidity began very high with an average visibility of 113.5 cm and as turbidity increased, average visibility fell to its lowest point (38.0 cm) in July. For Isle of Wight Bay, visibility decreased from April to May, then remained relatively stable from June to July when the amount of suspended particles in the water column resulted in Secchi averages of 38 and 38.5 cm, respectively. From August onward, visibility began to rise in this bay with only a slight decline in September. Sinepuxent Bay experienced relatively stable visibility compared to Assawoman Bay, the St. Martin's River, Isle of Wight Bay and Newport Bay. As turbidity increased, Secchi depth in Sinepuxent Bay decreased from an average of 94 cm in April to 69.3 cm in July and 64.8 cm in September. Chincoteague Bay also showed less fluctuation in water clarity, witnessing a gradual increase in turbidity from April to June and then leveling off until beginning an ascent in September. Newport demonstrated a massive downward trend in clarity beginning with a Secchi depth of 129 cm in April and bottoming out at 40.0 cm in June.

This season, the number of times the Secchi disk reached the bottom was examined (Figures 61 and 62). For 2012 trawls, the disk reached bottom six times out of 140 samples. Last season the disk was reported as encountering the bottom three times. Sites where the visibility reached to the bottom where the same in 2012 as in 2011 with one addition, site T020. In April, Secchi reached bottom at site T006 (91 cm). T018 made the list twice; once in April (131 cm) and again in October (144 cm). The Secchi disk encountered bottom at site T019 in April (107 cm) and October (91 cm). In September, the Secchi disk hit bottom with a measurement of 256 cm at T020. Last season, a Secchi reading of 243 cm was made at this same site, but visibility did not reach the substrate.

The number of occurrences with water clarity sufficient enough to view the disk as it encountered substrate was much greater for the seine component of our survey during 2012 and 2011 (Figures 61 and 62). For the 2012 season, the Secchi disk reached bottom nine times. During the previous sampling round (2011) it contacted bottom sixteen times. This would be expected as depths must be sufficiently shallow to permit wading. The most turbid water system was the St. Martin's River with an overall average Secchi reading of 63.0 cm. The least turbid bay was Chincoteague Bay returning an overall average of 81.9 cm (Figure 60).

Discussion

Differences in temperature, dissolved oxygen, salinity and turbidity are influenced by the flushing times of these systems. For example, the lower average water temperature observed in Sinepuxent Bay was likely a result of an increased flushing rate based on its close proximity to the Ocean City Inlet (Atlantic Ocean). Lung (1994) presented data from two summers indicating flushing times of 21.1 to 21.3 days for Assawoman Bay and 8.0 to 15.8 days for the St. Martin's River. Flushing rates of the Isle of Wight Bay were reported to be 9.3 to 9.6 days. It was predicted by Prichard (1960) that Chincoteague Bay required 62 days to replace 99 percent of its water. Flushing rates for both Sinepuxent Bay and Newport Bay are not known (Wazniak, *et al*. 2004). Given the proximity to the Ocean City Inlet, one can assume that flushing rates for Sinepuxent Bay would be relatively fast (more like Isle of Wight Bay) while the flushing rate in Newport Bay would be much longer (more like Chincoteague Bay). Small stream inputs exposed to warm air may explain why the St.

Martin's River was the overall warmest system. Another possible contribution centers on site T005 from this river being located in shallow water (Figure 1).

Dissolved oxygen concentrations will be discussed at greater length due its greater impact on fisheries resources. Some of the DO concentrations give rise to the concern that hypoxia is occurring in the Coastal Bays during the summer months. In a report by the Committee on Environmental Natural Resources (2000), hypoxia exists when dissolved oxygen levels can no longer support the majority of life; 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 therefore DO can experience a decline between May through October in the southern reaches of the Provence. When temperatures decrease, mixing of top and bottom water occurs more frequently, eliminating the hypoxic regions that grew during the summer (EPA 2000). For organisms in the Chesapeake Bay, 5.0 mg/L is usually accepted as necessary for life. Requirements for DO can be very different based on the type of organism. A DO of 6 mg/L is necessary for larvae and eggs of migratory fish, however, some animals such as crabs and bottom dwelling fish (Bay Anchovies) can tolerate DO levels as low as 3 mg/L (Chesapeake Bay Program 2007).

For each system, all surface DOs from trawl sites in that area are combined for surface average DO. The same is done with bottom DOs for all trawl sites for an average bottom DO. The average surface and bottom DOs are shown above the ranges for both surface and bottom DO in the water quality tables for trawls. These averages are reviewed to see if the system overall fell below 5.0 mg/L (critical level of hypoxia). While low levels of DO were observed at some sites, the majority of DO averages (top and bottom) for the bays rarely dipped below 5.0 mg/L in 2012 (Figure 52, Table 13).

Only twice did DO levels in Assawoman Bay fall below 5.0 mg/L and that was at the bottom in July for T003 (4.68 mg/L) and T001 (4.86 mg/L). The average bottom DO for Assawoman in July was 5.1 mg/L.

The average for bottom DO for the St. Martin's River in June, August and September fell below 5.0 mg/L. The lowest DO (2.68 mg/L) for the river was recorded at T005 in June, lowering the average DO to 4.3 mg/L. This site also had a bottom DO of 3.20 mg/L in May. During August sampling, the bottom DO average was 4.1 mg/L. Site T004 returned a bottom DO of 4.16 mg/L and a DO of 4.05 mg/L was taken at T005 in August. The September bottom average DO was 4.6 mg/L and readings of 2.96 mg/L and 6.19 mg/L taken at sites T004 and T005, respectively.

The average surface and bottom DOs for Isle of Wight Bay never dipped below 5.0 mg/L, but there were individual low readings at certain sites. A bottom reading of 4.65 mg/L for T006 in July and a surface measurement of 3.66 mg/L at the same site during September trawling were observed.

Sinepuxent Bay had average surface and bottom DOs above 5.0 mg/L. The only low DO taken at an individual site belonged to T010 (4.50 mg/L) for July. In Newport Bay, the average DO never went below 5.0 mg/L for either surface or bottom and no low DOs were measured at any sites. Chincoteague Bay had surface and bottom average DOs above 5.0 mg/L but there were some low readings at individual sites. A bottom DO of 2.58 mg/L was obtained at T014 during the May sampling. A bottom DO of 4.73 mg/L was measured in July at T015 and changed little (4.82 mg/L) the following month at the same location. This site returned 3.91 mg/L for bottom DO in September. Also, in that same month, T019 returned a top and bottom DO of 4.58 mg/L and 4.39 mg/L, respectively. Of the seine sites, Ayers Creek (S019) had the lowest recorded DO of 2.80 mg/L for June. An explanation concerning this event was presented earlier.

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

Overall, the 2012 season assumed a similar pattern to 2010 and 2011 with salinity rising as the months passed, except for some occasions where salinity actually dipped from April to May. The overall average for all bays combined was 27.0 ppt which was nearly the same as 2011 (27.1 ppt) and 2010 (27.9 ppt). It can be anticipated that during some years, average salinity per water system will decrease after its zenith is reached mid-season. A possible explanation for the severe decline in salinity between August and September 2012 in many of the bays could center upon precipitation levels. An online search of precipitation levels reveals averages of 0.20 inches (0.5 cm) and 0.17 inches (0.4 cm) for July and August, respectively. The greatest amount of precipitation during August 2012 arrived on the 25th resulting in 1.47 inches (3.7 cm). Field work had ended for August prior to this date so the precipitation which occurred on August 25th would not have affected our August salinity data. Before this date, 3.83 inches (9.7 cm) of rain had fallen since the beginning of August and salinity measurements could have been impacted by that. From August 26th to September 10th, the beginning of the September sampling session, no precipitation occurred (Wunderground, Inc. 2013a).

This past season (2012) stands out among the recent years as being the hottest for the United States with the majority (61%) of this country experiencing drought. Several weather events have each caused over a billion dollars in damages. Temperatures over 100 F (37.8 C) were witnessed by one third of the American people for at least 10 days or above (Gillis 2013). With an average of 77.6 F (25.3 C), July 2012 was the warmest month in this country's history. Heat records were witnessed in five nations worldwide (Borenstein 2013). By the end of July, 29 % of Maryland was in extreme drought; though the counties on the northern portion of the Eastern Shore were under drought conditions considered moderate (Dance 2012). Even with a drought during the summer, Ocean City, Maryland received a sum of 21.4 inches (54.36 cm) of precipitation compared to 14.4 inches (36.50 cm) and 7.18 inches (18.23 cm) for 2011 and 2010 over the course of April to October (Wunderground, Inc. 2013a). This total for 2012 is before Hurricane Sandy.

A review of Secchi data from the years, 2010, 2011 and 2012, demonstrates a decrease in visibility across the warmer months. This metric is subject to variability as there are occasions when light penetration will experience improvement in the middle of summer. Upon viewing a combination of turbidity averages from every month for all bays, it is clear that 2010 had greater turbidity (82.2 cm) compared to 2011 (78.9 cm) and 2012 (73.3 cm). Despite a drought, 2012 did have a higher average precipitation compared to the other two seasons for the Ocean City, MD area, yet its turbidity tracked very closely with 2011, with visibility being only slightly lower each month from May through October. This precipitation amount excludes rainfall after October 18, the last day of trawling for 2012. Clearly, some factor other than rainfall influenced visibility for 2010, 2011 and 2012.

The overall temperature average from all water systems was 22.9 C which was close to that number for 2011 (22.4 C) and only slightly higher than in 2010 (21.6 C). Temperatures usually are greatest in July (Figure 63). The only major difference in salinity was the month at which it peaked for each season (Figure 64). Overall average salinity for all systems continued to climb for 2010 through September. This metric peaked in June for 2011 and August for 2012. The potential reason for such a steep decline in salinity from August to September during the 2012 sampling season was examined above. Precipitation may have caused such a decline.

Dissolved oxygen typically decreases from April through the warmer months and then increases again in the fall (Figure 65). Like temperature and salinity, precipitation did not seem to be the driving factor for DO or turbidity. The possible exception where DO may be have been influenced by precipitation seems to have occurred at S019 during June where the ditch is narrow and may not be flushed as frequently as more open regions. Algal blooms, along with wind and rain can also cause turbidity in the bays. Visibility can be substantially lowered by a bloom of brown algae. Chlorophyll and turbidity data from Turville Creek were compared with Park Service precipitation data for 2004. Precipitation did not follow turbidity to the extent that chlorophyll *a* did (Dennison *et al*. 2009). Based on the 2012 water quality data it seems apparent that DO and turbidity are most likely influenced by phytoplankton abundance increasing in the summer months and decreasing in the early spring and fall.

Pilot SAV Habitat Survey

Introduction:
The Maryland Department of Natural Resources (MDNR) has been conducting the Coastal Bays Fisheries Investigations (CBFI) Trawl and Beach Seine Surveys since 1972, with a standardized protocol since 1989. These surveys aim to characterize and quantify juvenile finfish abundance but also process bycatch which includes crustaceans, molluscs, sponges, and macroalgae. The CBFI has a combined total of 39 trawl and beach seine sites; however, those surveys rarely sample in Submerged Aquatic Vegetation (SAV). Use of SAV beds as habitat for nekton (fish and crustaceans) is well documented (Rozas and Odum 1988, Heck *et al*. 1989, Rooker *et al.* 1998, Connolly and Hindell 2006). With SAV playing such a significant role in the life cycle of many fishes and decapods and it's susceptibility to anthropogenic perturbations (Connolly and Hindell 2006), the characterization of nekton assemblages in SAV is vital.

With the potential for SAV beds to serve as primary habitat, it is necessary to further investigate nekton assemblages of SAV and macroalgae beds in Maryland's Coastal Bays. Identification of primary habitat will benefit planners and managers when making land use, water use, or fisheries management decisions, and is an important part of eco-system based management. The goals of this survey are consistent with those of the CBFI Trawl and Beach Seine Survey.

In addition to the goals of the CBFI Trawl and Beach Seine Surveys, the Pilot SAV Habitat Survey also set out to accomplish some further objectives. In the pilot season, this project sampled throughout the entire season to determine when SAV beds are utilized most. This survey intends to determine whether the amount of coverage of an SAV bed has any effect on the density and diversity of fish populations inhabiting the beds. We decided to use random sites due to the ephemeral nature of SAV beds and their potential to die-off throughout the season. Four zones were created to ensure a full spatial coverage of Maryland's Coastal Bays, so that these data could be compared with CBFI Trawl and Beach Seine Surveys.

Methods:

Study Area
For this project, we delineated four zones: Northern Bays (north of the Route 50 Bridge), Sinepuxent Bay West (which follows the tip of South Point into Newport Bay), Sinepuxent Bay East and Chincoteague Bay (everything south of South Point). Sixteen random seine sites were sampled from May to September. The sites were chosen using the Excel Random Number Generator (RANDBETWEEN function) and a 305 m x 305 m grid (created with GIS) overlaying areas where SAV beds had been present for at least five years based on data provided by the Tidewater Ecosystem Assessment (TEA) unit of Maryland Department of Natural Resources (Figures 1-3). These data layers were created from the Virginia Institute of Marine Sciences (VIMS) SAV survey and TEA field observations. Grid site numbers from the maps are grouped by zone on an Excel spreadsheet. All of the grids were verified in ArcMap to make sure there were at least 600 m^2 of SAV for sampling. Grid sites that did not meet the minimum SAV bed size were eliminated from the Excel spreadsheet. Eight sites

were chosen for each zone, the first four sites were the primary sample sites and the next four were alternates (Table 15). Alternate sites were used when primary sites lacked SAV, the site was too deep, or it was inaccessible.

Each zone was sampled entirely in one day. Multiple zones were sampled in one day, providing there was enough time to complete sampling for each zone. There were no instances where severe weather or emergencies made it necessary to stop sampling before completing an entire zone

Data Collection
A 25 foot C-hawk with a 225 horsepower Evinrude E-tec engine was used for transportation to the sample sites and gear deployment. Latitude and longitude coordinates (waypoints) in decimal degrees, minutes, and fraction of minutes (ddmm.mmm) were used to navigate to sample locations. The GPS was also used to obtain coordinates at the start and stop points of the seine haul.

Gear
<u>Beach Seine</u>
A 15.24 m X 1.8 m X 6.4 mm mesh (50 ft X 6 ft X 0.25 in. mesh) zippered bag seine was used at random sites in depths less than 1.5 m (5 ft.) over SAV beds. A biologist estimated percent of net open and a range finder was used to quantify the distance of the seine haul. The target seine haul distance was 35 meters but field conditions sometimes resulted in shorter or longer hauls. The seine was pulled across the SAV beds and swung up through the water column once a distance of 35 meters was reached. The biologists then lifted the seine out of the water, using both the float and lead lines. Then the sample was shaken down into the bag section of the seine and carried back to the boat for processing.

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 (Appendix 4).

Salinity, water temperature, and DO were taken with a Yellow Springs Instrument (YSI) YSI Pro2030 at 30 cm (1 foot) below the surface at each seine site. Only surface chemical data were collected due to the shallow depth (<1.5 m). The YSI cord was marked in 1 ft intervals. 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. 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 typically determined using the tide feature on the GPS.

Sample Processing
Fishes and invertebrates were identified, counted, and measured for Total Length (TL) using a wooden millimeter (mm) measuring board with a 90 degree right angle. A meter stick was used for species over 500 mm. At each site, a sub-sample of the first 20 fish (when applicable) of each species were measured and the remainder counted. Broken fish, when the majority of the animal could be recovered, were added to counts and not measured. Heads or tails were chosen when counting parts.

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

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

Data Analysis
Catch Per Unit Effort (CPUE) for each species was calculated as number of individuals of a species per hectare. CPUEs in individuals per hectare were also calculated for species that were also present in the CBFI Trawl and Beach Seine data from 2012.

Chi-square goodness of fit analyses was used to investigate the significance of the month sampled as well as location on fish presence. A one way ANOVA with a Duncan's Multiple Range Test was used to determine whether the percent coverage of SAV beds had any effect on the average number of fish encountered per sample. Significance was determined at p=0.05.

Fisheries Results
There were 23 species of fish caught in the Pilot SAV Habitat Survey in 2012 (Table 16). A total of 838 fish were encountered across 80 samples in the Pilot SAV Habitat Survey. In the initial year of the Pilot SAV Habitat Survey, the samples were dominated by Silver Perch and Spot. Combined, those two species accounted for 66.87% of the total finfish catch for the 2012 SAV Beach Seine sampling season.

Factoring in catches from the CBFI Trawl and Beach Seine Surveys, Spot, Pinfish and Bay Anchovies were the most encountered species (Table 16). Overall, Spot accounted for 58.25% of all finfish encountered in 2012, across all three surveys.

Silver Perch and Spot had the highest CPUE values (>85 individuals per hectare) for the Pilot SAV Habitat Survey (Table 17). Bay Anchovies were the third most abundant species at 24.72 individuals per hectare. While Spot and Bay Anchovies were abundant across all three surveys, Silver Perch, Pinfish and Atlantic Silversides were encountered at their greatest abundance in nearshore (seine) surveys. In addition to those species, eight other species (Bluefish, Fourspine Stickleback, Naked Goby, Northern Pipefish, Northern Sennet, Rainwater Killifish, Spotfin Mojarra and Striped Blenny) also occurred in higher abundances in nearshore surveys (Table 17). Dusky Pipefish and Naked Gobies occurred in their highest numbers in SAV seines.

Finfish were present in every zone in every month of the survey. May and August produced significantly higher overall numbers of finfish at 331 and 258, respectively (p<0.001). June, July and September each produced less than 95 fish per month (Table 18).

There was no significant difference in the number of fish encountered for each zone (p=0.4147). The Sinepuxent East zone produced the most individual fish (257 fish; Table 18). The Northern Bays zone had the least individual fish encountered (173 fish). A large scale die-off of SAV in the Northern Bays zone in 2011, supported by ground-truthing in 2012, forced a restricted sampling area (ten possible sampling sites). Sinepuxent Bay was split into two zones, Sinepuxent Bay East and Sinepuxent Bay West. Sinepuxent Bay West also included sites just inside Newport Bay. Everything south of South Point was considered to be in the Chincoteague Bay zone (Figures 2 and 3).

There were 17 sites that had both species of SAV present. Of those 17 sites, two had equal distributions of Eel Grass and Widgeongrass, nine sites were dominated by Eel Grass and six were dominated by Widgeongrass. The remaining 63 sites had only Eel Grass present. There were zero sites where Widgeongrass was the only species of SAV present.

Out of 80 samples, eight were conducted over SAV beds that had up to 25 percent coverage. In those eight samples, only 18 total fish were encountered for an average of 2.25 fish per sample. In the other SAV percent coverage categories (26%-50%, 51%-75%, 76%-100%) there was an average of 11.45 fish per sample (Table 19). There were significantly more fish encountered per sample for the other three SAV percent coverage categories (26%-50%, 51%-75%, 76%-100; p=0.0019).

Fisheries Discussion

Overall, less fish were encountered in the Pilot SAV Habitat Survey when compared to both the CBFI Trawl and Beach Seine Surveys. While the Pilot SAV Habitat Survey encountered a total of 838 individual fish, the CBFI Trawl and Beach Seine encountered 36,002 and 11,289 fish, respectively. In addition to the lower overall total fish encountered, the Pilot SAV Habitat Survey also had fewer species represented. The CBFI Trawl and Beach Seine Surveys were statistically more diverse, with a total of 52 and 57 species encountered, respectively (Table 4). This could potentially be attributed to the sampling method. While the CBFI beach seine is brought to the shoreline, the SAV beach seine attempts to use water pressure to keep specimens in the net as it is lifted straight up out of the water. Fish could also be less abundant in the SAV beds as a result of a combination of factors, including the limited availability of SAV beds. The limited availability of SAV beds could have the potential to concentrate fish in these beds, however, it could have the adverse effect and force fish to seek out other habitat options. SAV beds are also ephemeral whereas we have observed that macroalgae are abundant throughout the sampling season. This could shift habitat preferences for some species of fish.

The results shown in Table 19 ($p<0.0001$) provides strong evidence to restrict future sampling to May and August. These months coincide with the SAV new shoot production and maximum biomass (Orth *et al.* 1979), which provides cover and foraging opportunities for nekton (Stevenson *et al.* 1979). July 2012 was the warmest month in United States history, with an average air temperature of 77.6 F (25.3 C; Gillis 2013). Locally, the average air temperature for July 2012 was 77.5 F (25.3 C), consistent with the United States average. However, the highest average temperature for Ocean City, Maryland in 2012 occurred in August at 78.4 F (25.8 C; Wunderground, Inc. 2013c). As a result, the water temperature during the month of July ranged between 28 and 31 C (Figures 66-69, Table 20). This coincided with a sharp decline in DO (Figures 66-69, Table 20). These two factors, combined with the routine sloughing of SAV shoots could account for the low number of fish encountered in July. Additionally, the CBFI Beach Seine Survey is conducted annually in June and September. These months were selected based on historical observations and data, suggesting that these two months yield the most representative samples. Furthermore, the highest numbers of fish seen in SAV beds were in May and August. The increase in number of fish seen in May also coincides with the historical height of the SAV biomass which occurs in May (Orth *et al*. 1979). This potentially suggests that fish occupy SAV beds while the new shoots are emerging and reaching peak biomass, then shift to other habitats as these shoots begin to slough.

While the percent coverage of the SAV beds in the Northern Bays was not abnormal, the restricted sampling area may have had negative effects on the amount of fish encountered. Sinepuxent Bay was split into two zones, Sinepuxent Bay East and Sinepuxent Bay West due to perceived notions regarding the substrate when planning the survey. The shoreline for the Sinepuxent Bay West zone is dominated by salt marshes, muddy substrate and sharp drop-offs. The Sinepuxent East shoreline is Assateague Island which has a more gradual sloping, sandy beach habitat. Although the shorelines would seem to be distinct, the SAV beds in Sinepuxent Bay East and Sinepuxent Bay West were similar in substrate and species composition. Using those data and based on staff observations, future sampling could combine both the Sinepuxent Bay East and Sinepuxent Bay West zones to form a single Sinepuxent Bay zone.

There was a significant lack of fish caught at sites in which the coverage of SAV was less than 25% ($p=0.0019$). This suggests that fish do not appear to be selective regarding the amount of coverage of an SAV bed above 25% coverage. In the Northern Bays zone, there were five sites which fell into the "Up to 25%" coverage category, the most of any zone (Table 21). The Northern Bays zone also had the least number of fish encountered in the 2012 survey (Table 18). Alternately, the Sinepuxent East and Chincoteague Bay zones had the least amount of sites in the "Up to 25%" coverage category and the most individual fish encountered (Tables 18 and 21). As long as there is a semblance of an SAV bed, it is holding fish, providing cover and foraging opportunities. While the data from the Pilot SAV Habitat Survey suggest that finfish prefer beds with greater SAV density, there appears to be no direct relationship between site preference for finfish species of concern, (species results presented earlier in this chapter) and macroalgae density seen in the CBFI Trawl and Beach Seine Surveys (Figures 64 and 65). SAV density appears to have a greater effect on habitat preference then macroalgae density.

SAV beds in Maryland's Coastal Bays appear to be an important area of primary habitat for fish. Sampling for 2012 occurred from May to September. During this time period, SAV beds appear to be primarily used during the months of May and August, when new shoots are being produced and the beds are approaching peak biomass. Observations drawn from 2012 sampling show strong evidence to support that fish transition from SAV beds to nearshore habitat. This evidence supports the fixed sampling of the CBFI Beach Seine Survey in June and September.

Water Quality and Physical Characteristics Results

Temperature
Analysis of the 2012 CBFI Pilot SAV Habitat Survey water quality data beginning in May showed increasing average water temperature through July for all zones. The highest water temperature (31.5 C) was observed at site V354 in the Chincoteague Bay zone in July (Figures 3 and 66). The lowest water temperature (17.5 C) was observed twice, both times in May, in the Northern Bay zone at sites V008 and V011 (Figures 1 and 67).

The Sinepuxent East zone was the warmest with a combined average of 25.1 C (Figure 68). The Chincoteague Bay zone was the coolest with a combined average of 24.5 C. Overall, only 0.6 C separated the highest from the lowest combined average temperatures by zone. The overall average temperature for all of the zones was 24.9 C (Table 20).

Dissolved Oxygen
As expected, dissolved oxygen (DO) levels generally decreased as water temperatures increased. In the Sinepuxent West zone, the water temperature actually increased from August to September, prompting the DO to remain steady (Figure 69). In all other zones, the average DO increased from July to September, corresponding with decreasing average temperatures.

The range of DO levels across all zones was 3.7 mg/L to 11.1 mg/L for the entire season. The lowest DO value occurred in July in the Sinepuxent West zone at site V195 (Figure 2). The highest DO value occurred in May in the Chincoteague Bay zone at site V401 (Figure 3). The Chincoteague Bay zone had the highest average DO level for the entire season at 7.7 mg/L, while the Northern Bay zone had the lowest average DO level at 6.3 mg/L. For 2012, the overall average DO level for all zones combined was 6.8 mg/L. In 2012, the average DO for a zone only dropped below 5.0 mg/L on two occasions, both in July (Table 20).

Salinity
After all of the salinity data were analyzed for each zone, Sinepuxent East had the highest combined average at 29.2 ppt. The Northern Bays zone had the lowest combined average salinity at 27.4 ppt. The highest single salinity reading (31.8 ppt) in this survey in 2012 occurred in August in the Sinepuxent East zone at site V299 (Figure 2). The lowest salinity observation was 21.7 ppt in the Chincoteague Bay zone at site V706 in September (Figure 3). Overall, salinity generally increased in each zone from May to August. However, in the Northern Bays and Sinepuxent East zones, salinity dropped slightly (<0.4 ppt) from May to June. Across all zones, a sharp decline in salinity was observed from August to September. The average salinity across all zones for 2012 was 28.3 ppt (Table 20).

Secchi
Secchi observations for the 2012 SAV Habitat Survey season varied, but showed a general overall increase in visibility from May to September. The Northern Bays zone had the greatest overall visibility with an average of 74.1 cm. The Chincoteague Bay zone had the lowest overall average visibility at 58.4 cm. The greatest Secchi depth in 2012 was 126 cm, observed in the Sinepuxent East zone at site V276 in June (Figure 2). In September, the shortest Secchi depth of 21 cm was observed in the Sinepuxent West zone at site V287 in September (Figures 2 and 70, Table 20). In 2012, the Secchi disk reached bottom and was still visible 27 times out of a total of 80 (Figure 71). The greatest number of Secchi to bottom readings occurred in May (14 occurrences), while the least number of Secchi to bottom readings occurred in September (2 occurrences).

Water Quality and Physical Characteristics Discussion
The summer of 2012 was one of the hottest summers in history for the United States. The average temperature for July 2012 was 77.6 F (25.3 C), which is the hottest monthly average in United States history (Gillis 2013). Locally, the average temperature in Ocean City, Maryland for July 2012 was 77.5 F (25.3 C), consistent with the United States average. However, August 2012 was the hottest month in Ocean City, Maryland with an average temperature of 78.4 F (25.8 C). Although the hottest air temperatures in Ocean City, Maryland were observed in August, the water temperatures peaked in July for all zones and began to taper off in August and September, coinciding with trends observed for the CBFI Trawl and Beach Seine Surveys. The overall average water temperature across all zones was 24.9 C, which is two degrees higher than the overall temperatures for the CBFI surveys. This is to be expected, considering that the SAV Habitat Survey seines were all conducted in water less than 1.5 m deep.

Dissolved oxygen levels tend to decrease as water temperature increases and vice versa. This trend was observed throughout the 2012 Pilot SAV Habitat Survey. DO was observed at its lowest average levels for all zones in July, corresponding with the highest average water temperatures. An area is considered hypoxic when the DO is so low that it can no longer support the majority of life. The level at which hypoxia occurs can vary by system and organisms present. Some organisms can tolerate DO levels as low as 3.0 mg/L while others require a DO of 6.0 mg/L or higher (Chesapeake Bay Program 2007). In the Chesapeake Bay, a DO of 5.0 mg/L is generally considered to be necessary for life. In 2012, the average DO only dropped below 5.0 mg/L on two occasions, both in July, corresponding with high temperatures. Consequently, July 2012 also had the lowest number of individual fish encountered at 70 (Table 18). Alternately, the greatest number of individual fish encountered (331 fish; Table 18) occurred in May, corresponding with the highest average DO observed (8.4 mg/L). The overall average DO for all zones combined for 2012 was 6.8 mg/L which is identical to the overall average DO for the CBFI Trawl and Beach Seine Surveys (Tables 14 and 20).

The overall average salinity across all zones for 2012 was 28.3 ppt. This is 1.3 ppt higher than the average salinities seen in the CBFI Trawl and Beach Seine surveys (Tables 14 and 20). This could be attributed to the timing of the surveys. The Pilot SAV Habitat Survey was always conducted the week before the CBFI Trawl and Beach Seine Surveys. The summer of 2012 was not only one of the warmest on record, but it also included record setting droughts. In July 2012, only 0.2 inches (0.5 cm) of precipitation was recorded, allowing for salinity levels to approach their peak. Salinity levels reached their pinnacle in August 2012. Shortly after sampling concluded in August, several large rain events occurred totaling 3.83 inches (9.7 cm) of precipitation. September 2012 saw sharp declines in salinity across all zones and this can potentially be attributed to the increase in rainfall.

Turbidity showed an overall trend toward increasing in visibility from May to September. As the sampling season progressed, the drought continued, there was very little runoff and overall visibility continued to improve. Two zones saw a decrease in visibility from August to September, and this could be attributed to the large scale rain events in late August which would have produced high amounts of runoff and low visibility. It should also be taken into account that the Coastal Bays, particularly the Northern Bays zone and Sinepuxent zones experience unusually high volumes of boat traffic. Excessive boat traffic, particularly in shallow water, disturbs the bottom and greatly increases the amount of suspended particulate matter in the water column which can hinder light penetration (Garrad and Hey 1987). The average Secchi depth for the entire 2012 Pilot SAV Habitat Survey season was 64.9 cm, much lower then the average of 73.3 cm for the CBFI Trawl and Beach Seine Surveys. This can be misleading though, as all of the SAV beach seines were conducted in water less than 1.5 meters deep. Therefore, Secchi depth for the SAV beach seine can never be greater than 150 cm, while the CBFI Trawl Survey had several observations of Secchi depths greater than 150 cm (Tables 14-16). In contrast, during the Pilot SAV Habitat Survey, the Secchi disk reached bottom 34% of the time compared to 4% in the CBFI Trawl survey and 24% in the CBFI Beach Seine Survey.

Although 2012 was an anomalous year with extreme heat and drought, many of the water quality metrics exhibited trends similar to recent years. While the metrics for the Pilot SAV Habitat Survey sometimes deviated from the other surveys, these fluctuations can be generally attributed to outside influences or basic site characteristics, namely depth.
We recommend long-term sampling of SAV beds during the months of May and August, based on this sampling design. Future analyses will work to discern areas of primary fisheries habitat within Maryland's Coastal Bays; the relationship between water quality, SAV beds, and species diversity in Maryland's Coastal Bays; and areas of preferred habitat by species.

Further Study

The 2012 SAV Habitat Survey was conducted as a pilot survey. It served as a basis for long-term sampling of SAV beds in Maryland's Coastal Bays. Based on data from 2012, we recommend long-term sampling in May and August under a similar sampling design. Results from the 2012 SAV Habitat Survey suggest that both the fish assemblages and the amount of individual fish encountered are similar for both the Sinepuxent East and Sinepuxent West zones. The only other major change recommended to the sampling design is to combine the Sinepuxent West and Sinepuxent East zones into a single zone.

Future work will continue to monitor community assemblages and number of individual fish encountered over SAV beds. We will still monitor the temporal and spatial distributions of fish, but also intend to analyze length data in an effort to understand the life stage usage of different habitats in Maryland's Coastal Bays. Data gathered on invertebrate organisms encountered will also be compared with data from the CBFI Trawl and Beach Seine surveys, as well. Future analyses will also work to discern areas of primary fisheries habitat in Maryland's Coastal Bays; the relationship between water quality, SAV beds, and fish diversity; and preferred Maryland Coastal Bays habitat by species.

References:

Able, Kenneth W., Michael P. Fahay. 1998. The first year in the life of estuarine fishes in the Middle Atlantic Bight. Rutgers University Press. New Brunswick, NJ. 342 pp.

Abraham, Barbara J. 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic) mummichog and striped killifish. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.40). U.S. Army Corp. of Engineers. TR EL-82-4. 23 pp.

Amos, William H., Stephen H. Amos. 1998. Atlantic and Gulf Coasts. National Audubon Society Nature Guide. Chanticleer Press. New York. 671 pp.

Atlantic States Marine Fisheries Commission. November 2006. Addendum III to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Menhaden. Available: http://www.asmfc.org/.

Beck, Michael W., Kenneth L. Heck, Jr., Kenneth W. Able, Daniel L. Childers, David B. Eggleston, Bronwyn M. Gillanders, Benjamin S. Halpern, Cynthia G. Hays, Kaho Hoshino, Thomas J. Minello, Robert J. Orth, Peter F. Sheridan, and Michael P. Weinstein. 2003. The role of nearshore ecosystems as fish and shellfish nurseries. Issues of Ecology. Ecological Society of America.

Borenstein, Seth. "2012 Extreme Weather Sets Records, Fits Climate change Forecasts." Huffinton Post. Huffington Post, 20 Dec. 2012. Web. 22 Feb. 2013. http://www.huffingtonpost.com/2012/12/21/2012-extreme-weather-climate-change_n_2348079.html

CENR, 2000. Integrated assessment of hypoxia in the Northern Gulf of Mexico. National Science and Technology Council Committee on Environment and Natural Resources, Washington, D.C.

Chesapeake Bay Program. 2007. Dissolved Oxygen-About the Bay. http://www.chesapeakebay.net/discover/bayecosystem/dissolvedoxygen

Common and Scientific Names of Fishes from the United States, Canada, and Mexico. 7th ed. American Fisheries Society, in prep.

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

Dance, Scott. "Drought area shrinks slightly across nation, but worsens in Md." *Baltimore Sun*. Baltimore Sun, 2 Aug. 2012. Web. 22 Feb. 2013. http://articles.baltimoresun.com/2012-08-02/news/bal-wx-drought-persists-nationwide-and-in-maryland-20120802_1_moderate-drought-severe-drought- drought-area

Dennison, W. C., J. E. Thomas, C. J. Cain, T. J. B. Carruthers, M. R. Hall, R. V. Jesien, C. E. Wazniak and D. E. Wilson. 2009. Shifting sands: Environmental and cultural changes in Maryland's Coastal Bays. University of Maryland Center for Environmental Science, Cambridge, MD.

Doctor, S., C. Jones, C. Kennedy, G. Tyler and A. Willey. 2012. Investigation of Maryland's Coastal Bays and Atlantic Ocean finfish stocks 2007 – 2011 Final Report. Maryland Department of Natural Resources. Federal Aid Project No. F-50-R-20. Annapolis, MD.

EPA, U.S., 2000. Ambient aquatic life water criteria for Dissolved oxygen (saltwater): Cape Cod to Cape Hatteras. U.S. Environmental Protection Agency. Office of Water. EPA-822-R-00-012, Washington, DC.

Eyes on the Bay. 2013 Maryland Department of Natural Resources. 27 February 2013. http://mddnr.chesapeakebay.net/newmontech/contmon/archived_quick_fullyear_graph2012.cfm?param=chlorophyll&year=2012&shortname=publiclanding&tablename=publiclanding2012

Garrad, P. N. and R. D. Hey. 1987. Boat traffic, sediment resuspension and turbidity in a Broadland river. *Journal of Hydrology.* 95:289-297.

Gillis, Justin. "Not Even Close: 2012 Was Hottest Ever in U.S." *New York Times*. New York Times, 8 Jan. 2013. Web. 11 Feb. 2013. http://www.nytimes.com/2013/01/09/science/earth/2012-was-hottest-year-ever-in-us.html?_r=0

Gore, R. H., E. E. Gallager, L. E. Scotto and K. A. Wilson. 1981. Studies on decapod crustacean from the Indian River region of Florida. *Estuarine, Coastal and Shelf Science.* 12:485-508.

Goshorn, Dave, Margaret McGinty, Carrie Kennedy, Calvin Jordan, Cathy Wazniak, Kara Schwenke, and Kevin Coyne. 2001. An examination of benthic macroalgae communities as indicators of nutrients in middle Atlantic coastal estuaries – Maryland component, Final Report 1998-1999. Maryland Department of Natural Resources. Annapolis, MD.

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

Heck, Jr., K. L., K. W. Able, M. P. Fahay and C. T. Roman. 1989. Fishes and decapod crustaceans of Cape Cod Eel Grass meadows: species composition, seasonal abundance patterns and comparison with unvegetated substrates. *Estuaries.* 12:59-65.

Howell, Penelope, and David Simpson. 1994. Abundance of marine resources in relation to dissolved oxygen in Long Island Sound. Estuaries, 17 (2):394-402.

Integration and Application Network (IAN), University of Maryland Center for Environmental Science (UMCES). 2012. Coastal Bays Report Card 2011. Produced October 2012.

Latour, Robert J., James Gartland, Christopher Bonzek, RaeMarie A. Johnson. 2008. The trophic dynamics of Summer Flounder in Chesapeake Bay. Fishery Bulletin, January.

Lung, W.S. 1994. Water quality modeling of the St. Martin River, Assawoman and Isle of Wight Bays. Maryland Department of the Environment, Final Report. 156 pp.

Maryland Coastal Bays Program. 2005. The Comprehensive Conservation and Management Plan for Maryland's Coastal Bays. Available: http://www.mdcoastalbays.org/. (February 16, 2007).

Maryland Department of Natural Resources. 2005. Investigation of Maryland's Coastal Bays and Atlantic Ocean Finfish Stocks. Federal Aid Project F-50-R-15

Maryland Department of the Environment. 2001. Total Maximum Daily Loads of Nitrogen and Phosphorus for Five Tidal Tributaries in the Northern Coastal Bays System Worcester County, Maryland.

Morand, P. and Merceron, M. 2005. Macroalgae population and sustainability. Journal of Coastal Research, 21(5), 1009-1020. West Palm Beach, FL.

Murdy, Edward, Ray S. Birdsong, and John M. Musick. 1997. Fishes of Chesapeake Bay. Smithsonian Institution Press. Washington, DC. 324 pp.

Nelson, Joseph S, Edwin J. Crossman, Héctor Espinosa-Pérez, Lloyd T. Findley, Carter R. Gilbert, Robert N. Lea, and James D. Williams. 2004. Common and Scientific Names of Fishes from the United States Canada and Mexico Sixth Edition. American Fisheries Society. 386 pp.

Northeast Fisheries Science Center. 2009. 48th Northeast regional stock assessment workshop (48th SAW) assessment summary report. US Dept Commerce, Northeast Fish Sci Cent Ref Doc. 09-10; 50 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://www.nefsc.noaa.gov/nefsc/publications/

Nye, Janet A, Matthew Baker, Richard Bell, Andrew Kenny, K. Halimeda Kilbourne, Kevin D. Friedland, Edward Martino, Megan M. Stachura, Kyle S. Van Houtan, Robert Wood. Ecosystem effects of the Atlantic Multidecadal Oscillation, Journal of Marine Systems, Available online 21 February 2013, ISSN 0924-7963, 10.1016/j.jmarsys.2013.02.006. (http://www.sciencedirect.com/science/article/pii/S0924796313000316)

Olla, B. J., A. J. Bejda and A. D. Martin. 1979. Seasonal dispersal and habitat selection of cunner, *Tautogolabrus adspersus*, and young Tautog, *Tautoga onitis*, in Fire Island inlet, Long Island, New York. *Fishery Bulletin.* 77:255-261.

Orth, R. J., K. A. Moore and H. H. Gordon. 1979. The distribution and abundance of submerged aquatic vegetation in the lower Chesapeake Bay, Virginia. Final Report EPA 600/8-79-029/SAV 1, 199 pp.

Prichard. D. W. 1960. Salt balance and exchange rate for Chincoteague Bay. Chesapeake Science 1(1): 48-57.

Raposa, K. B. and C. A. Oviatt. 2000. The influence of contiguous shoreline type, distance from shore, and vegetation biomass on nekton community structure in eelgrass beds. *Estuaries*. 23:46-55.

Ricker, W. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada. Bulletin 191.

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

Rooker, J. R., S. A. Holt, M. A. Soto and G. J. Holt. 1998. Postsettlement patterns of habitat use by sciaenid fishes in subtropical seagrass meadows. *Estuaries*. 21:318-327.

Rozas, L. P. and W. E. Odum. 1988. Occupation of submerged aquatic vegetation by fishes: testing the roles of food and refuge. *Oecologia*. 77:101-106.

Sogard, S. M. and K. W. Able. 1990. A comparison of eelgrass, sea lettuce macroalgae, and marsh creeks as habitats for epibenthic fishes and decapods. *Estuarine, Coastal and Shelf Science*. 33:501-519.

Stevenson, J. C., C. B. Piper and N. Confer. 1979. Decline of Submerged Plants in Chesapeake Bay. *United States Fish and Wildlife Service Report.* Web. http://www.fws.gov/chesapeakebay/savpage.htm 26 Feb 2013.

Stoner, A. W., and R. J. Livingston. 1980. Distributional ecology and food habits of the banded blenny *Paraclinus fasciatus* (Clinidae): a resident in a mobile habitat. *Marine Biology*. 56:239-246.

Strobel, Charles J., Henry W. Buffum , Sandra J. Benyi ., Elise A. Petrocelli., Daniel R. Reifsteck, and Darryl J. Keith. 1995. Statistical Summary: EMAP-Estuaries Virginian Provence-1990-1993 U.S. Environmental Protection Agency, National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, RI. EPA/620/R-94/026.

Sze, Philip.1998. A biology of Algae 3rd edition. McGraw-Hill. Boston.

Timmons, M. and K.S. Price. 1996. The macroalgae and associated fauna of Rehoboth and Indian River Bays, Delaware. *Botanica Marina* 39:231-238.

Tyler, R. M. 2010. Seaweed distribution and abundance in the inland bays. Delaware Department of Natural Resources and Environmental Control. FY09 Research and Demonstration Project. Dover, DE.

Wazniak, Catherine, Darlene Wells, and Matthew Hall. 2004. Maryland's Coastal Bays: Ecosystem Health Assessment. Pages 9-20 *in* Chapter 1.2: The Maryland Coastal Bays ecosystem. Maryland Department of Natural Resources, Document Number DNR-12-1 02-0009.

Wazniak, Catherine, David Goshorn, Matthew Hall, David Blazer, Roman Jesien, David Wilson, Carol Cain, William Dennison, Jane Thomas, Tim Carruthers, Brian Sturgis. 2004. State of the Maryland Coastal Bays. Maryland Department of Natural Resources. Maryland Coastal Bays Program. University of Maryland Center for Environmental Science, Integration and Application Network.

Wilson, K. A., K. W. Able and K. L. Heck, Jr. 1990. Predation rates on juvenile blue crabs in estuarine nursery habitats: evidence for the importance of macroalgae (*Ulva lactuca*). *Marine Ecology Progress Series*. 58:243-251.

Wunderground, Inc. Weather Underground. Web. 11 Feb. 2013a http://www.wunderground.com/.

Wunderground, Inc. Weather Underground. Web. 11 Feb. 2013b http://www.wunderground.com/.

Wunderground, Inc. Weather Underground. Web. 21 Mar. 2013c. http://www.wunderground.com/.

Wyneken, Jeanette. 2001. Sea Turtle Anatomy: Standard Measurements. Available: http://courses.science.fau.edu/~jwyneken/sta/SeaTurtleAnatomy-Standard_Measurements.pdf.

List of Tables

List of Tables (con't)

List of Figures

List of Figures (con't.)

List of Figures (con't.)

List of Figures (con't.)

.

List of Figures (con't)

List of Figures (con't)

List of Figures (con't)

List of Figures (con't)

List of Figures (con't)

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 2012 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, 2012. 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
Spot	*Leiostomus xanthurus*	27,763	22,597	5,166	1296.6	135.9
Bay Anchovy	*Anchoa mitchilli*	11,472	10,925	547	625.9	14.4
Atlantic Menhaden	*Brevoortia tyrannus*	2,186	124	2,062	7.1	54.3
Silver Perch	*Bairdiella chrysoura*	1,137	668	469	38.4	12.3
Atlantic Silverside	*Menidia menidia*	879	5	874	0.3	23.0
Pinfish	*Lagodon rhomboides*	535	38	497	2.2	13.1
Summer Flounder	*Paralichthys dentatus*	400	353	47	20.5	1.2
Mummichog	*Fundulus heteroclitus*	320	157	163	8.9	4.3
Golden Shiner	*Notemigonus crysoleucas*	313		313		8.2
Winter Flounder	*Pseudopleuronectes americanus*	271	81	190	4.6	5.0
Atlantic Croaker	*Micropogonias undulatus*	219	218	1	12.5	<0.1
Weakfish	*Cynoscion regalis*	201	201		11.4	
Hogchoker	*Trinectes maculatus*	166	161	5	9.2	0.1
Striped Killifish	*Fundulus majalis*	157		157		4.1
White Mullet	*Mugil curema*	151	2	149	0.1	3.9
Black Sea Bass	*Centropristis striata*	125	92	33	5.6	0.9
Spotfin Mojarra	*Eucinostomus argenteus*	125	3	122	0.2	3.2
Striped Anchovy	*Anchoa hepsetus*	84	26	58	1.5	1.5
Oyster Toadfish	*Opsanus tau*	83	54	29	3.3	0.8
Striped Mullet	*Mugil cephalus*	74	2	72	0.1	1.9
Naked Goby	*Gobiosoma bosc*	71	57	14	3.8	0.4
Green Goby	*Microgobius thalassinus*	49	47	2	2.7	<0.1
Northern Pipefish	*Syngnathus fuscus*	34	24	10	1.4	0.3
Bluefish	*Pomatomus saltatrix*	33	5	28	0.3	0.7
Atlantic Needlefish	*Strongylura marina*	28		28		0.7
Gizzard Shad	*Dorosoma cepedianum*	28		28		0.7
American Eel	*Anguilla rostrata*	26	17	9	1.3	0.2
Blackcheek Tonguefish	*Symphurus plagiusa*	26	1	25	0.1	0.7
Rainwater Killifish	*Lucania parva*	23	13	10	0.7	0.3
Southern Stingray	*Dasyatis americana*	23	1	22	0.1	0.6
Lined Seahorse	*Hippocampus erectus*	21	21		1.2	
Halfbeak	*Hyporhamphus unifasciatus*	20		20		0.5
Black Drum	*Pogonias cromis*	18	1	17	0.1	0.4
Southern Kingfish	*Menticirrhus americanus*	17	3	14	0.2	0.4
Dusky Pipefish	*Syngnathus floridae*	16	14	2	0.8	<0.1
Striped Burrfish	*Chilomycterus schoepfii*	16	11	5	0.6	0.1
Northern Puffer	*Sphoeroides maculatus*	15	9	6	0.5	0.2

Table 4 (con't). List of fishes collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2012. Species are listed bv 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**
Spotted Hake	*Urophycis regia*	14	14		0.8	
Spotted Seatrout	*Cynoscion nebulosus*	14		14		0.4
Fourspine Stickleback	*Apeltes quadracus*	12	6	6	0.3	0.2
Striped Bass	*Morone saxatilis*	12	1	11	0.1	0.3
Northern Searobin	*Prionotus carolinus*	11	11		0.6	
Mosquitofish	*Gambusia affinis*	8		8		0.2
Banded Killifish	*Fundulus diaphanus*	7		7		0.2
Bluegill	*Lepomis macrochirus*	7		7		0.2
Smallmouth Flounder	*Etropus microstomus*	7	7		0.4	
Striped Blenny	*Chasmodes bosquianus*	7	1	6	0.1	0.2
Inshore Lizardfish	*Synodus foetens*	6	3	3	0.2	<0.1
Rough Silverside	*Membras martinica*	6		6		0.2
Feather Blenny	*Hypsoblennius hentz*	5		5		0.1
Blueback Herring	*Alosa aestivalis*	4	4		0.2	
Clearnose Skate	*Raja eglanteria*	4	4		0.2	
Harvestfish	*Peprilus paru*	4		4		0.1
Red Drum	*Sciaenops ocellatus*	4		4		0.1
Windowpane	*Scophthalmus aquosus*	4	4		0.2	
Atlantic Herring	*Clupea harengus harengus*	3	3		0.2	
Northern Kingfish	*Menticirrhus saxatilis*	3	2	1	0.1	<0.1
Skilletfish	*Gobiesox strumosus*	3	1	2	0.1	<0.1
Striped Cusk-eel	*Ophidion marginatum*	3	2	1	0.1	<0.1
Blue Runner	*Caranx crysos*	2		2		<0.1
Northern Sennet	*Sphyraena borealis*	2		2		<0.1
Pipefishes	*Gasterosteiformes*	2		2		<0.1
Scup	*Stenotomus chrysops*	2	2		0.1	
Sheepshead	*Archosargus probatocephalus*	2	1	1	0.1	<0.1
Smooth Butterfly Ray	*Gymnura micrura*	2	2		0.1	
Atlantic Spadefish	*Chaetodipterus faber*	1	1		0.1	
Cownose Ray	*Rhinoptera bonasus*	1		1		<0.1
Hickory Shad	*Alosa mediocris*	1		1		<0.1
Lookdown	*Selene vomer*	1	1		0.1	
Silver Hake	*Merluccius bilinearis*	1	1		0.1	
Striped Searobin	*Prionotus evolans*	1		1		<0.1
	Total Finfish	**47,291**	**36,002**	**11,289**		

Table 5. List of crustaceans collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2012. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	**Scientific Name**	**Total Number Collected**	**Number Collected (T)**	**Number Collected (S)**	**Estimated Count (T)**	**Estimated Count (S)**	**CPUE (T) #/Hect.**	**CPUE (S) #Haul**
Blue Crab	*Callinectes sapidus*	7,950	6,258	1,692			365.4	44.5
Sand Shrimp	*Crangon septemspinosa*	5,436	10	1	4,875	550	282.2	14.5
Grass Shrimp	*Palaemonetes sp.*	4,249	62		2,937	1,250	178.8	32.9
Say Mud Crab	*Dyspanopeus sayi*	257	249	8			14.3	0.2
Long-armed Hermit Crab	*Pagurus longicarpus*	125	62	63			3.5	1.6
Brown Shrimp	*Farfantepenaeus aztecus*	119	87	32			5.0	0.8
Lady Crab	*Ovalipes ocellatus*	97	57	40			3.2	1.1
White Shrimp	*Litopenaeus setiferus*	52	27	25			1.5	0.7
Lesser Blue Crab	*Callinectes similis*	39	23	16			1.3	0.4
Mantis Shrimp	*Squilla empusa*	29	29				1.6	
Barnacles	*Cirripedia*	25			25		1.4	
Portly Spider Crab	*Libinia emarginata*	10	10				0.6	
Flatclaw Hermit	*Pagurus pollicaris*	5	2	3			0.1	<0.1
Atlantic Mud Crab	*Panopeus herbstii*	2	1	1			0.1	<0.1
Bigclaw Snapping Shrimp	*Alpheus heterochaelis*	2	2				0.1	
	Total Crustaceans	**18,397**	**6,879**	**1,881**	**7,837**	**1,800**		

Table 6. List of molluscs collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2012. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	**Scientific Name**	**Total Number Collected**	**No. Collect (T)**	**No. Collect (S)**	**Est. Cnt. (T)**	**Est. Cnt. (S)**	**Total Est. Vol. (T)**	**Total Est. Vol. (S)**	**CPUE Vol. (T)**	**CPUE Vol. (S)**	**CPUE (T) #/Hect.**	**CPUE (S) #Haul**
Solitary Glassy-bubble	*Haminoea solitaria*	1,793	3		1,790						102.1	
Blue Mussel	*Mytilus edulis*	1,117	2		1,095	20					62.5	0.5
Convex Slippersnail	*Crepidula convexa*	632	127	15	230	260					20.3	7.2
Atlantic Brief Squid	*Lolliguncula brevis*	90	90								5.1	
Eastern White Slippersnail	*Crepidula plana*	62	10	7	45						3.1	0.2
Eastern Mudsnail	*Nassarius obsoletus*	51	6	45							0.3	1.2
Lemon Drop	*Doriopsilla pharpa*	18	18								1.0	
Common Atlantic Slippersnail	*Crepidula fornicata*	5			5						0.3	
Bruised Nassa	*Nassarius vibex*	4	2	2							0.1	<0.1
Common Jingle	*Anomia simplex*	4	4								0.2	
Northern Dwarf-tellin	*Tellina agilis*	4	4								0.2	
Atlantic Oyster Drill	*Urosalpinx cinerea*	3	3								0.2	
Ponderous Ark	*Noetia ponderosa*	2	2								0.1	
Purplish Tagelus	*Tagelus divisus*	2	2								0.1	
Dwarf Surfclam	*Mulinia lateralis*	1	1								0.1	
Green Jackknife	*Solen viridis*	1	1								0.1	
Northern Quahog	*Mercenaria mercenaria*	1	1								0.1	
Stout Tagelus	*Tagelus plebeius*	1	1								0.1	
Squid Family – Egg Mass	*Loliginidae*						0.5		<0.1			
	Total Molluscs	**3,791**	**277**	**69**	**3,165**	**280**						

Table 7. List of other species collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2012. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	**Scientific Name**	**Total Number Collected**	**No. Collect (T)**	**No. Collect (S)**	**Est. Cnt. (T)**	**Est. Cnt. (S)**	**Spec. Vol. (L) (T)**	**Spec. Vol. (L) (S)**	**Est. Vol. (L) (T)**	**Est. Vol. (L) (S)**	**CPUE (T) #/Hect.**	**CPUE (S) #/Haul**	**CPUE (T) #/Hect. Vol.**	**CPUE (S) #/Haul Vol.**
Sea Squirt	*Molgula manhattensis*	636	5		621	10					44.2	0.3		
Comb Jellies	*Ctenophora sp.*	555		5	550		132.1	17.4	8.4	3.3	31.3	0.1	8.0	0.5
Hairy Sea Cucumber	*Sclerodactyla briareus*	256	200	56							11.8	1.5		
Sea Nettle	*Chrysaora quinquecirrha*	111	67	4	40		0.5				6.1	0.1	<0.1	
Beroe Comb Jelly	*Beroe ovata*	61	55	1	5						3.4	<0.1		
Horseshoe Crab	*Limulus polyphemus*	31	30	1							1.7	<0.1		
Serpulid Worms	*Hydroides dianthus*	20			20		1.4	1.1	0.8		1.1		<0.1	<0.1
Moon Jelly	*Aurelia aurita*	15	15								0.9			
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	15	3	12							0.2	0.3		
Forbes Asterias	*Asterias forbesi*	4	4								0.2			
Sea Walnut	*Mnemiopsis leidyi*	2	2						0.3		0.1		<0.1	
Common Sea Cucumber	*Cucumaria pulcherrima*	2	2								0.1			
Thyonella gemmata	*Thyonella gemmata*	2		2								<0.1		
White Anemone	*Diadumene leucolena*	1	1								0.1			
Goldstar Tunicate	*Botryllus schlosseri*						8.2						0.8	
Sea Pork	*Aplidium sp.*						145.0	2.0					8.3	<0.1
Bryozoans	*Ectoprocta*						102.7	7.0		<0.1			5.8	0.2
Rubbery Bryozoan	*Alcyonidium sp.*						58.5	5.6					4.2	0.2
Fig Sponge	*Suberites ficus*						121.3						6.9	
Halichondria Sponge	*Halichondria sp.*						185.0	5.6					13.0	0.2
Red Beard Sponge	*Microciona prolifera*						82.2	1.1					5.0	<0.1
Sulphur Sponge	*Cliona celata*						51.3						2.9	
	Total Other	**1,711**	**384**	**81**	**1,236**	**10.0**	**888.2**	**39.8**	**9.5**	**3.3**				

Table 8. List of Submerged Aquatic Vegetation (SAV) and macroalgae collected in Maryland's Coastal Bays Trawl (T) and Beach Seine (S) Surveys from April through October, 2012. Species are listed by order of total abundance. Total trawl sites = 140, total seine sites = 38.

Common Name	Genus	Specific Volume (L) (T)	Specific Volume (L) (S)	Estimated Volume (L) (T)	Estimated Volume (L) (S)
SAV					
Eel Grass	*Zostera*	23.6	48.7		<0.1
Widgeongrass	*Ruppia*	0.7	4.4		
	Total SAV	**24.3**	**53.1**		**<0.1**
Macroalgae					
Brown					
Sour Weeds	*Desmarestia*	0.6	0		
Common Southern Kelp	*Laminaria*	0.1			
		0.7	**0**		
Green					
Green Tufted Seaweed	*Cladophora*	146.0	3.5		
Sea Lettuce	*Ulva*	112.2	40.1		<0.1
Hollow Green Weed	*Enteromorpha*	88.8	2.2		
Green Fleece	*Codium*	27.0	52.6		
Green Hair Algae	*Chaetomorpha*	1.1	1.0		
		375.1	**99.3**		**<0.1**
Red					
Graceful Red Weed	*Gracilaria*	1,205.3	2.2		
Agardh's Red Weed	*Agardhiella*	951.5	628.9		
Tubed Weeds	*Polysiphonia*	546.6	152.3		
Hairy Basket Weed	*Spyridia*	51.4	3.3		
Banded Weeds	*Ceramium*	47.6	0.1		
Barrel Weed	*Champia*	27.3	3.6		
Hooked Red Weed	*Hypnea*	0.4			
		2,830.0	**790.4**		
Yellow-Green					
Water Felt	*Vaucheria*	48.3	29.2		
		48.3	**29.2**		
Unknown					
Unknown Macroalgae	*Unknown*	14.0			
		14.0			
	Total Macroalgae	**3,268.0**	**918.9**		**<0.1**

Table 9. Coastal Bays Fisheries Investigations 2012 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	2	1				2					2				2					
Atlantic Croaker	1	1	1	1	1	1	2				1	1	2	1	2		2	2		
Atlantic Menhaden					1	1														
Atlantic Silverside					1										1		1		1	
Bay Anchovy	1	1	1	1	1	1	1		2	1	1	1	1	1	1	1	1		1	2
Black Sea Bass	1	1	1	2			1		1	1	1				1		1			2
Bluefish			1				1				1									
Spot	1	1	1	1	1	1	1		2	2	1	1	1	1	1	2	1	2	1	
Summer Flounder	2	1	2	1	1	1	1	2	1	1	1	1	1	1	1		1	1	1	
Tautog																				
Weakfish			1	1							2	2		2		2				

Table10. Coastal Bays Fisheries Investigations 2012 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					1					1		
Atlantic Croaker																	1		
Atlantic Menhaden	2	2	2		2	2	2	2		1		2	2					2	2
Atlantic Silverside	1	1	1	2	1	1	1	1	1	1	1	1		1	1	1	1	1	1
Bay Anchovy	1	1	1		1	1	1			1	1	1	2	1	1	1		2	1
Black Sea Bass	1	1		1	1														
Bluefish	1		1		1	1	1	1	1	1	1	1					1	1	
Spot	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
Summer Flounder		2	2		1	1			1	1	2	1	1		1	1	1		
Tautog																			
Weakfish																			

Table 11. Summary of Maryland recreational regulations for 2012.

Species	Area	Minimum Size Limit (inches)	Creel (person/day)	Season
American Eel	A	6	25	Open Year Round
Atlantic Croaker	A	9	25	Open Year Round
Black Sea Bass	A	12.5	25	May 19 thru Oct. 14 Closed on Nov. 1
Black Drum	A	16	1 6/boat	Open Year Round
Bluefish	A	8	10	Open Year Round
Red Drum	A	18 to 27	1	Open Year Round
Speckled Trout	A	14	10	Open Year Round
Summer Flounder	A	17	3	April 14 thru December 16
Tautog	A	16	4	January 1* thru May 15 and Nov. 1 thru Nov. 26
			2	May 16 thru Oct. 31
Weakfish	A	13	1	Open Year Round

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

*Tautog size and season regulations became effective April 2, 2012.

Table 12. Summary of Maryland commercial regulations for 2012.

Species	Area	Size (inches) gear	Commercial Season, Days, Times, & Area Restrictions	Special Conditions/Comments
American Eel	A	6	Open Year Round	25/person/day<6" If pot mesh < ½" x ½", escape panel required
Atlantic Croaker	A	9 Seine, Trotline, Pot, Trap, Net, Hook & Line	Mar 16-Dec 31	Closed Jan 1-Mar 15
Atlantic Menhaden	A	None	None	Harvest cap of 109,020 metric-tons
Black Sea Bass	A	11 Trawl, Pot, Trap Bay-No Trawl	Landing Permit Required Closed on Oct. 8	Individual IFQ issued. Bycatch: 50 lbs.
Black Drum	B		No commercial harvest in Bay	
Black Drum	C	16 Line, Net, Pot, Trap, Trotline, Seine	1,500 lbs. Open Year Round	May only land Black Drum from waters of the Atlantic Ocean, not including Coastal Bays
Bluefish	A	8 Hook & Line, Pot, Trotline, Net	Open Year Round	
Summer Flounder	C	14 Net, Pot, Trap, Trotline, Seine	April 14 thru December 31	IFQ issued Bycatch: 100 lbs/day
		18 Hook&Line	January 1 thru April 13	
		17 Hook & Line	April 14 thru December 31	
Summer Flounder	B	14 Net, Pot, Trap, Trotline, Seine	April 14 thru December 31	IFQ issued Bycatch: 50 lbs/day
		18 Hook&Line	January 1 thru April 13	
		17 Hook & Line	April 14 thru December 31	
Tautog Jan 1 - May 15 & Nov. 1 – Nov. 25	A	16 Hook&Line, Net, Pot, Trap, Trotline, Seine	4	November 26 - December 31closed
Tautog May 16 – Oct. 31	A	16 Hook&Line, Net, Pot, Trap, Trotline, Seine	2	

Table 12 (con't). Summary of Maryland commercial regulations for 2012.

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

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

B- Includes Chesapeake Bay & all tributaries

C- Includes Atlantic Ocean & Coastal Bays

Table 13. Coastal Bays Fisheries Investigations 2012 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:	18.7 (18.3-18.9)	20.6 (20.1-21.0)	22.6 (22.2-22.8)	28.2 (27.8-28.6)	27.6 (27.5-27.8)	23.0 (22.9-23.0)	16.5 (16.4-16.6)
	Bottom:	18.6 (18.2-18.9)	20.6 (20.2-21.0)	22.2 (22.0-22.6)	27.7 (27.5-27.8)	27.4 (27.2-27.8)	23.0 (22.8-23.1)	16.5 (16.3-16.6)
DO (mg/L)	Surface:	7.8 (7.8-7.9)	7.4 (7.0-7.8)	7.4 (7.2-7.6)	6.2 (5.5-6.8)	6.4 (5.8-6.7)	8.3 (7.7-8.9)	7.9 (7.9-8.0)
	Bottom:	7.8 (7.7-7.9)	7.3 (6.8-7.8)	7.0 (6.6-7.2)	5.1 (4.7-5.8)	5.6 (5.4-5.7)	5.3 (5.0-5.6)	7.8 (7.7-8.1)
Salinity (ppt)	Surface:	26.6 (25.8-27.7)	24.8 (21.5-26.9)	27.2 (26.7-28.0)	26.9 (26.8-27.2)	28.3 (28.2-28.4)	23.3 (22.8-23.7)	27.4 (26.4-28.6)
	Bottom:	26.9 (26.2-27.7)	25.7 (25.0-26.9)	27.3 (26.8-28.1)	27.4 (27.0-27.8)	28.5 (28.3-28.9)	24.9 (24.6-25.1)	27.4 (26.4-28.6)
Secchi (cm)		104.3 (76.0-152.0)	126.0 (95.0-143.0)	24.0 (23.0-25.0)	67.0 (58.0-72.0)	49.7 (44.0-59.0)	61.7 (52.0-67.0)	77.0 (71.0-83.0)
				Saint Martins River (Sites: T004 and T005)				
Temp (°C)	Surface:	20.9 (19.4-22.4)	23.2 (22.4-24.0)	25.0 (24.5-25.4)	31.0 (30.5-31.4)	29.6 (28.7-30.5)	24.9 (24.1-25.7)	17.8 (17.4-18.2)
	Bottom:	20.5 (19.1-21.8)	23.3 (22.3-24.2)	25.0 (24.5-25.4)	30.8 (30.2-31.4)	27.9 (26.9-28.9)	25.4 (24.5-26.3)	17.4 (16.9-17.8)
DO (mg/L)	Surface:	6.8 (6.1-7.5)	7.6 (7.4-7.8)	5.8 (5.6-6.0)	6.1 (5.7-6.6)	7.3 (7.3-7.4)	6.9 (6.9-7.0)	8.0 (8.0-8.1)
	Bottom:	6.7 (5.9-7.5)	5.0 (3.2-6.9)	4.3 (2.7-5.9)	5.5 (5.3-5.7)	4.1 (4.1-4.2)	4.6 (3.0-6.2)	7.7 (7.6-7.8)
Salinity (ppt)	Surface:	25.3 (23.6-26.9)	23.3 (20.8-25.8)	24.1 (21.7-26.5)	26.7 (25.3-28.0)	24.1 (21.6-26.6)	16.7 (11.7-21.6)	26.6 (25.0-28.2)
	Bottom:	25.7 (24.2-27.1)	23.5 (21.0-25.9)	25.3 (24.0-26.5)	26.6 (25.2-28.0)	26.4 (24.7-28.0)	20.5 (13.0-28.0)	27.0 (25.3-28.7)
Secchi (cm)		113.5 (98.0-129.0)	55.5 (22.0-89.0)	53.5 (45.0-62.0)	38.0 (32.0-44.0)	43.0 (41.0-45.0)	50.3 (49.5-51.0)	87.5 (84.0-91.0)

Table 13 (con't). Coastal Bays Fisheries Investigations 2012 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:	18.5 (16.4-20.5)	22.3 (19.9-24.7)	24.6 (24.6-26.1)	29.5 (27.9-31.0)	25.3 (24.0-26.5)	24.5 (23.0-25.9)	18.1 (18.0-18.2)
	Bottom:	18.0 (15.6-20.4)	19.5 ------[A]	22.2 ------[A]	29.0 (27.3-30.6)	23.5 ------[A]	23.0 ------[A]	17.9 (17.6-18.1)
DO (mg/L)	Surface:	8.4 (8.1-8.8)	8.2 (8.2-8.2)	7.5 (7.4-7.5)	5.9 (5.4-6.5)	7.5 (7.5-7.6)	5.3 (3.7-7.0)	7.9 (7.6-8.2)
	Bottom:	8.3 (8.2-8.5)	8.2 ------[A]	6.9 ------[A]	5.3 (4.7-5.9)	7.2 ------[A]	7.3 ------[A]	7.9 (7.5-8.4)
Salinity (ppt)	Surface:	26.7 (25.1-28.2)	24.3 (20.4-28.2)	26.5 (24.7-28.3)	27.7 (27.4-28.0)	27.6 (25.7-29.5)	22.0 (14.7-29.6)	29.2 (26.7-31.7)
	Bottom:	26.9 (25.3-28.4)	28.2 ------[A]	28.4 ------[A]	28.2 (27.8-28.5)	29.6 ------[A]	31.0 ------[A]	29.6 (27.4-31.7)
Secchi (cm)		111.5 (91.0-132.0)	92.5 (61.0-124.0)	38 (23.0-53.0)	38.5 (18.0-59.0)	80.5 (62.0-99.0)	72.0 (54.0-90.0)	88.0 (86.0-90.0)
Sinepuxent Bay (Sites: T008, T009, and T010)								
Temp (°C)	Surface:	15.6 (12.4-17.8)	18.4 (17.8-19.1)	26.2 (24.3-28.4)	27.9 (24.7-29.8)	25.5 (21.3-27.8)	23.0 (22.7-23.7)	17.1 (16.2-17.9)
	Bottom:	15.4 (12.3-17.8)	18.5 (17.9-19.0)	26.2 (24.2-28.4)	27.5 (24.7-29.6)	25.4 (21.3-27.8)	23.0 (22.7-23.5)	17.1 (16.1-17.9)
DO (mg/L)	Surface:	8.3 (7.8-8.5)	7.9 (7.7-8.2)	6.6 (6.5-6.7)	5.7 (5.3-6.1)	6.5 (6.1-6.9)	6.1 (5.5-6.7)	7.4 (7.2-7.6)
	Bottom:	8.1 (8.0-8.3)	7.9 (7.6-8.0)	6.5 (6.1-6.8)	5.6 (4.5-6.2)	6.4 (6.1-6.7)	6.0 (5.4-6.7)	7.7 (7.6-7.8)
Salinity (ppt)	Surface:	28.2 (27.5-29.2)	28.7 (28.5-28.9)	28.6 (28.4-28.8)	30.2 (29.9-30.4)	29.9 (29.8-30.1)	27.5 (24.9-29.2)	30.5 (28.5-31.8)
	Bottom:	28.3 (27.5-29.2)	28.7 (28.5-28.9)	28.5 (28.4-28.7)	30.1 (29.9-30.2)	29.9 (29.8-30.1)	27.5 (25.0-29.2)	30.6 (28.6-31.8)
Secchi (cm)		94.0 (84.0-109.0)	112.3 (87.0-134.0)	77.3 (66.0-86.0)	69.3 (61.0-76.0)	75.3 (68.0-88.0)	64.8 (46.0-84.0)	80.0 (70.0-88.0)

Table 13 (con't). Coastal Bays Fisheries Investigations 2012 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:	16.2	20.6	25.7	31.2	27.6	23.4	17.5
		(16.1-16.2)	(20.5-20.7)	(24.6-26.7)	(30.6-31.7)	(27.5-27.6)	(23.1-23.7)	(16.9-18.0)
	Bottom:	16.3	19.4	25.7	30.6	27.5	23.4	17.2
		(16.1-16.5)	-----[B]	(24.6-26.7)	(30.5-30.6)	(27.4-27.5)	(23.2-23.6)	(16.7-17.7)
DO (mg/L)	Surface:	7.4	7.6	6.6	6.1	7.3	6.7	8.2
		(7.4-7.5)	(7.1-8.2)	(5.8-7.3)	(6.1-6.1)	(6.8-7.9)	(6.5-6.8)	(8.2-8.2)
	Bottom:	7.3	6.2	6.6	5.7	7.1	6.7	7.4
		(7.0-7.6	-----[B]	(5.8-7.4)	(5.3-6.1)	(6.5-7.7)	(6.5-6.9)	(6.7-8.1)
Salinity (ppt)	Surface:	24.5	24.4	25.7	28.5	28.7	18.6	25.1
		(22.6-26.3)	(20.5-28.2)	(22.7-28.7)	(27.7-29.2)	(28.1-29.3)	(16.0-21.2)	(24.1-26.1)
	Bottom:	24.8	28.2	26.1	28.4	28.7	18.6	25.8
		(23.3-26.3)	-----[B]	(23.7-28.5)	(27.6-29.2)	(28.1-29.3)	(17.3-21.2)	(24.8-26.7)
Secchi (cm)		129.0	82.0	40.0	40.5	57.0	45.0	92.5
		(75.0-183.0)	(60.0-104.0)	(35.0-45.0)	(34.0-47.0)	(45.0-69.0)	(45.0-45.0)	(80.0-105.0)
Chincoteague Bay (Sites: T013, T014, T015, T016, T017, T018, T019 and T020)								
Temp (°C)	Surface:	16.4	22.4	25.4	29.9	27.8	23.1	16.5
		(15.6-17.1)	(19.9-23.8)	(21.5-28.6)	(28.9-31.1)	(27.1-28.5)	(22.4-24.3)	(16.0-17.3)
	Bottom:	16.2	22.0[C]	24.1[C]	29.3[C]	27.3[C]	22.9	16.1[C]
		(15.6-16.7)	(19.7-23.3)	(21.5-26.9)	(28.8-29.9)	(27.0-27.8)	(21.9-23.6)	(14.9-16.5)
DO (mg/L)	Surface:	7.4	7.1	6.7	5.9	7.4	6.2	7.7
		(7.1-7.8)	(6.2-8.2)	(6.0-7.5)	(5.3-6.6)	(6.0-9.5)	(4.6-7.6)	(7.1-8.1)
	Bottom:	7.4	6.3[C]	6.7[C]	5.6[C]	6.9[C]	5.5	7.1[C]
		(7.2-8.1)	(2.6-7.8)	(5.4-7.2)	(4.7-6.1)	(4.8-8.9)	(3.9-6.4)	(5.6-7.8)
Salinity (ppt)	Surface:	28.0	26.7	28.7	30.6	31.0	27.1	28.8
		(27.1-28.8)	(25.9-27.6)	(28.0-30.1)	(29.1-32.1)	(29.9-32.8)	(25.0-30.6)	(26.8-31.5)
	Bottom:	28.0	26.9[C]	28.9[C]	30.5[C]	31.1[C]	27.3	28.6[C]
		(27.1-28.7)	(26.1-27.9)	(28.1-30.1)	(29.1-32.0)	(30.1-32.8)	(25.1-30.6)	(27.0-31.5)
Secchi (cm)		98.8	84.5	67.6	67.5	66.9	85.9	101.9
		(29.0-133.0)	(64.0-134.0)	(22.0-143.0)	(52.0-109.0)	(48.0-82.0)	(40.0-256.0)	(66.0-189.0)

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 T012 for bottom water quality to be taken. Surface and bottom measurements were recorded from T011.
C-Conditions too shallow at site T019 for bottom water quality to be taken. Surface and bottom measurements were recorded from seven sites.

Table 14. Coastal Bays Fisheries Investigations 2012 surface water quality data collected during beach seine sampling. Mean values are reported with the range in parentheses.

Parameter		June	September
		Assawoman Bay (Sites: S001, S002, and S003)	
Temp (°C)	Surface:	23.2 (22.5-24.1)	23.7 (23.5-23.9)
DO (mg/L)	Surface:	7.6 (7.3-8.1)	7.1 (6.5-7.4)
Salinity (ppt)	Surface:	27.3 (26.7-27.6)	23.6 (23.1-23.9)
Secchi (cm)		59.0 (51.0-67.0)	56.3 (47.0-68.0)
		Saint Martins River (Site: S006)	
Temp (°C)	Surface:	25.2	25.5
DO (mg/L)	Surface:	6.7	6.7
Salinity (ppt)	Surface:	26.5	22.5
Secchi (cm)		52.0	24.0
		Isle of Wight Bay (Sites: S004, S005, and S007)	
Temp (°C)	Surface:	23.6 (22.2-25.1)	23.6 (23.5-23.7)
DO (mg/L)	Surface:	7.0 (6.8-7.3)	7.0 (6.5-7.8)
Salinity (ppt)	Surface:	28.2 (27.5-28.5)	25.4 (23.7-27.3)
Secchi (cm)		67.7 (32.0-96.0)	53.7 (53.0-54.0)
		Sinepuxent Bay (Sites: S008, S009, and S010)	
Temp (°C)	Surface:	26.9 (24.6-29.3)	22.6 (22.2-23.4)
DO (mg/L)	Surface:	7.1 (6.1-8.2)	7.3 (6.2-8.7)
Salinity (ppt)	Surface:	28.8 (28.5-29.1)	28.1 (25.4-30.1)
Secchi (cm)		58.0 (43.0-68.0)	40.3 (32.0-46.0)

Table 14 (con't). Coastal Bays Fisheries Investigations 2012 surface water quality data collected during beach seine sampling. Mean values are reported with the range in parentheses.

Parameter	Location	June	September
		Newport Bay (Sites: S011 and S012)	
Temp (°C)	Surface:	25.1 (24.4-25.8)	23.6 (23.3-23.8)
DO (mg/L)	Surface:	7.0 (5.0-9.0)	6.6 (4.8-8.3)
Salinity (ppt)	Surface:	26.8 (26.4-27.2)	21.9 (20.3-23.5)
Secchi (cm)		44.5 (42.0-47.0)	35.0 (33.0-37.0)
		Chincoteague Bay (Sites: S013, S014, S015, S016, S017, S018, S019)	
Temp (°C)	Surface:	25.2 (21.7-29.2)	23.3 (18.2-27.1)
DO (mg/L)	Surface:	5.9 (2.8-7.6)	6.9 (4.8-8.8)
Salinity (ppt)	Surface:	24.5 (0.4-29.3)	22.8 (0.1-28.9)
Secchi (cm)		56.7 (38.0-77.0)	47.1 (27.0-94.0)

Table 15. Maryland's Coastal Bays Pilot SAV Habitat Survey 2012 sampled sites by month.

	May	June	July	August	September
Northern Bays (Assawoman Bay, Isle of Wight Bay)	V008, V011 V050, V052	V008, V052 V053, V054	V008, V050 V052, V058	V011, V052 V054, V058	V008, V049 V053, V054
Sinepuxent Bay West	V150, V168 V171, V295	V186, V210 V218, V228	V140, V195 V211, V092	V175, V190 V267, V275	V196, V219 V275, V287
Sinepuxent Bay East	V231, V240 V245, V285	V105, V148 V247, V276	V193, V238 V245, V253	V115, V193 V239, V299	V194, V212 V230 V245
Chincoteague Bay	V401, V409 V543, V685	V371, V418 V438, V566	V354, V439 V454, V586	V322, V359 V395, V396	V685, V706 V715, V717

Table 16. List of fishes collected in Maryland's Coastal Bays Pilot SAV Habitat Survey from May through September, 2012. Species are listed by order of total abundance in CBFI Pilot SAV Habitat Survey. Total SAV beach seine sites = 80. Corresponding species encountered in the CBFI Trawl (BTRW) and Beach Seine (BCHS) Surveys are also included. Species not encountered in the Pilot SAV Habitat Survey are not included.

Common Name	**Scientific Name**	**Number Collected SAV BCHS**	**% of Total Catch**	**Number Collected BTRW**	**% of Total Catch**	**Number Collected BCHS**	**% of Total Catch**
Silver Perch	*Bairdiella chrysoura*	286	34.21	668	1.86	469	4.15
Spot	*Leiostomus xanthurus*	273	32.66	22597	62.77	5166	45.76
Bay Anchovy	*Anchoa mitchilli*	79	9.45	10925	30.35	547	4.85
Pinfish	*Lagodon rhomboides*	73	8.73	38	0.11	497	4.40
Atlantic Silverside	*Menidia menidia*	48	5.74	5	0.01	874	7.74
Naked Goby	*Gobiosoma bosc*	16	1.91	57	0.16	14	0.12
Dusky Pipefish	*Syngnathus floridae*	10	1.20	14	0.04	2	0.02
Northern Pipefish	*Syngnathus fuscus*	9	1.08	24	0.07	10	0.09
Oyster Toadfish	*Opsanus tau*	7	0.84	54	0.15	29	0.26
Summer Flounder	*Paralichthys dentatus*	6	0.72	353	0.98	47	0.42
Fourspine Stickleback	*Apeltes quadracus*	5	0.60	6	0.02	6	0.05
Rainwater Killifish	*Lucania parva*	4	0.48	13	0.04	10	0.09
Bluefish	*Pomatomus saltatrix*	3	0.36	5	0.01	28	0.25
Lined Seahorse	*Hippocampus erectus*	3	0.36	21	0.06		
Striped Blenny	*Chasmodes bosquianus*	3	0.36	1	0.00	6	0.05
American Eel	*Anguilla rostrata*	2	0.24	17	0.05	9	0.08
Atlantic Croaker	*Micropogonias undulatus*	2	0.24	218	0.61	1	0.01
Striped Burrfish	*Chilomycterus schoepfii*	2	0.24	11	0.03	5	0.04
Atlantic Menhaden	*Brevoortia tyrannus*	1	0.12	124	0.34	2062	18.27
Black Sea Bass	*Centropristis striata*	1	0.12	92	0.26	33	0.29
Mummichog	*Fundulus heteroclitus*	1	0.12	157	0.44	163	1.44
Northern Sennet	*Sphyraena borealis*	1	0.12			2	0.02
Spotfin Mojarra	*Eucinostomus argenteus*	1	0.12	3	0.01	122	1.08
	Total Finfish	836	100	35403	98.34	10102	89.49

Table 17. Catch Per Unit Effort (CPUE) data for species encountered in CBFI Pilot SAV Habitat Survey (BCHS50), Beach Seine (BCHS), and Trawl (BTRW) Surveys. Species are listed by order of total abundance in CBFI SAV Seine Survey.

Species	Scientific Name	CPUE BCHS50 (#/Hectare)	CPUE BCHS (#/Hectare)	CPUE BTRW (#/Hectare)
Silver Perch	*Bairdiella chrysoura*	89.49	144.62	38.04
Spot	*Leiostomus xanthurus*	85.42	1592.99	1286.94
Bay Anchovy	*Anchoa mitchilli*	24.72	168.67	622.20
Pinfish	*Lagodon rhomboides*	22.84	153.26	2.16
Atlantic Silverside	*Menidia menidia*	15.02	269.51	0.28
Naked Goby	*Gobiosoma bosc*	5.01	4.32	3.25
Dusky Pipefish	*Syngnathus floridae*	3.13	0.62	0.80
Northern Pipefish	*Syngnathus fuscus*	2.82	3.08	1.37
Oyster Toadfish	*Opsanus tau*	2.19	8.94	3.08
Summer Flounder	*Paralichthys dentatus*	1.88	14.49	20.10
Fourspine Stickleback	*Apeltes quadracus*	1.56	1.85	0.34
Rainwater Killifish	*Lucania parva*	1.25	3.08	0.74
Bluefish	*Pomatomus saltatrix*	0.94	8.63	0.28
Lined Seahorse	*Hippocampus erectus*	0.94	0.00	1.20
Striped Blenny	*Chasmodes bosquianus*	0.94	1.85	0.06
American Eel	*Anguilla rostrata*	0.63	2.78	0.97
Atlantic Croaker	*Micropogonias undulatus*	0.63	0.31	12.42
Striped Burrfish	*Chilomycterus schoepfii*	0.63	1.54	0.63
Atlantic Menhaden	*Brevoortia tyrannus*	0.31	635.84	7.06
Black Sea Bass	*Centropristis striata*	0.31	10.18	5.24
Mummichog	*Fundulus heteroclitus*	0.31	50.26	8.94
Northern Sennet	*Sphyraena borealis*	0.31	0.62	
Spotfin Mojarra	*Eucinostomus argenteus*	0.31	37.62	0.17

Table 18. Number of fishes encountered in CBFI Pilot SAV Habitat Survey from May through September, 2012. (* indicates a significant difference, $p<0.0001$).

Month	NB	SE	SW	CB	Total Fish per Month
May	68	110	35	118	331*
June	21	18	42	13	94
July	3	32	30	5	70
August	73	52	82	51	258*
September	8	45	9	23	85
Total Fish per Zone	173	257	198	210	838

Table 19. Average fish per sample encountered in CBFI Pilot SAV Habitat Survey from May through September, 2012. (* indicates a significant difference, $p=0.0019$).

SAV Coverage	Total Samples	Total Fish	Avg. Fish per Sample
Up to 25%	8	18	2.25*
26% - 50%	15	177	11.80
51% - 75%	28	309	11.04
76% - 100%	29	334	11.52

Table 20. Maryland's Coastal Bays Pilot SAV Habitat Survey 2012 surface water quality data. Mean values are reported with the range in parentheses. Mean values are reported with the range in parentheses.

Parameter		May	June	July	August	September
				Northern Bays		
Sites		V008, V011 V050, V052	V008,V052 V053, V054	V008, V050 V052, V058	V011, V052 V054, V058	V008, V049 V053, V054
Temp (°C)	Surface:	19.4 (17.5-21.8)	22.8 (22.6-23.0)	28.4 (28.2-28.6)	27.2 (27.1-27.3)	27.0 (26.8-27.2)
DO (mg/L)	Surface:	7.5 (5.7-8.7)	7.3 (6.9-7.6)	4.9 (4.5-5.5)	5.5 (5.1-5.8)	6.2 (6.0-6.5)
Salinity (ppt)	Surface:	24.7 (24.1-25.1)	28.0 (27.4-28.2)	27.7 (27.1-28.0)	29.5 (29.4-29.6)	27.2 (25.1-28.1)
Secchi (cm)		93.3 (86.0-102.0)	84.8 (72.0-93.0)	75.8 (61.0-84.0)	56.8 (49.0-70.0)	59.8 (52.0-65.0)
				Sinepuxent Bay West		
Sites		V150, V168 V171, V295	V186, V210 V218, V228	V140, V195 V211, V092	V175, V190 V267, V275	V196, V219 V275, V287
Temp (°C)	Surface:	19.1 (18.6-19.6)	21.6 (21.3-21.9)	28.9 (26.8-29.7)	27.5 (27.4-27.8)	27.9 (27.5-28.1)
DO (mg/L)	Surface:	7.1 (6.3-8.4)	8.4 (8.0-9.1)	4.3 (3.7-4.9)	6.1 (4.6-7.5)	6.2 (5.5-6.8)
Salinity (ppt)	Surface:	26.5 (25.0-27.4)	28.8 (28.8-28.9)	29.4 (29.2-29.5)	30.4 (30.3-30.5)	25.5 (25.4-25.6)
Secchi (cm)		94.3 (83.0-102.0)	80.0 (63.0-109.0)	55.5 (43.0-74.0)	59.8 (50.0-72.0)	28.5 (21.0-33.0)
				Sinepuxent Bay East		
Sites		V231, V240 V245, V285	V105, V148 V247, V276	V193, V238 V245, V253	V115, V193 V239, V299	V194, V212 V230, V245
Temp (°C)	Surface:	18.9 (18.5-19.4)	20.9 (19.5-21.7)	30.1 (29.6-30.4)	28.0 (27.4-28.4)	27.8 (27.1-28.1)
DO (mg/L)	Surface:	9.8 (8.8-10.4)	8.1 (7.0-8.6)	5.5 (5.2-5.8)	5.6 (4.2-6.4)	5.9 (5.6-6.2)
Salinity (ppt)	Surface:	29.1 (28.9-29.3)	29.0 (28.7-29.1)	29.7 (29.6-29.8)	31.1 (30.7-31.8)	27.0 (26.3-27.2)
Secchi (cm)		81.8 (67.0-96.0)	106.5 (77.0-126.0)	66.8 (48.0-87.0)	36.0 (31.0-41.0)	25.3 (22.0-29.0)

Table 20 (con't). Maryland's Coastal Bays Pilot SAV Habitat Survey 2012 surface water quality data. Mean values are reported with the range in parentheses. Mean values are reported with the range in parentheses.

Parameter	Location	May	June	July	August	September
				Chincoteague		
Sites		V401, V409 V543, V685	V371, V418 V438, V566	V354, V439 V454, V586	V322, V359 V395, V396	V685, V706 V715, V717
Temp (°C)	Surface:	19.2 (17.7-21.0)	22.6 (22.1-23.6)	30.8 (29.5-31.5)	27.0 (26.4-27.7)	23.1 (19.2-27.4)
DO (mg/L)	Surface:	9.2 (7.6-11.1)	7.9 (6.9-8.4)	6.1 (5.2-7.6)	6.1 (5.4-7.0)	9.0 (6.4-10.9)
Salinity (ppt)	Surface:	27.1 (26.5-27.5)	27.9 (27.6-28.1)	29.7 (29.3-30.3)	31.1 (30.6-31.5)	25.6 (21.7-29.4)
Secchi (cm)		84.0 (63.0-119.0)	57.8 (53.0-66.0)	59.0 (43.0-73.0)	42.3 (38.0-48.0)	48.8 (42.0-56.0)

Table 21. Number of samples grouped by zone and percent SAV coverage in CBFI Pilot SAV Habitat Survey from May through September, 2012.

SAV Coverage	NB	SE	SW	CB	Total
Up to 25%	5	1	2		8
26% - 50%	5	2	4	4	15
51% - 75%	7	7	5	9	28
76% - 100%	3	10	9	7	29
Total	20	20	20	20	80

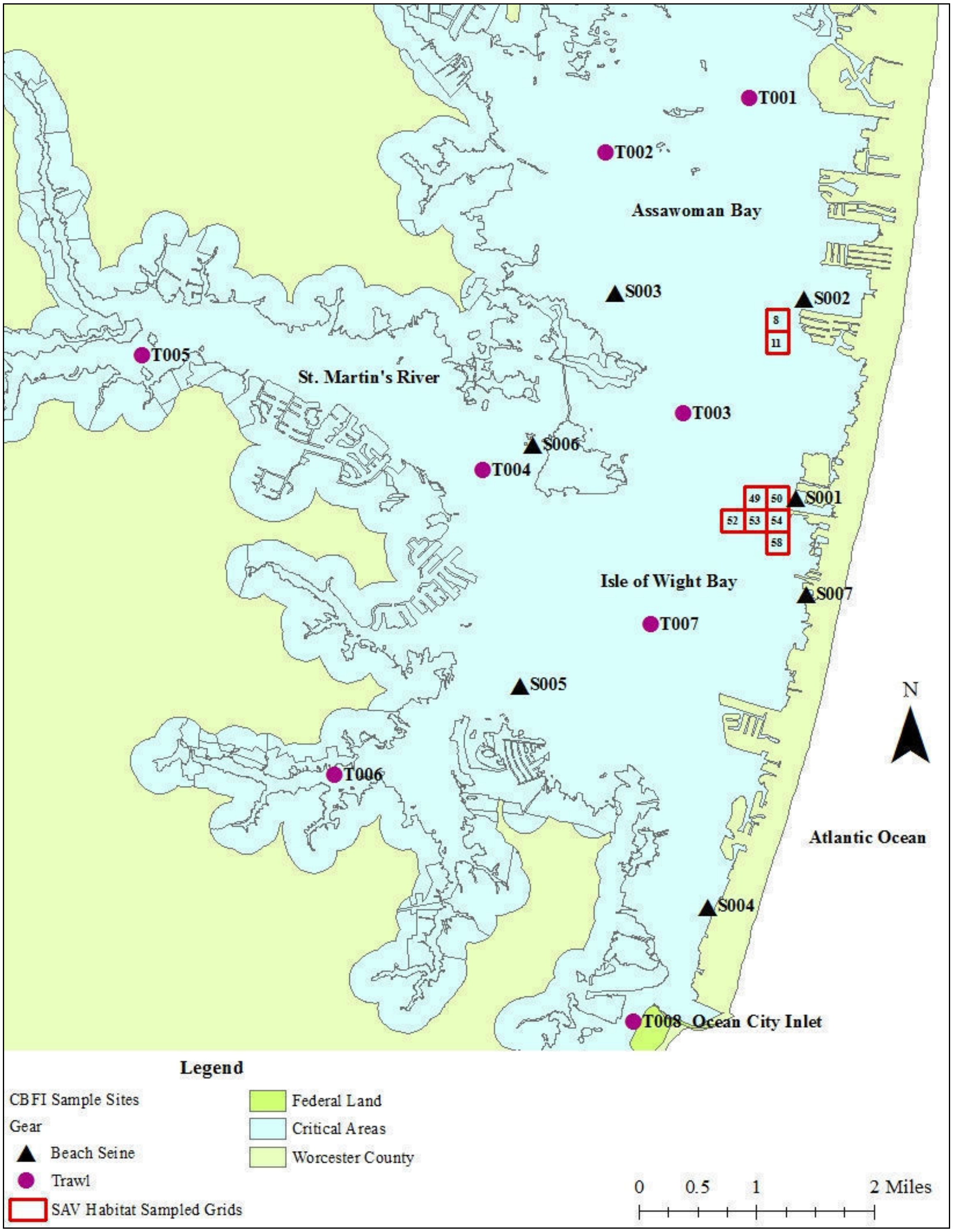


Figure 1. Coastal Bays Fisheries Investigation 2012 sampling locations in the northern Coastal Bays, Maryland.

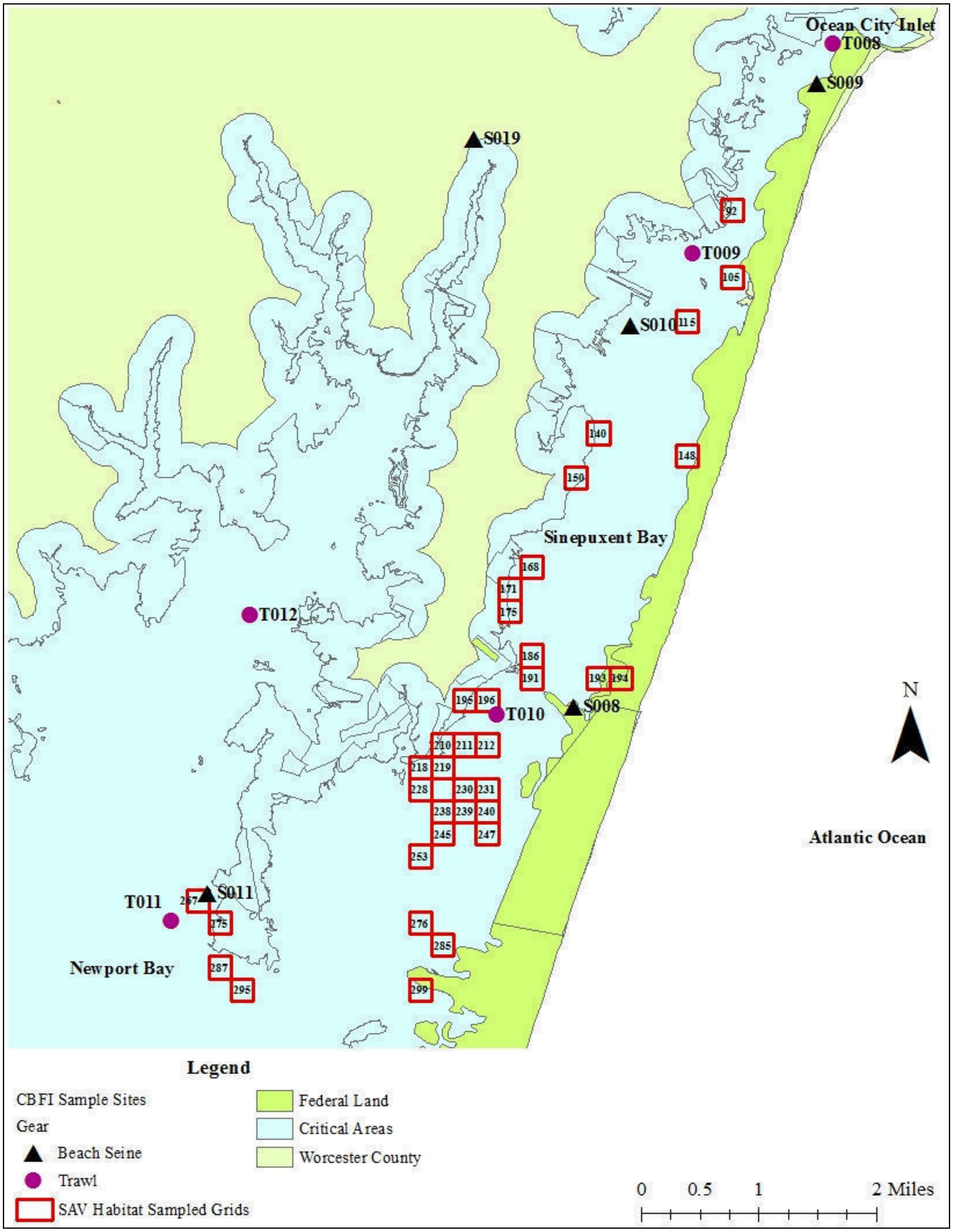


Figure 2. Coastal Bays Fisheries Investigation 2012 sampling locations in Sinepuxent and Newport Bays, Maryland.

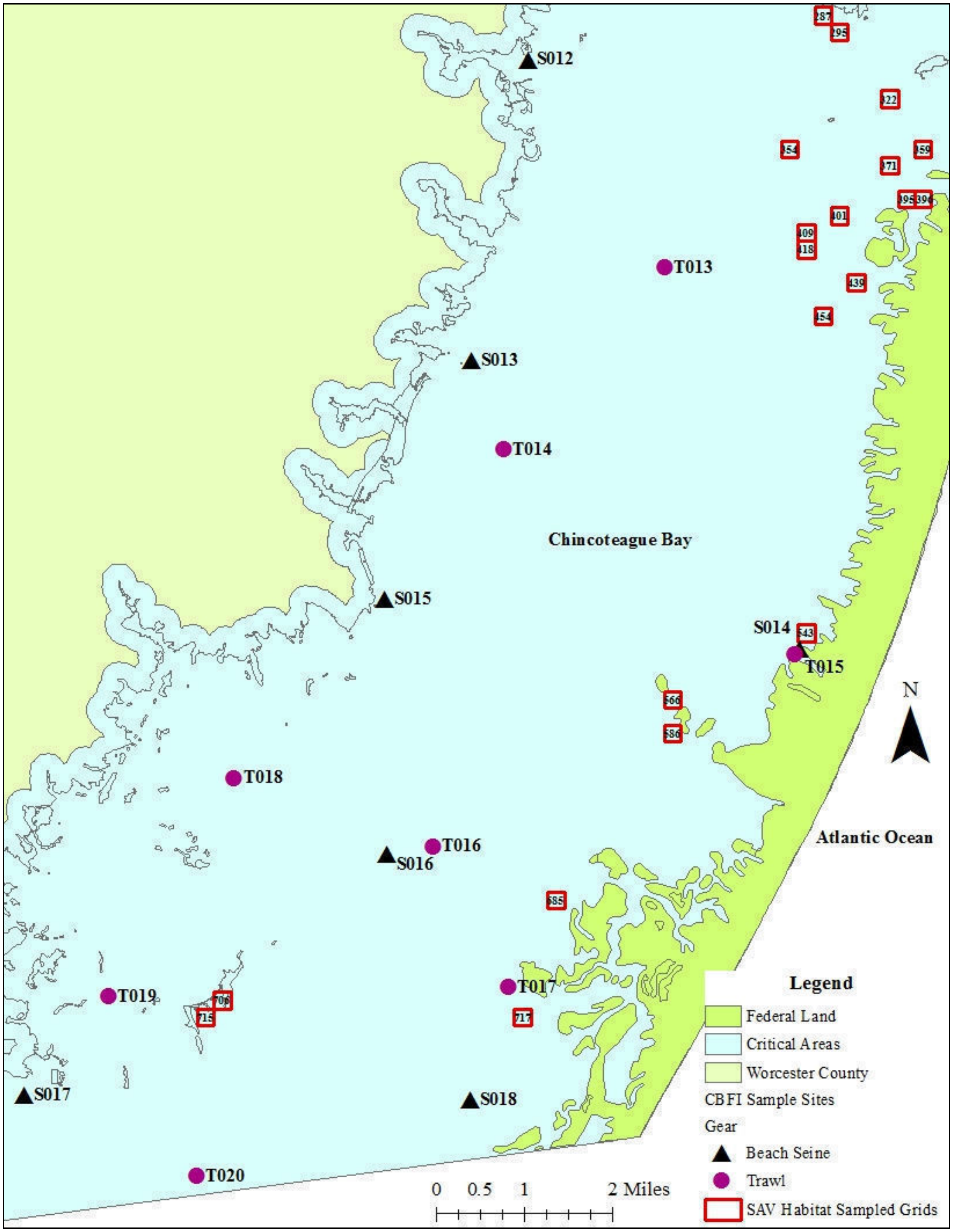


Figure 3. Coastal Bays Fisheries Investigation 2012 sampling locations in Chincoteague Bay, Maryland.

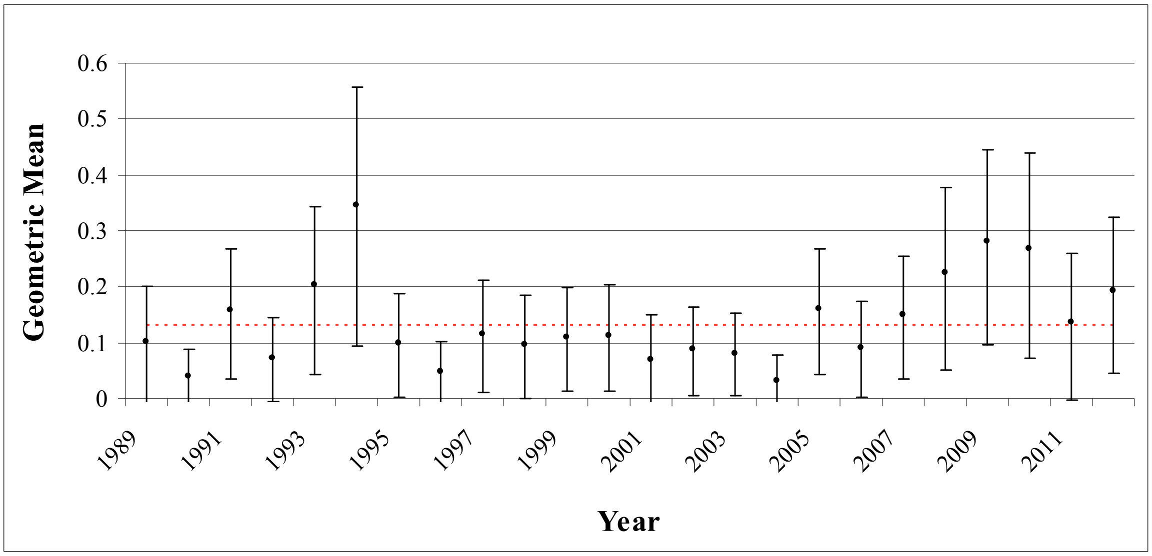


Figure 4. American Eel (*Anguilla rostrata)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

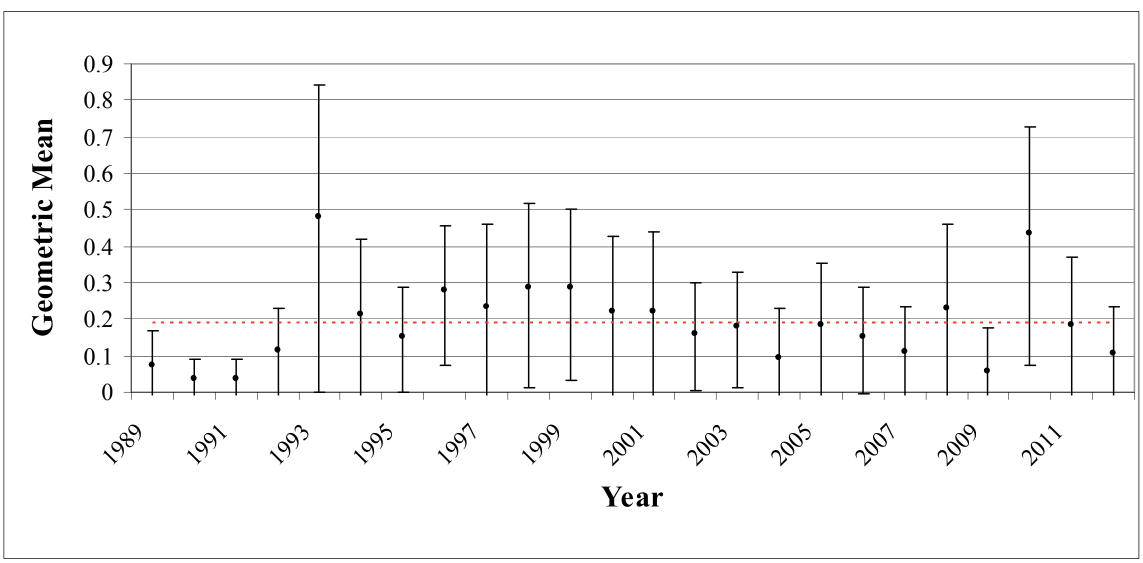


Figure 5. American Eel (*Anguilla rostrata)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

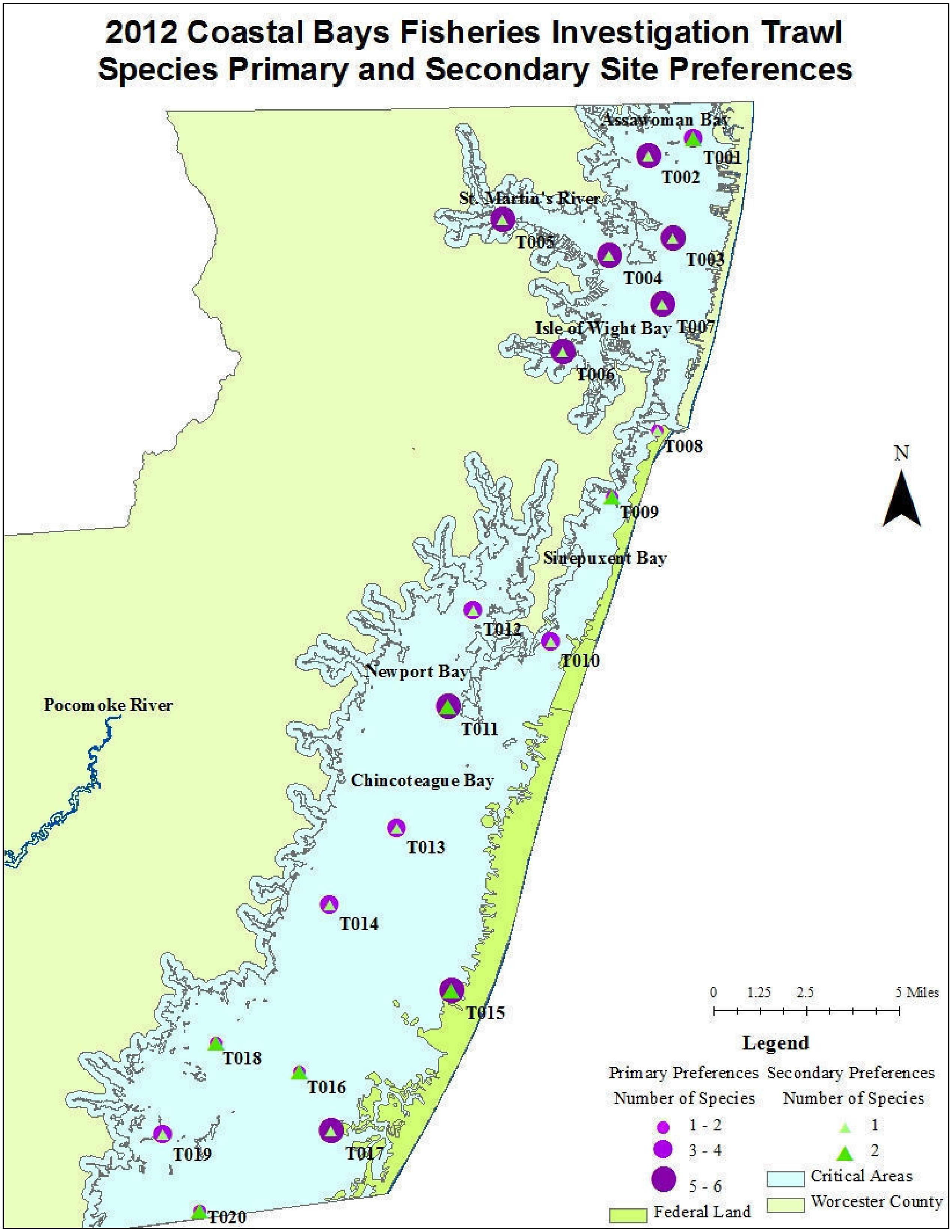


Figure 6. Coastal Bays Fisheries Investigation Trawl primary and secondary site preferences.

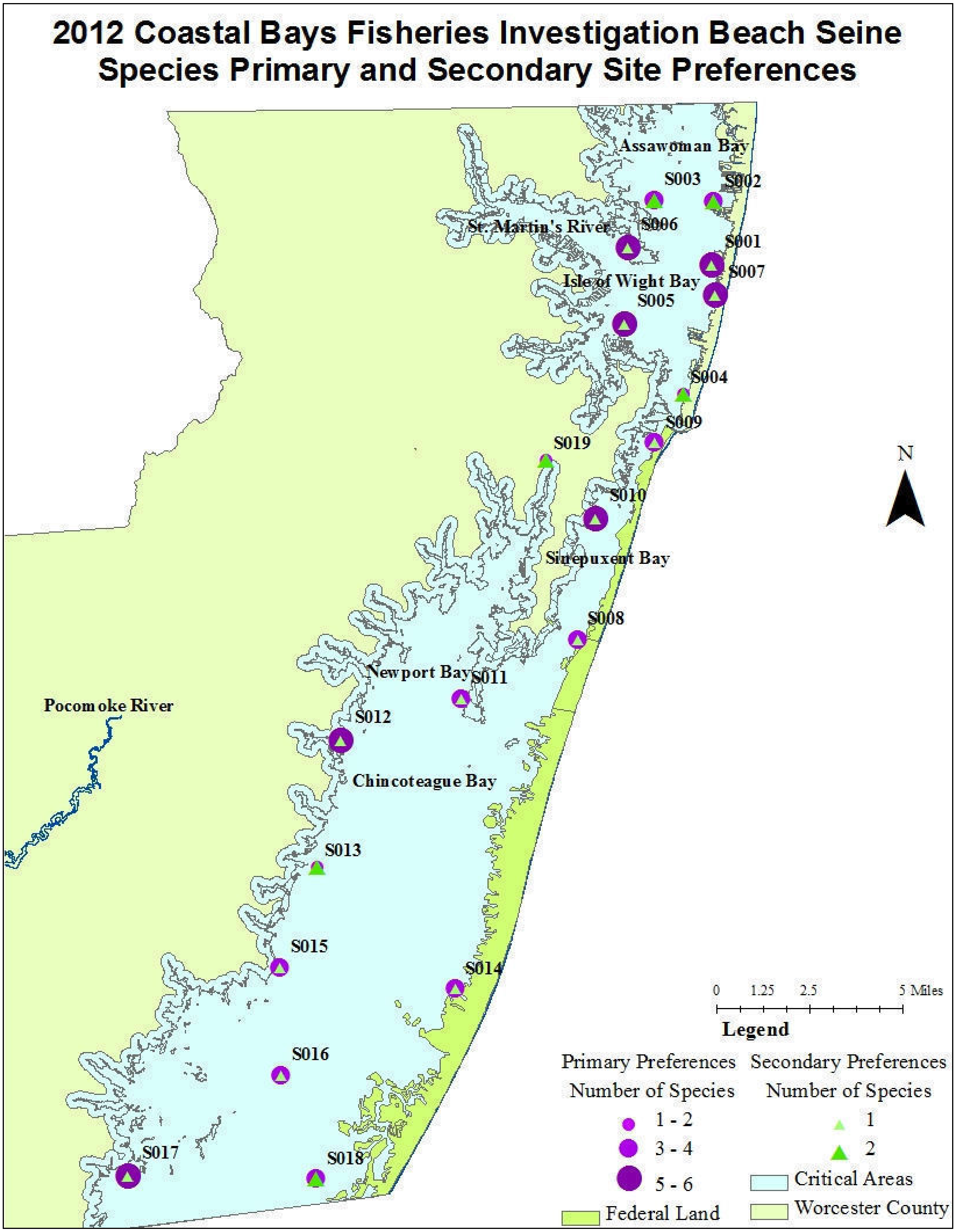


Figure 7. Coastal Bays Fisheries Investigation beach seine primary and secondary site preferences.

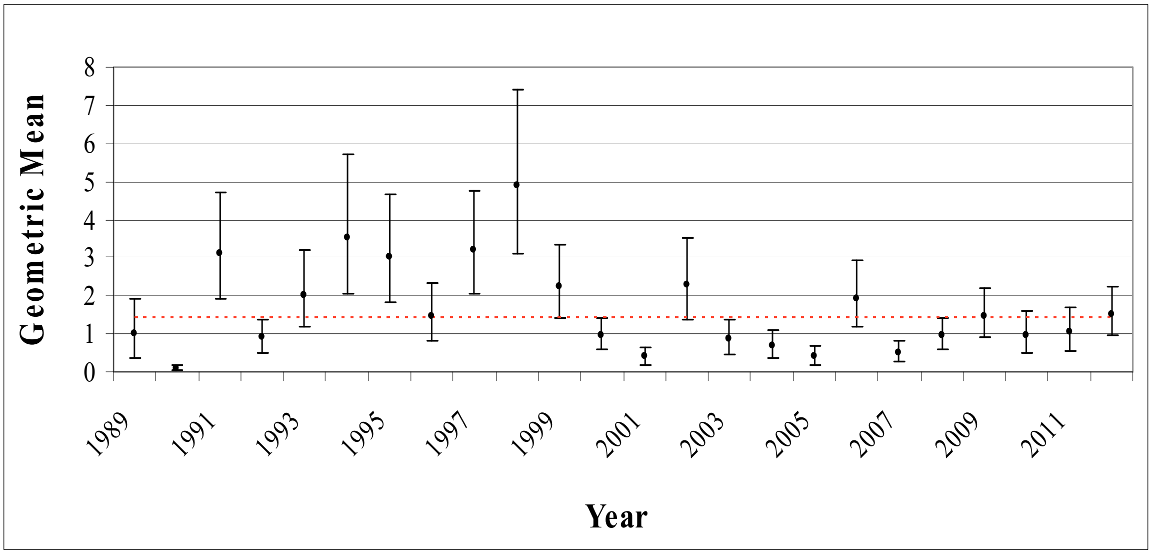


Figure 8. Atlantic Croaker (*Micropogonias undulates*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

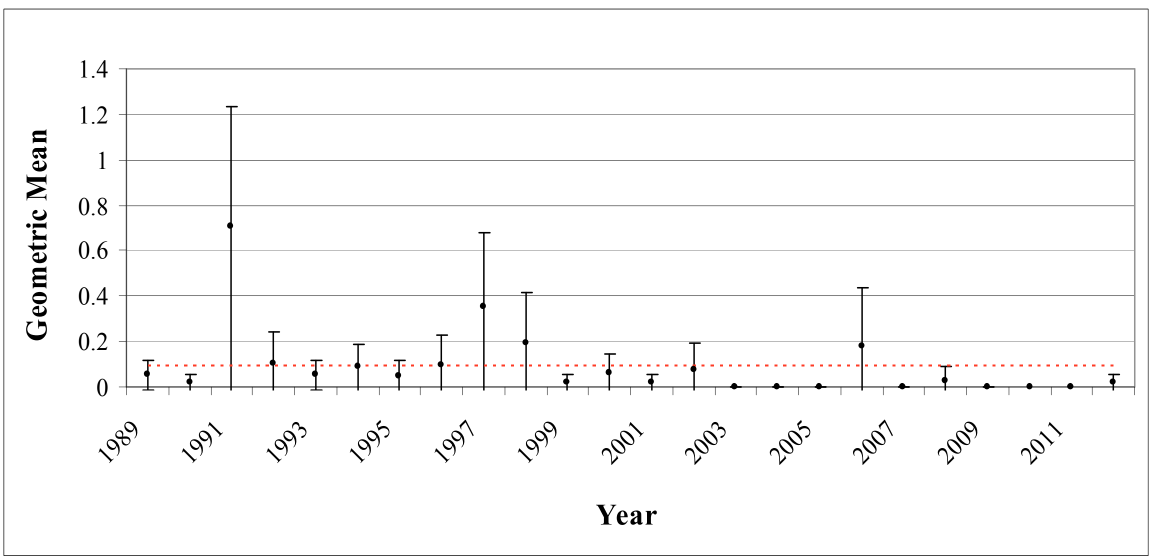


Figure 9. Atlantic Croaker (*Micropogonias undulates*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

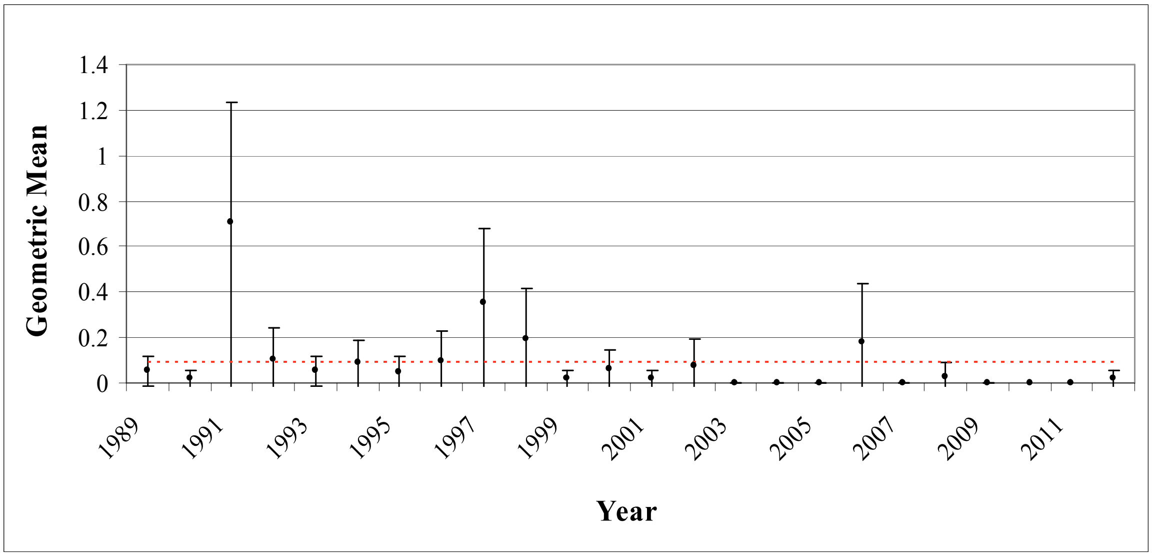


Figure 10. Atlantic Menhaden (*Brevoortia tyrannus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

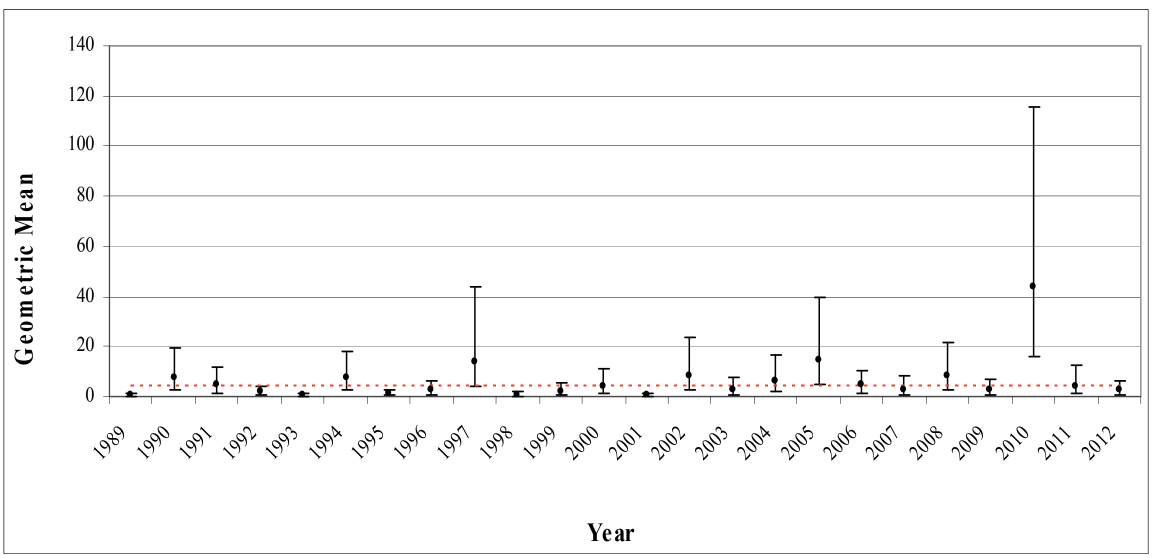


Figure 11. Atlantic Menhaden (*Brevoortia tyrannus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

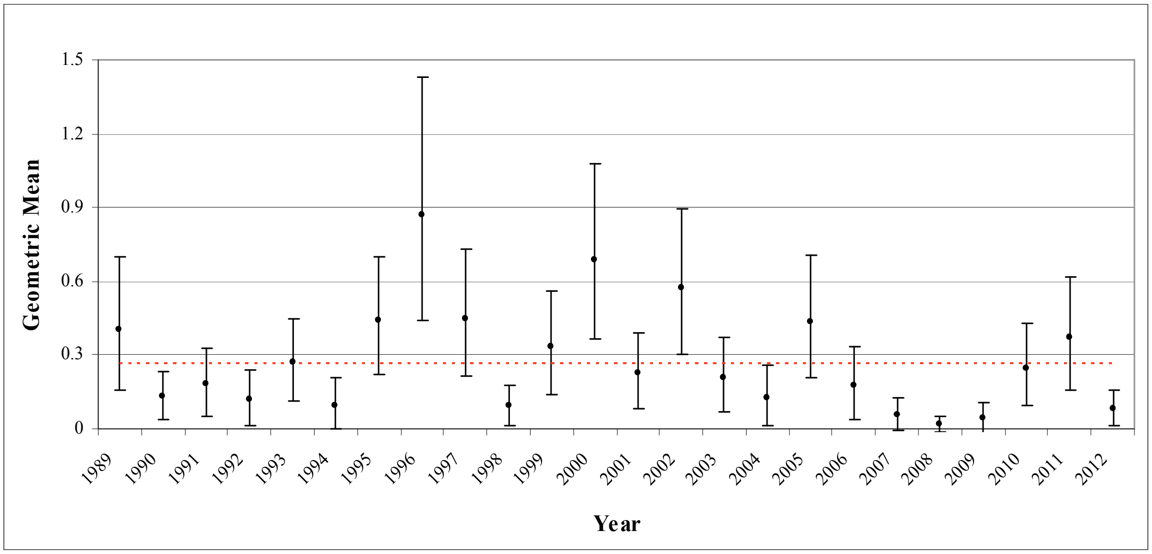


Figure 12. Atlantic Silverside (*Menidia menidia*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

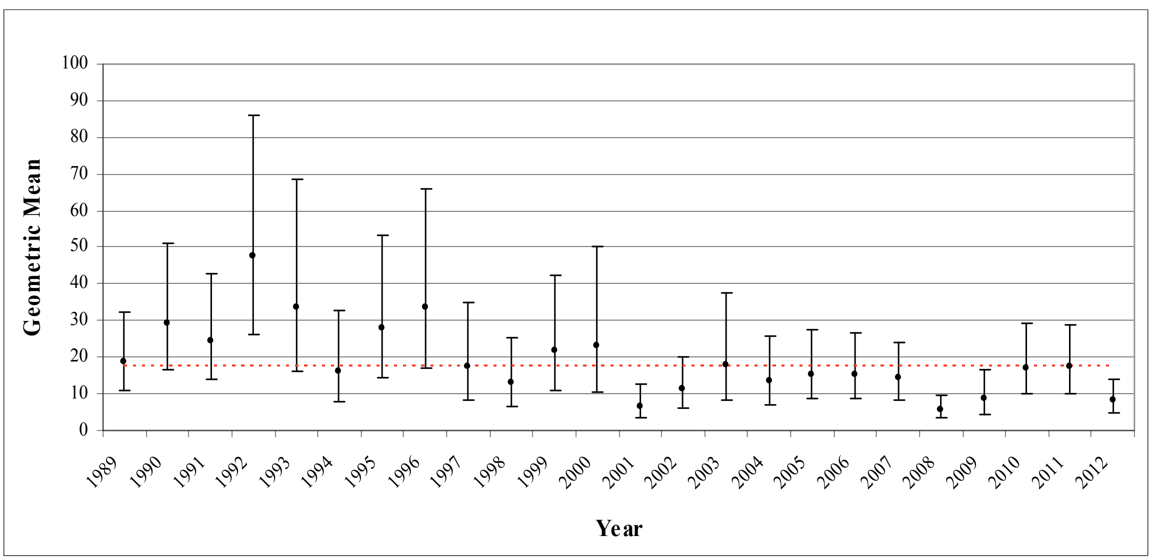


Figure 13. Atlantic Silverside (*Menidia menidia*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

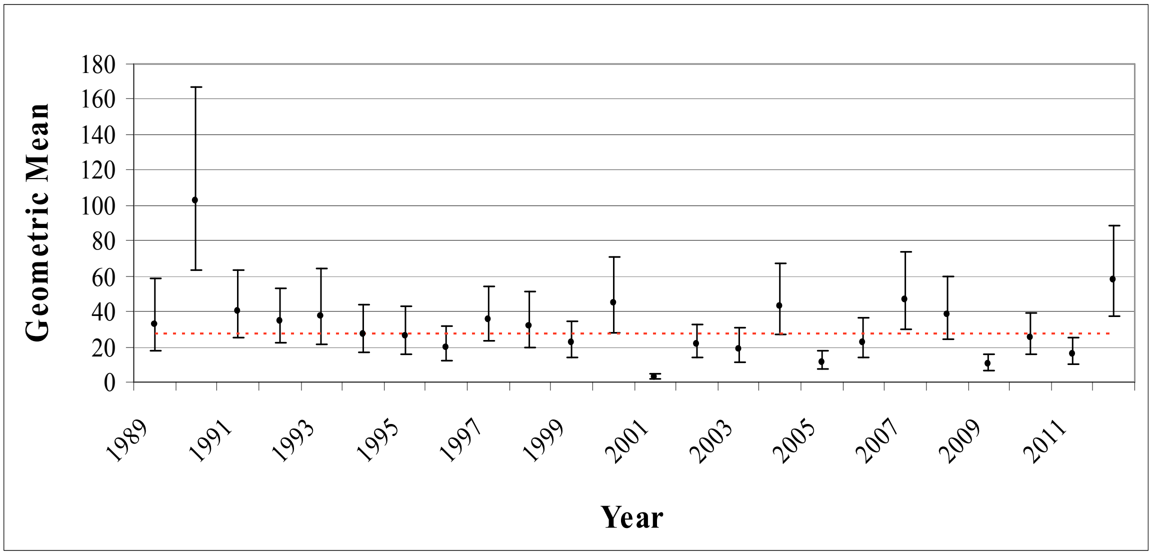


Figure 14. Bay Anchovy (*Anchoa mitchilli*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

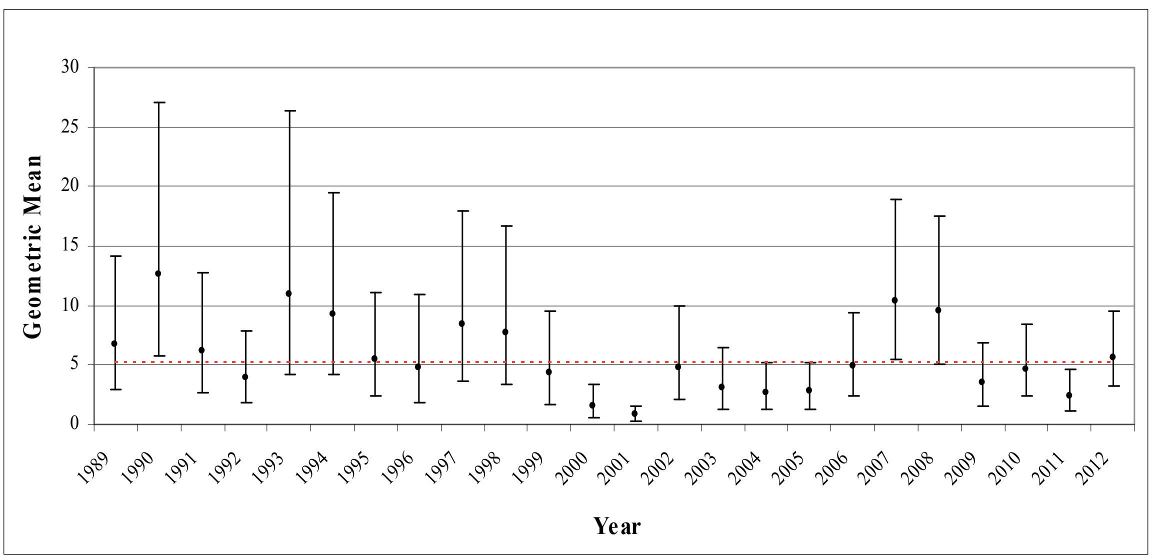


Figure 15. Bay Anchovy (*Anchoa mitchilli*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

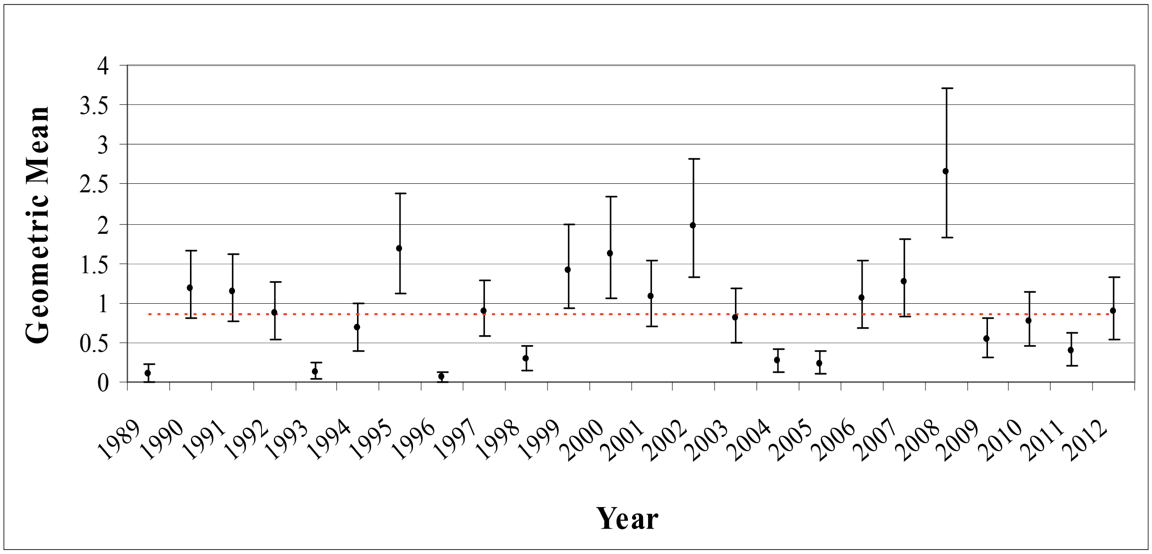


Figure 16. Black Sea Bass (*Centropristis* striata) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

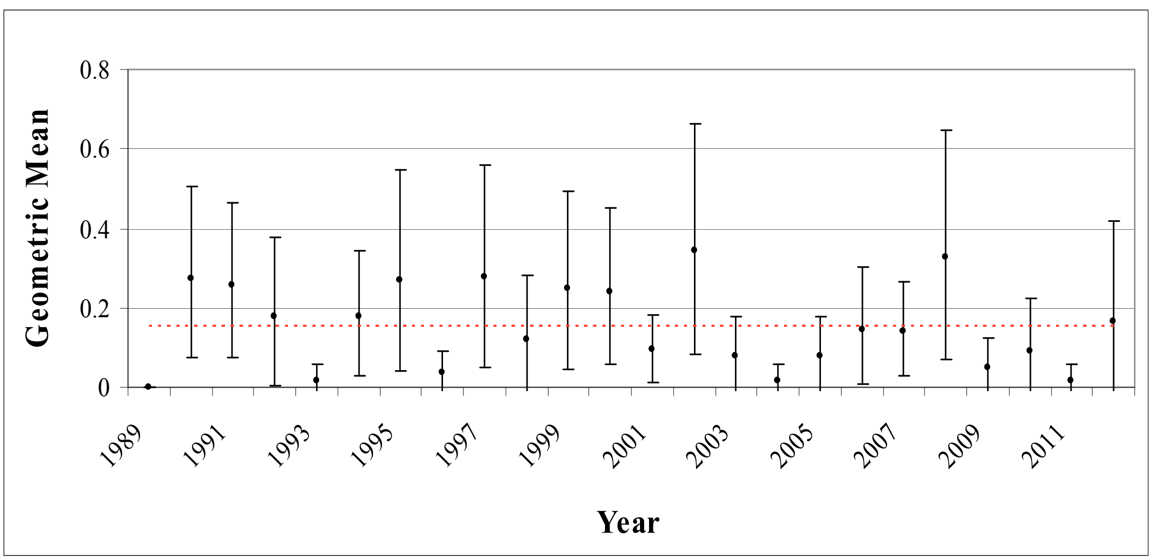


Figure 17. Black Sea Bass (*Centropristis* striata) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

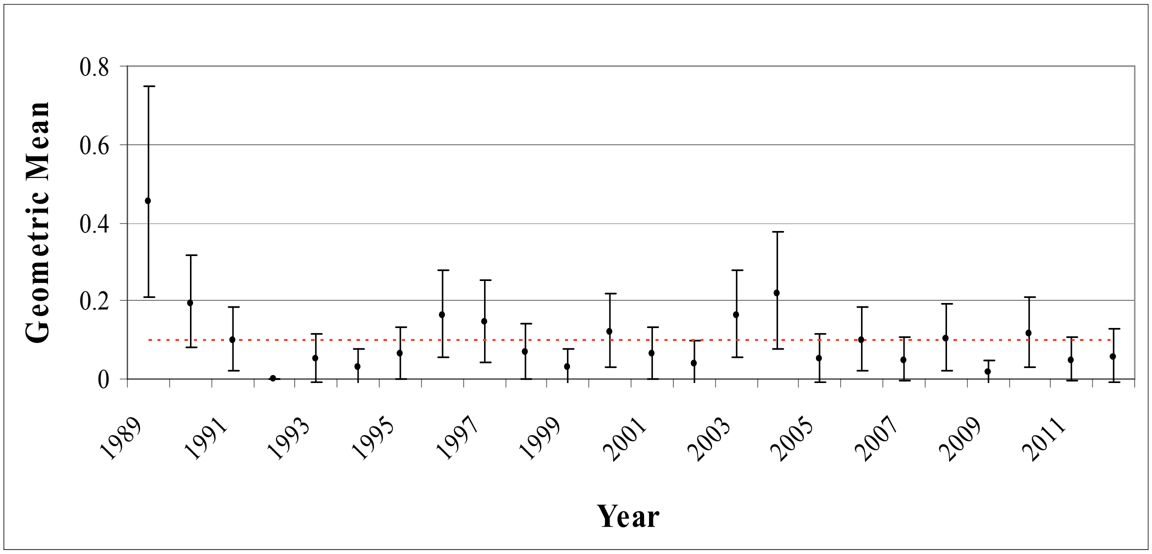


Figure 18. Bluefish (*Pomatomus saltatrix*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

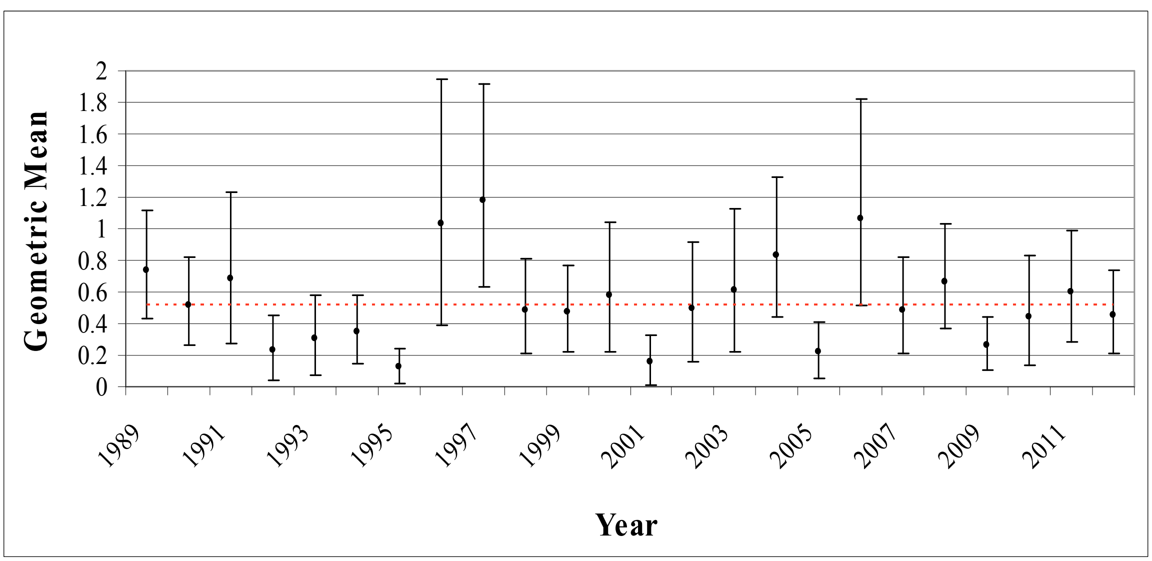


Figure 19. Bluefish (*Pomatomus saltatrix*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

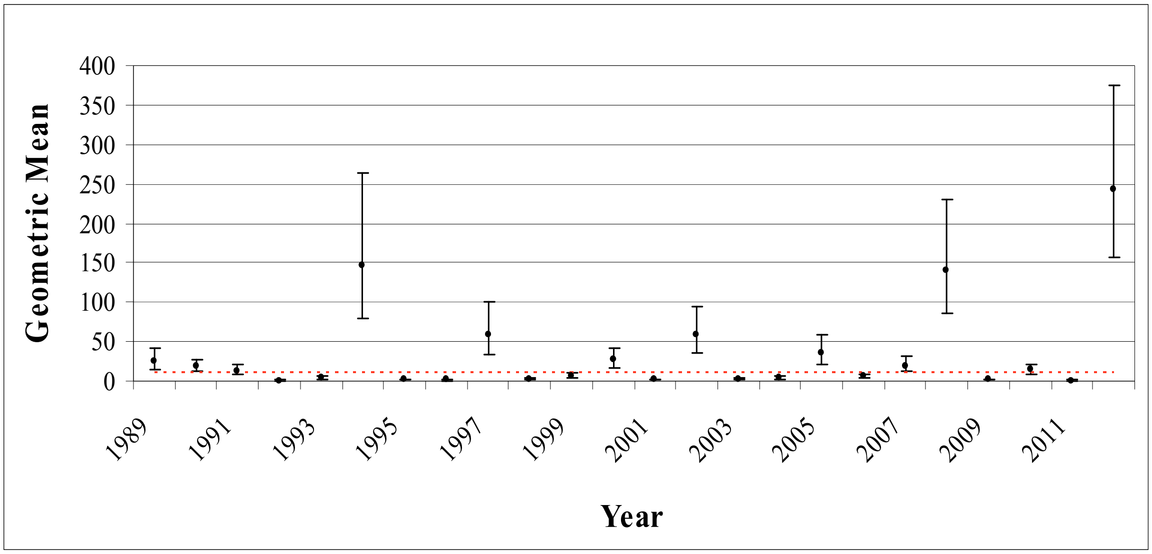


Figure 20. Spot (*Leiostomus xanthurus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

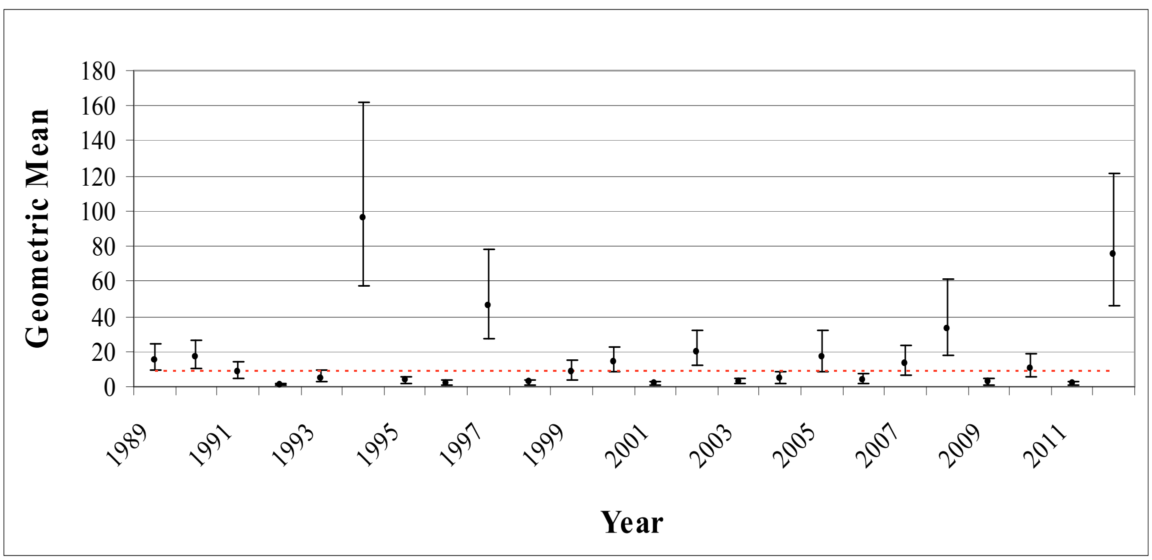


Figure 21. Spot (*Leiostomus xanthurus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

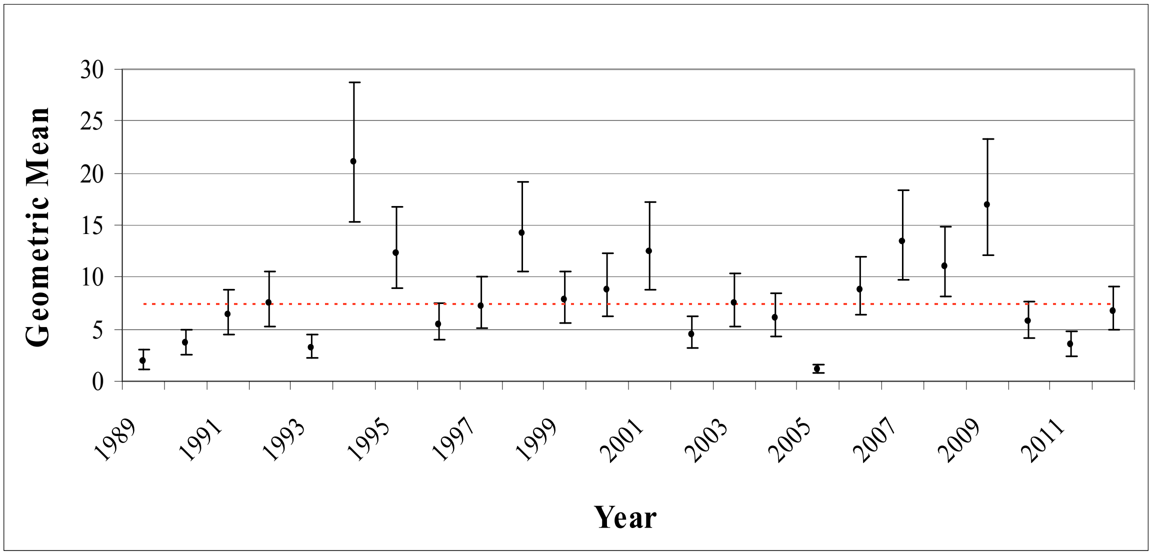


Figure 22. Summer Flounder (*Paralichthys dentatus*) trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

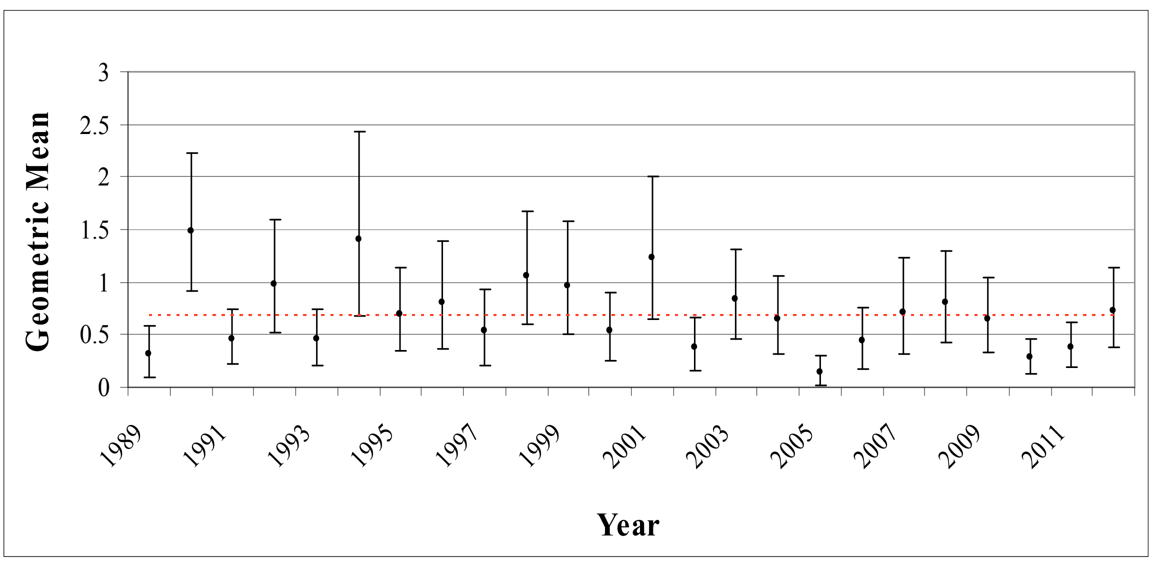


Figure 23. Summer Flounder (*Paralichthys dentatus*) beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

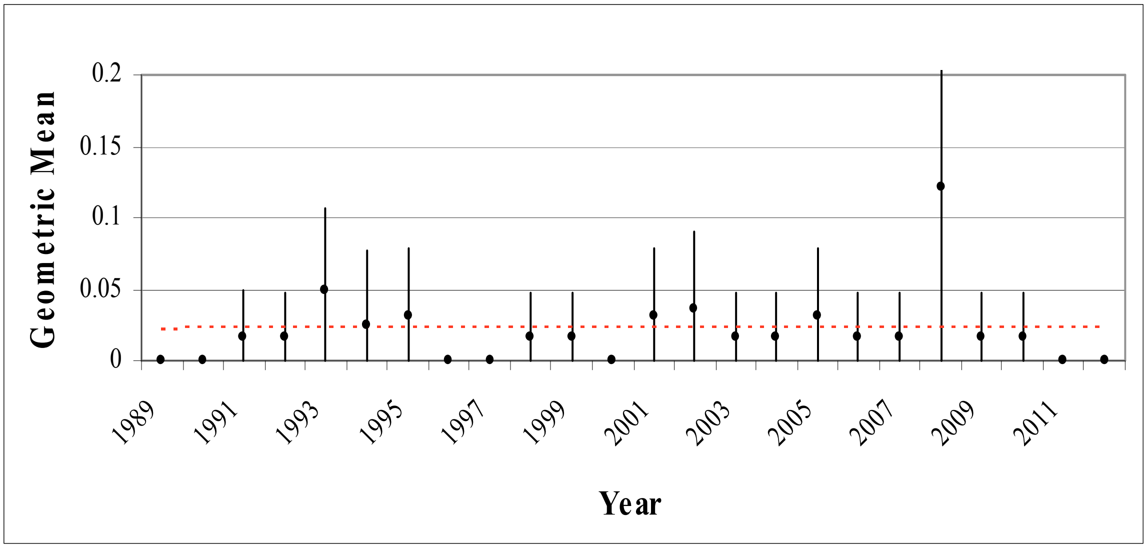


Figure 24. Tautog (*Tautoga onitis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

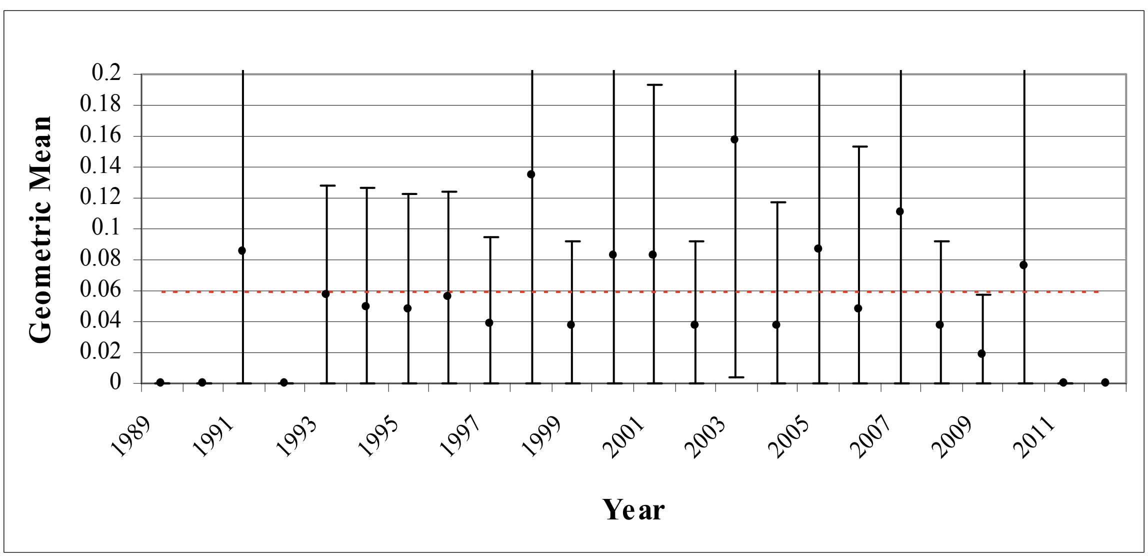


Figure 25. Tautog (*Tautoga onitis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

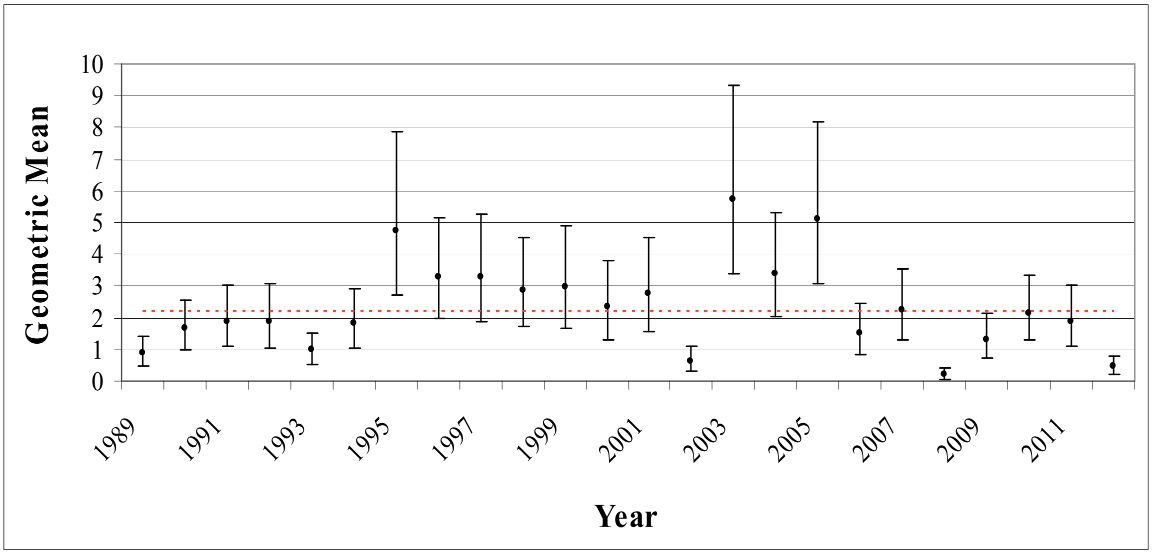


Figure 26. Weakfish (*Cynoscion regalis)* trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

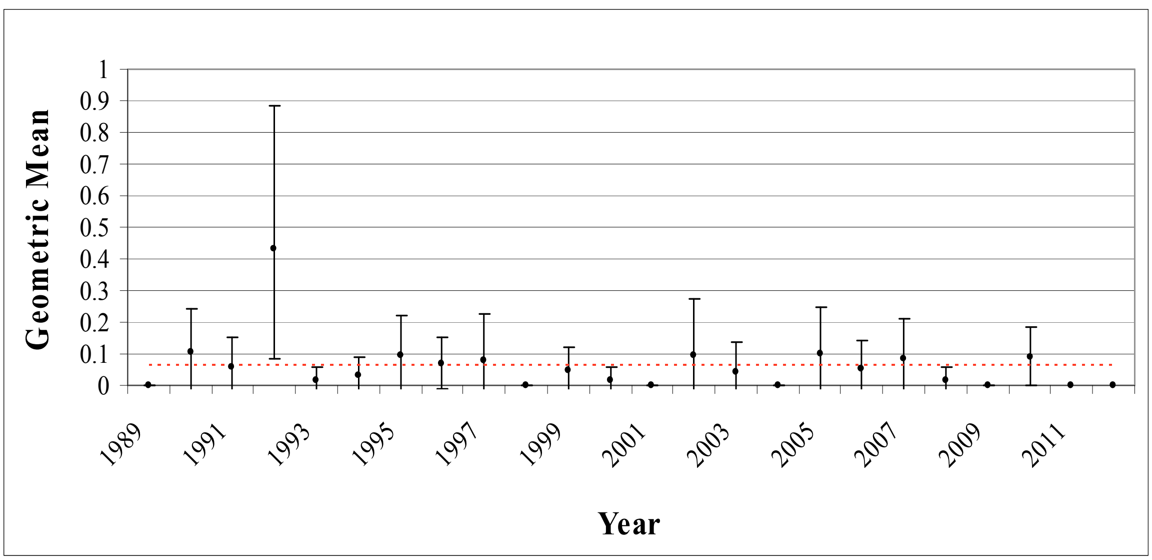


Figure 27. Weakfish (*Cynoscion regalis)* beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2012). Dotted line represents the 1989-2012 time series grand mean. Protocols of the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

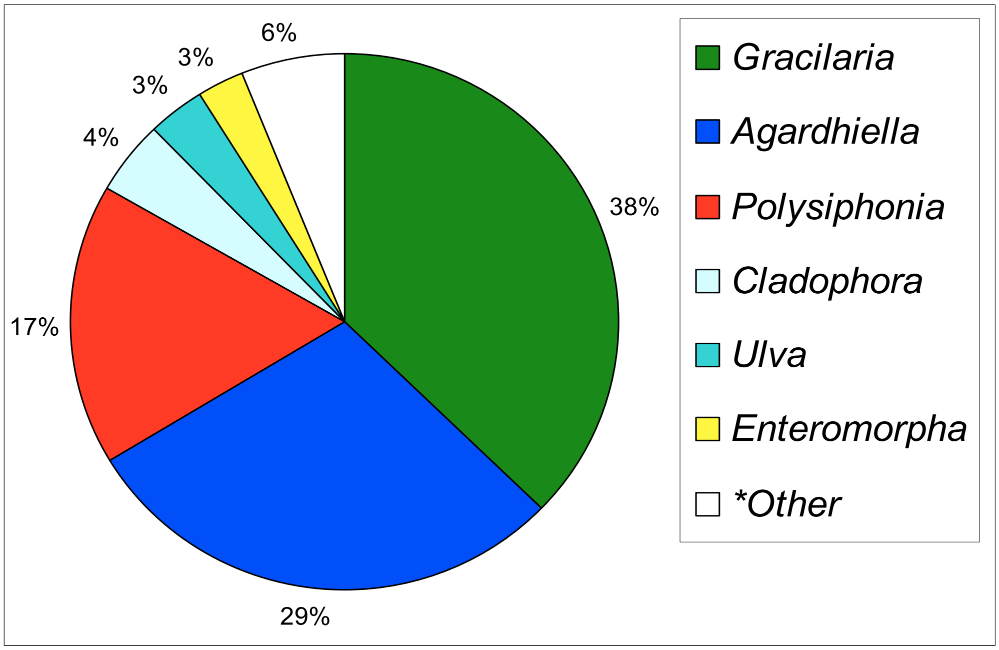


Figure 28. Percentages of total macroalgae biomass collected in 2012 Coastal Bays Fisheries Investigation Trawl Survey. *Other consisted of macroalgae genera that were less than 2% of the total volume: *Desmarestia, Laminaria, Champia, Ceramium, Spyridia, Hypnea, Chaetomorpha, Codium, Vaucheria* and Unknown.

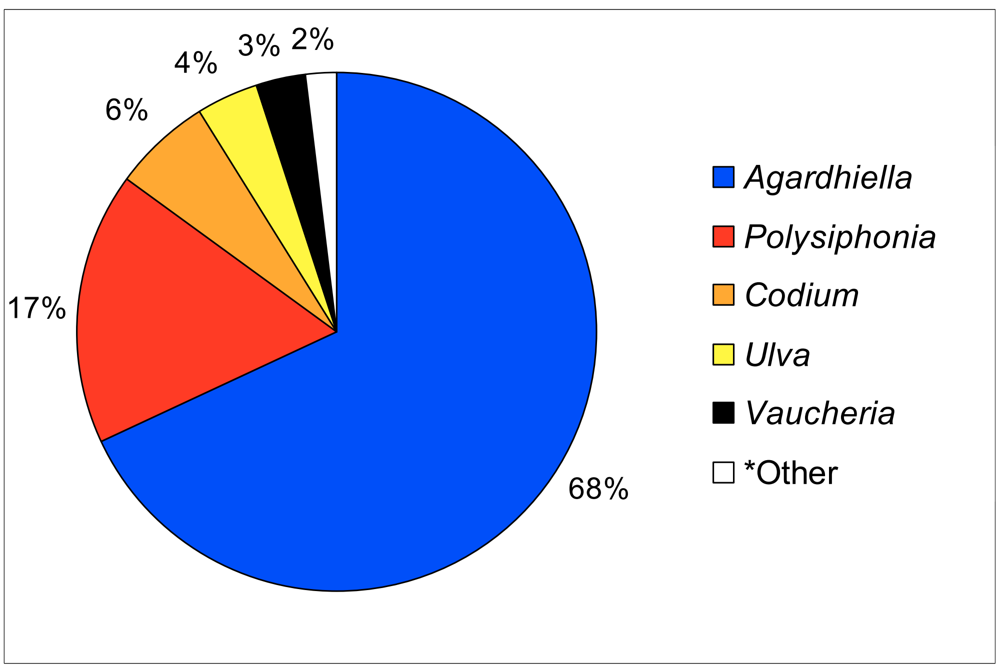


Figure 29. Percentages of total macroalgae biomass collected in 2012 Coastal Bays Fisheries Investigation Beach Seine Survey. *Other consisted of macroalgae that were 2% or less of the total volume: *Desmarestia, Gracilaria, Champia, Ceramium, Spyridia, Ulva, Cladophora, Enteromorpha,* and *Chaetomorpha*.

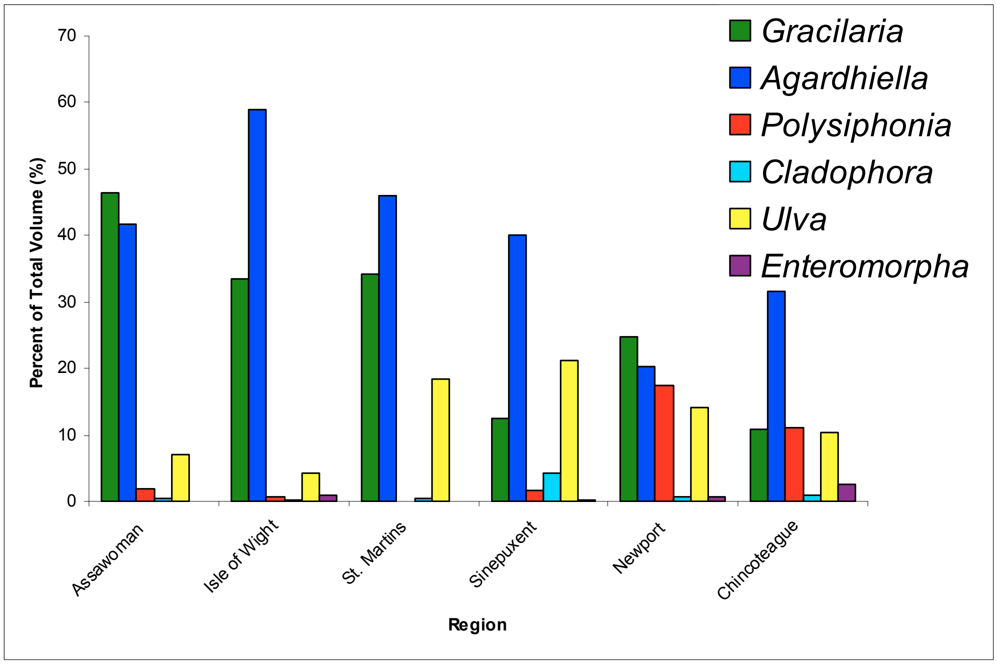


Figure 30. Percent of total volume of each dominant genus (*Gracilaria, Agardhiella, Polysiphonia, Cladophora, Ulva and Enteromorpha*) by region from 2006 – 2012 in the Coastal Bays Fisheries Investigation Trawl Survey. Macroalgae was present in all regions; no graphical representation indicates total volume from that region is less than 0.1%.

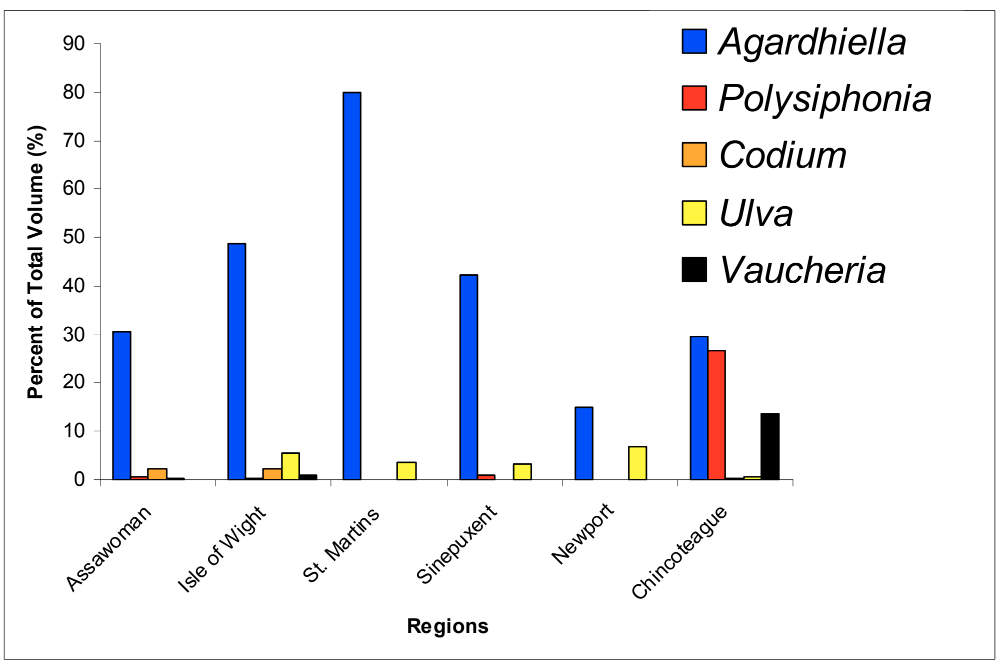


Figure 31. Percent of total volume of each dominant genus (*Agardhiella, Polysiphonia, Codium, Ulva and Vaucheria*) by region from 2006 – 2012 in the Coastal Bays Fisheries Investigation Beach Seine Survey. Macroalgae was not present or less than 1% at sites represented with no bar.

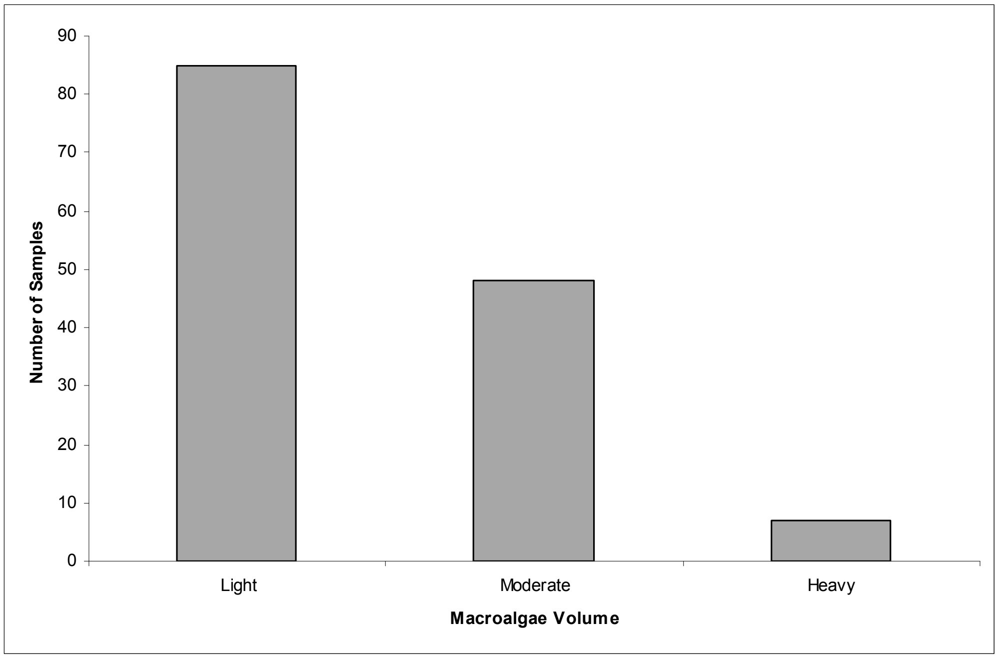


Figure 32. Macroalgae volume (L) categories of all 2012 Coastal Bays Fisheries Investigation Trawl Survey macroalgae samples (n=140).

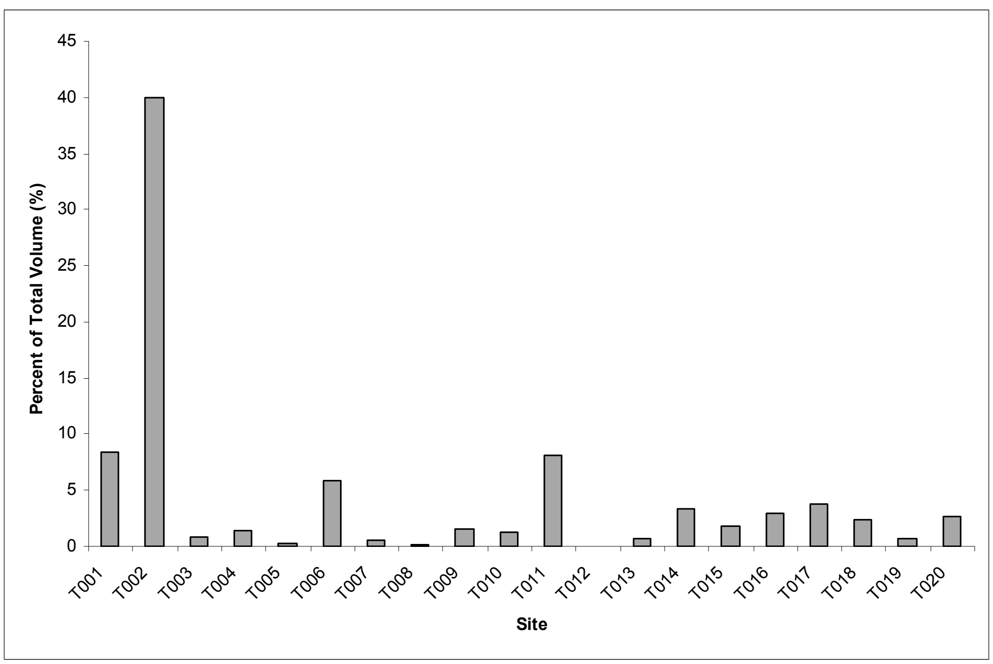


Figure 33. Percent of total volume of macroalgae by site for 2012 in the Coastal Bays Fisheries Investigation Trawl Survey. Macroalgae was present at all sites; no bar indicates total volume less than 0.1%.

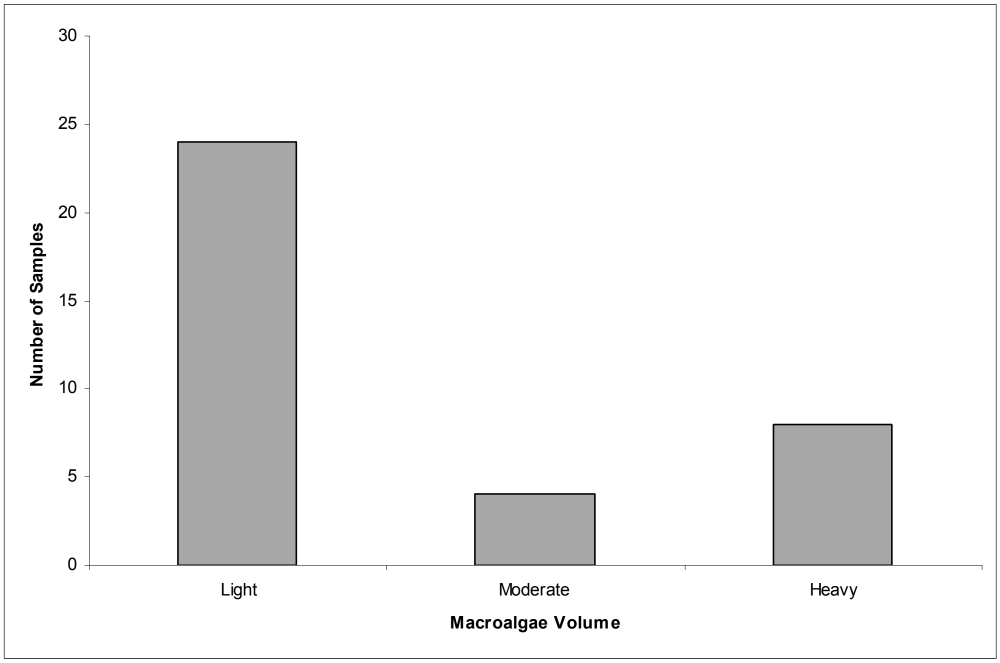


Figure 34. Macroalgae volume (L) categories of all 2012 Coastal Bays Fisheries Investigation Beach Seine Survey macroalgae samples (n=36).

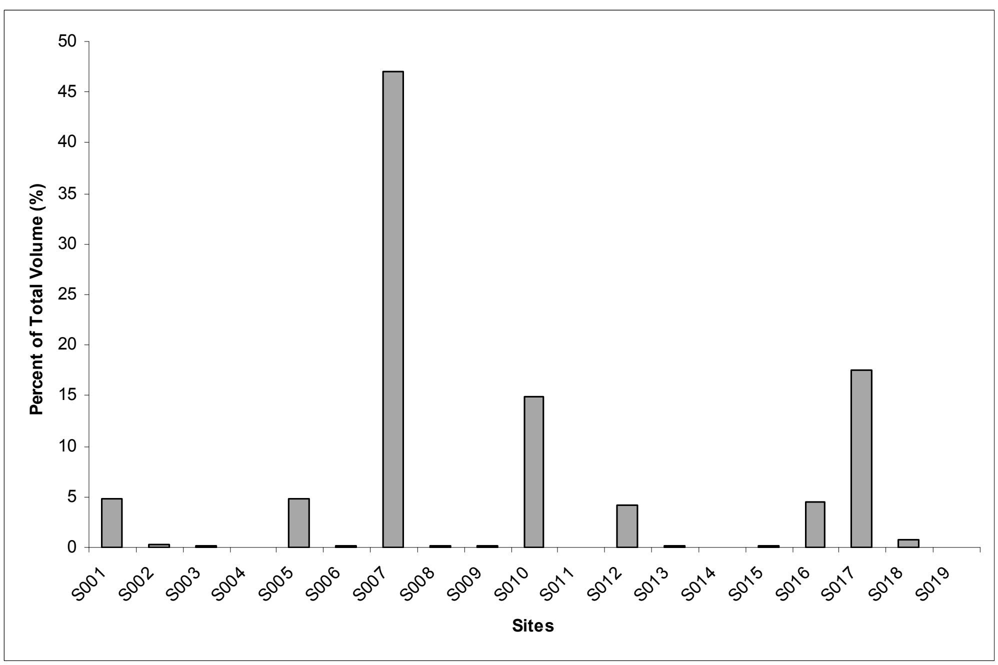


Figure 35. Percent of total macroalgae by site from 2012 in the Coastal Bays Fisheries Investigation Beach Seine Survey. Macroalgae was not present or less than 0.1% at sites represented with no bar.

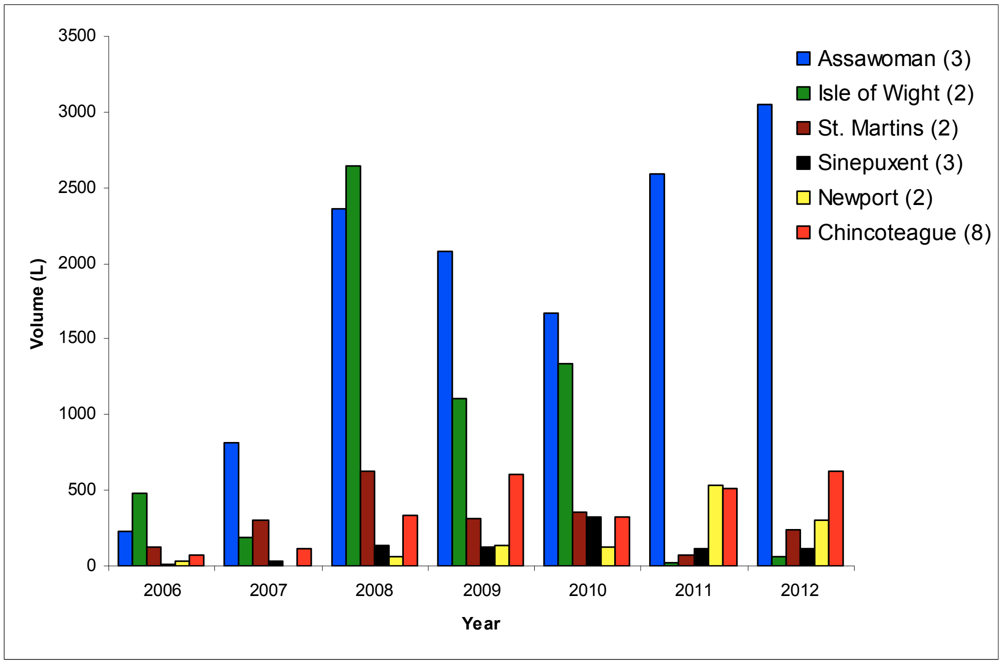


Figure 36. Total volume of (red and green) macroalgae by year and region for Coastal Bays Fisheries Investigation Trawl Survey. The number in parenthesis after the region name is the number of trawl sites in that region.

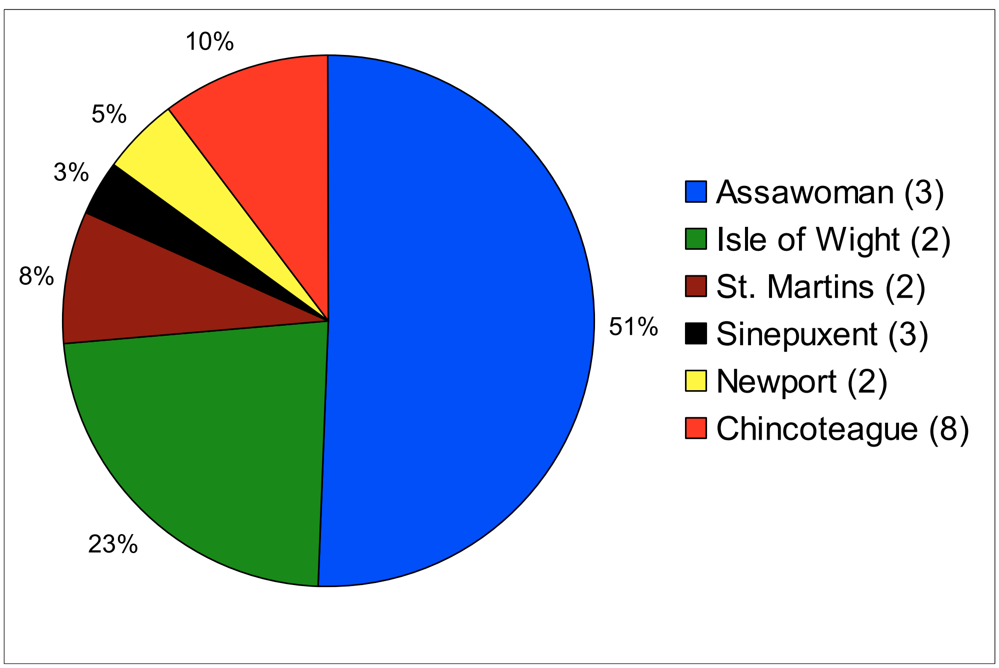


Figure 37. Percentage of total volume of macroalgae by region from 2006 – 2012 for Coastal Bays Fisheries Investigation Trawl Survey. The number in parenthesis after the region is the number of trawl sites in that region.

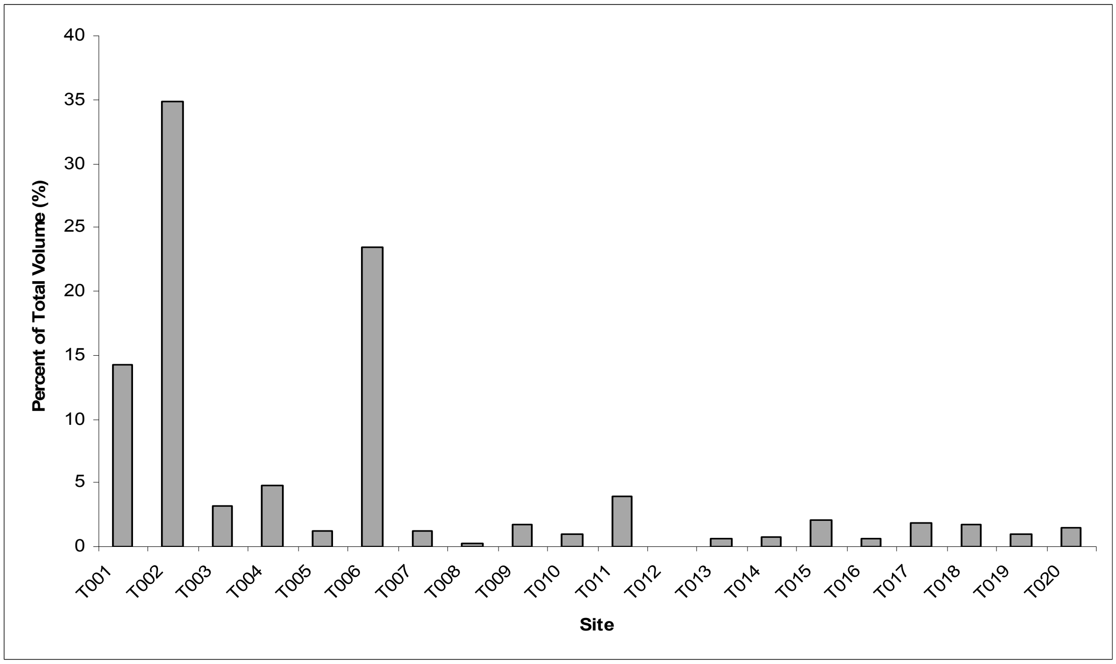


Figure 38. Percent of total volume of (red and green) macroalgae by site from 2006 – 2012 in the Coastal Bays Fisheries Investigation Trawl Survey. Macroalgae was present at all sites; no bar indicates total volume less than 0.1%.

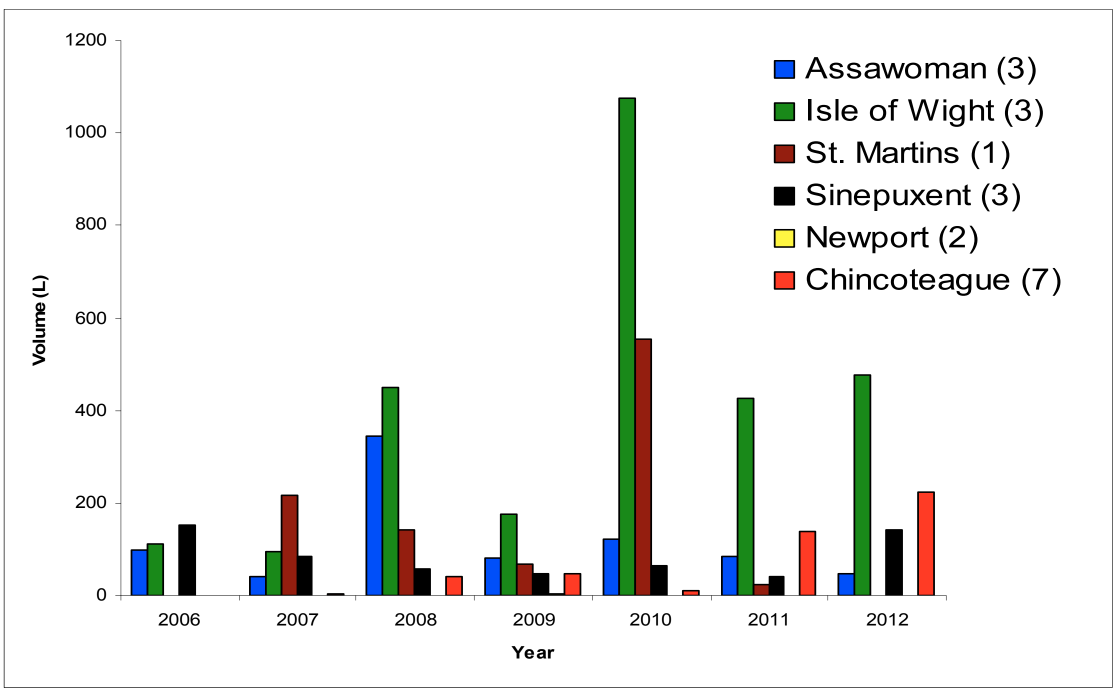


Figure 39. Total volume (L) of (red and green) macroalgae by region for Coastal Bays Fisheries Investigation Beach Seine Survey. The number in parenthesis after the region name is the number of seine sites in that region. Macroalgae was present in all regions; no graphical representation indicates total volume from that region is less than 0.1%.

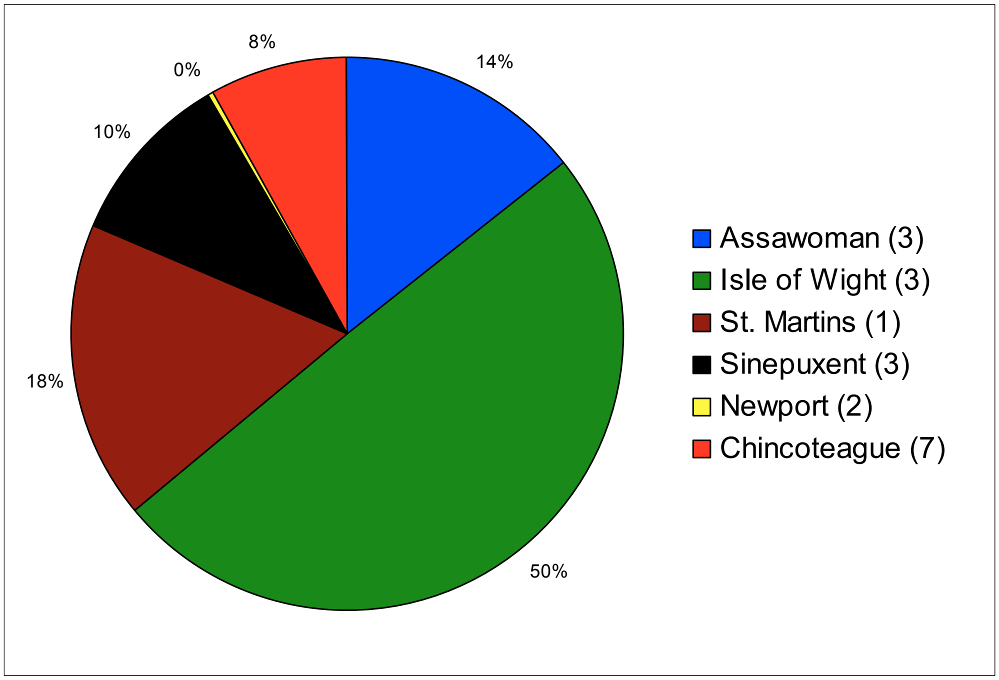


Figure 40. Percentage of total volume of macroalgae by region from 2006 – 2012 for Coastal Bays Fisheries Investigation Beach Seine Survey. The number in parenthesis after the region is the number of trawl sites in that region. Macroalgae was present in all regions; no graphical representation indicates total volume from that region is less than 0.1%.

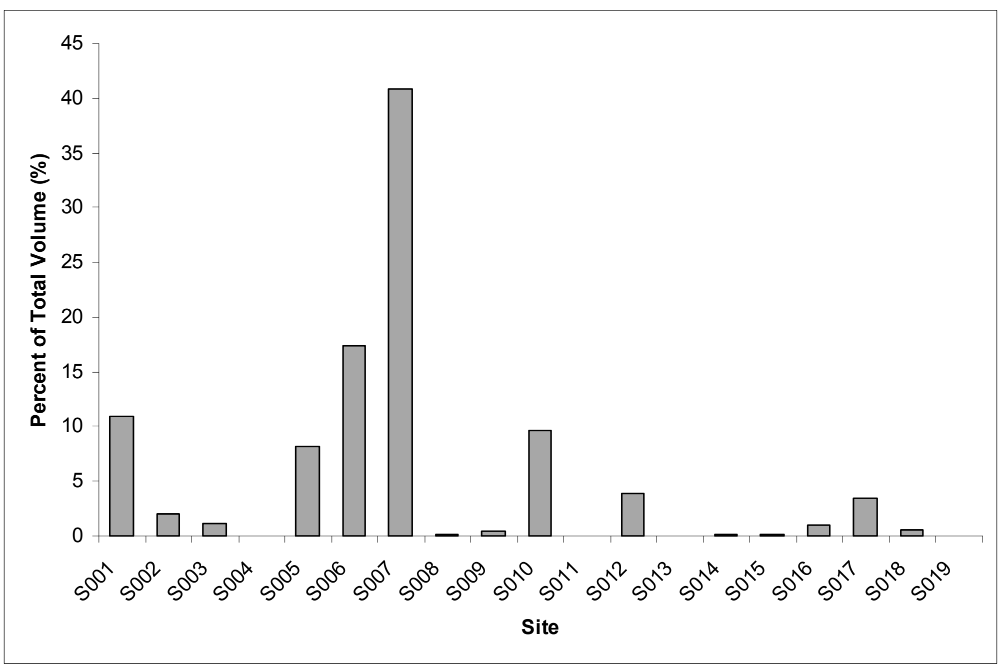


Figure 41. Percent of total (red and green) macroalgae by site from 2006 – 2012 in the Coastal Bays Fisheries Investigation Beach Seine Survey. Macroalgae was present at all sites; no bar indicates that total volume was less than 0.1%.

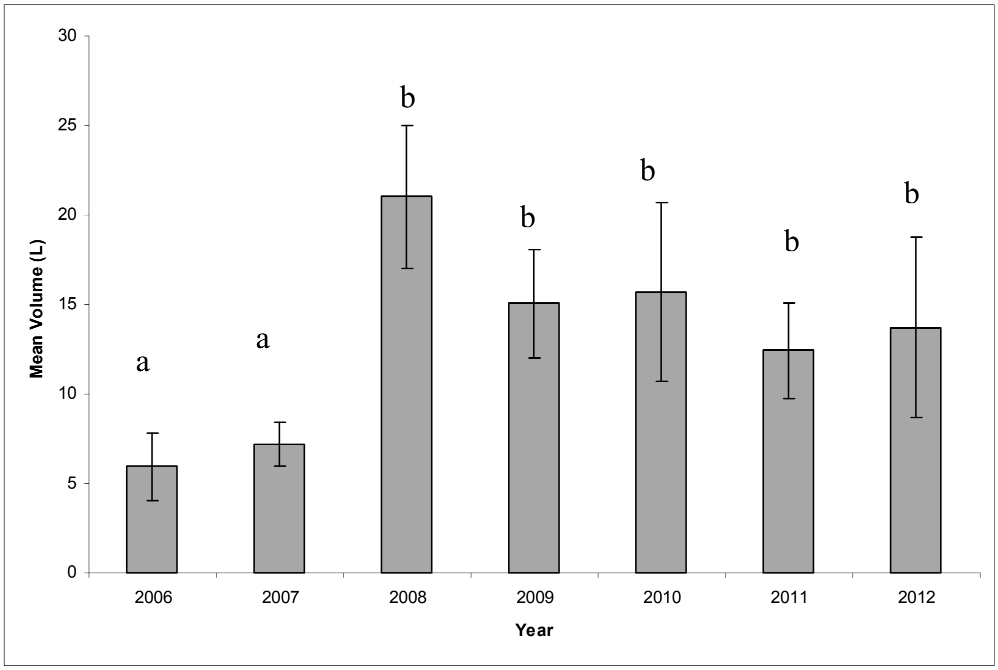


Figure 42. Mean volume (L) ± standard error of total (red and green) macroalgae by year from 2006 – 2012 for the Coastal Bays Fisheries Investigation Trawl Survey. Years with different letters are significantly different from each other.

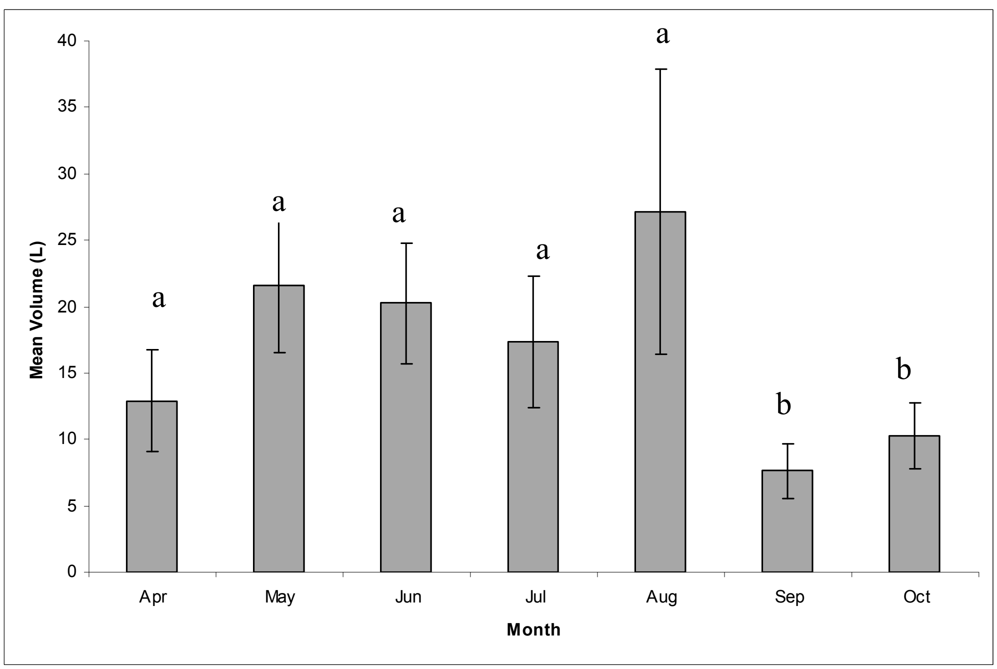


Figure 43. Mean volume (L) ± standard error of total (red and green) macroalgae by month from 2006 – 2012 for the Coastal Bays Fisheries Investigation Trawl Survey. Years with different letters are significantly different from each other.

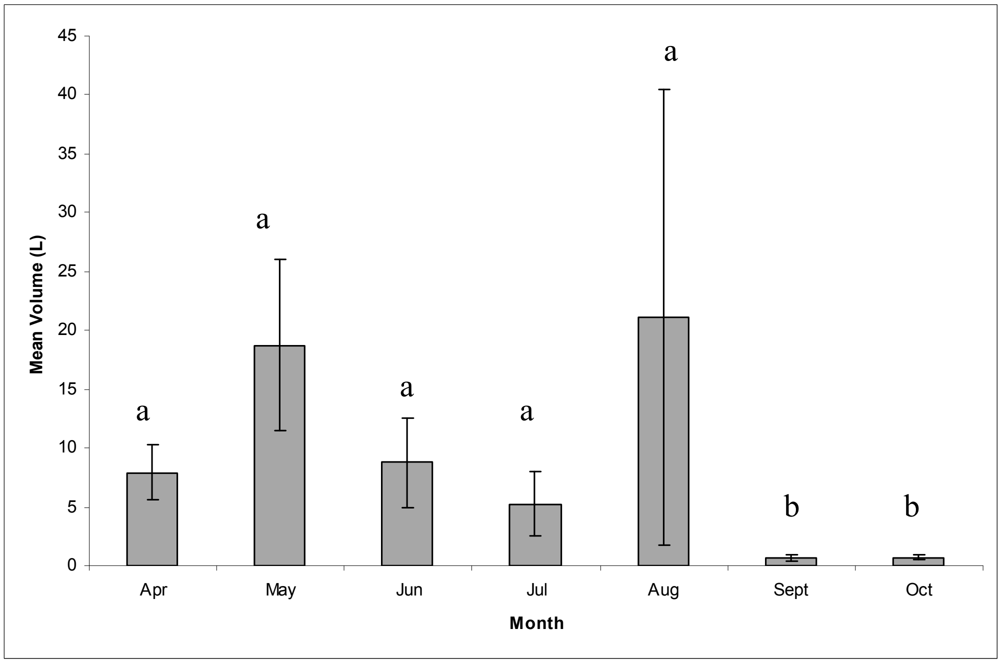


Figure 44. Mean volume (L) ± standard error of total (red and green) macroalgae by month for 2012 for the Coastal Bays Fisheries Investigation Trawl Survey. Months with different letters are significantly different from each other.

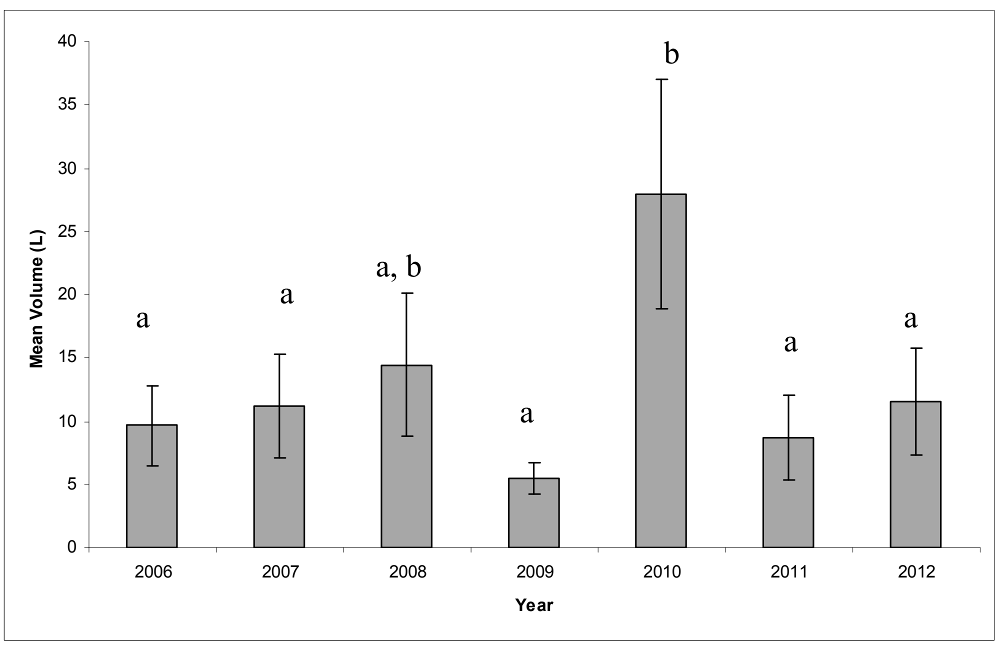


Figure 45. Mean volume (L) ± standard error of total (red and green) macroalgae by year from 2006 – 2012 for the Coastal Bays Fisheries Investigation Beach Seine Survey. Years with different letters are significantly different from each other.

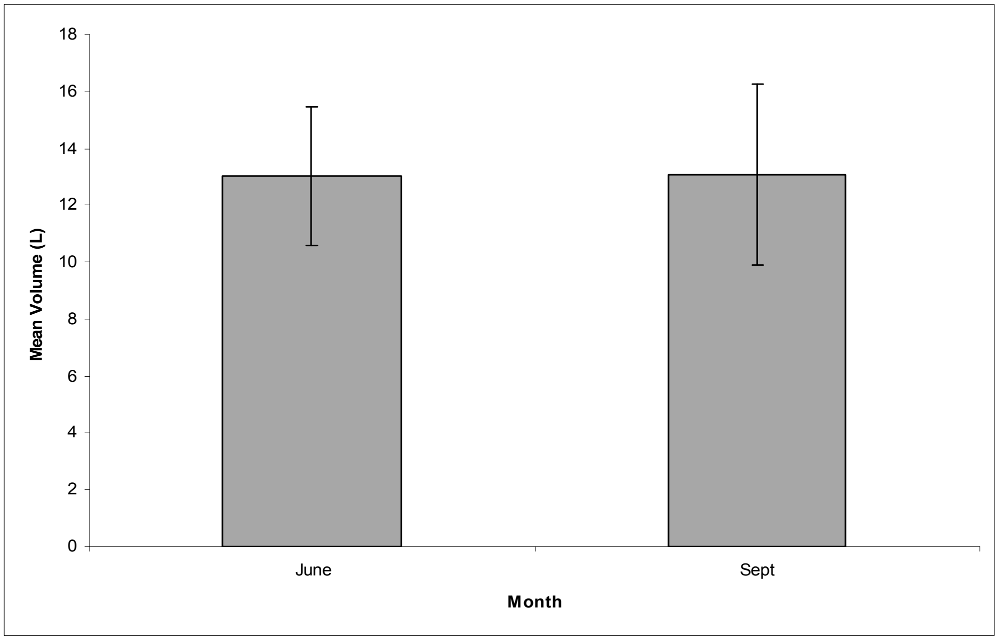


Figure 46. Mean volume (L) ± standard error of total (red and green) macroalgae by month from 2006 – 2012 for the Coastal Bays Fisheries Investigation Beach Seine Survey.

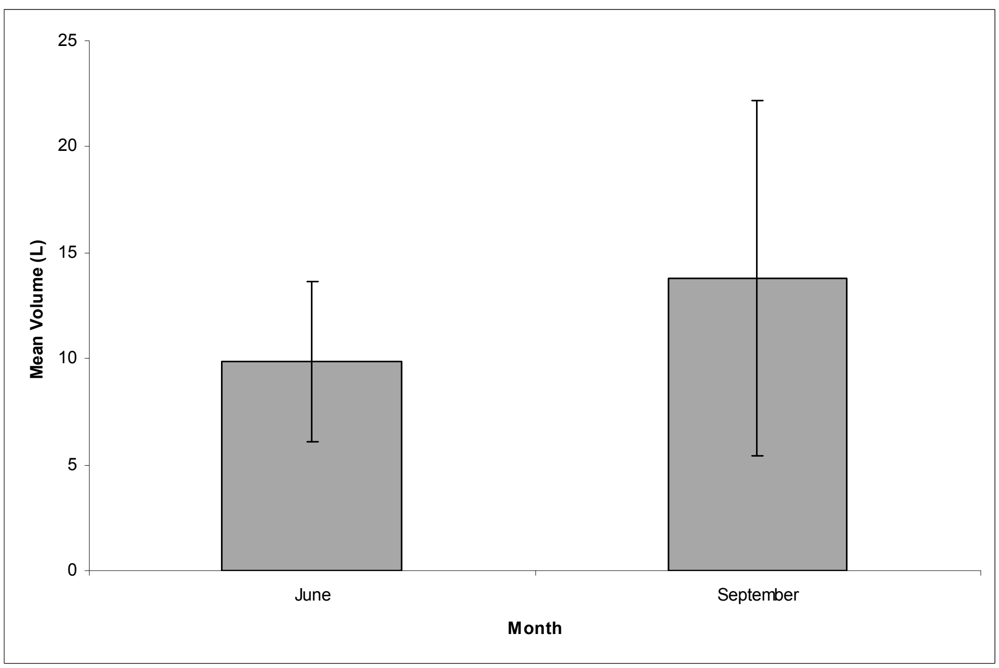


Figure 47. Mean Volume (L) ± standard error of total (red and green) macroalgae by month from 2012 for the Coastal Bays Fisheries Investigation Beach Seine Survey.

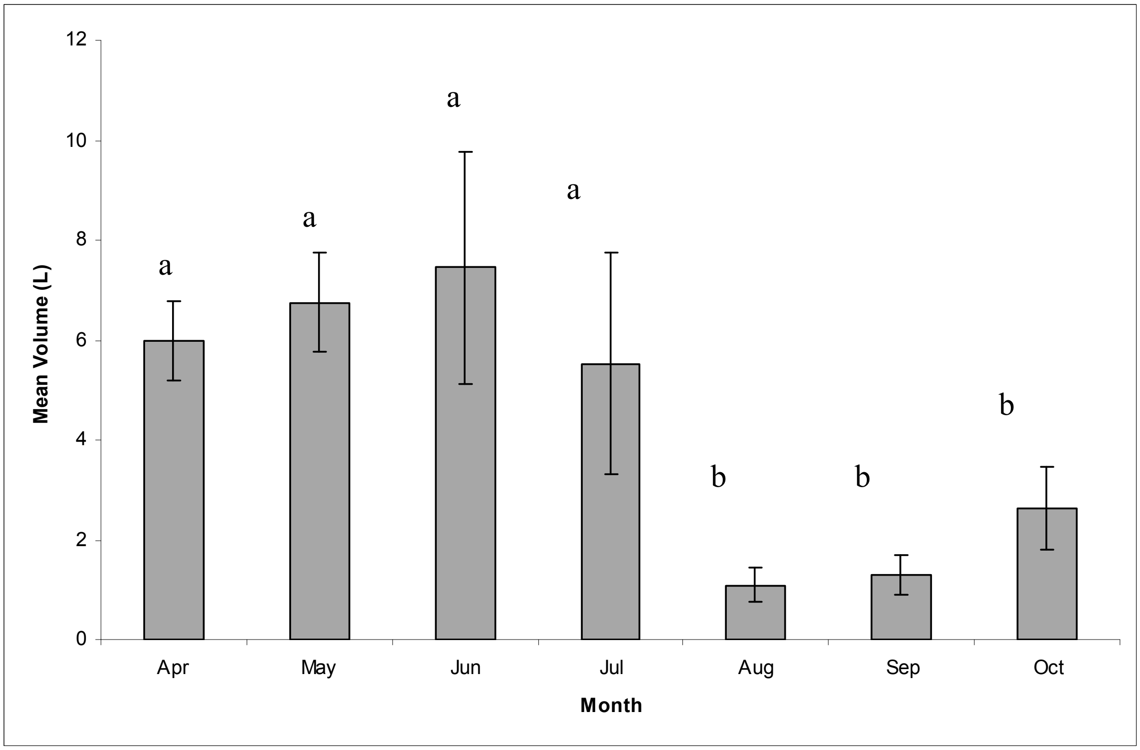


Figure 48. Mean volume (L) ± standard error of green macroalgae by month from 2006-2012 in the Coastal Bays Fisheries Investigation Trawl Survey. Months with different letters are significantly different from each other.

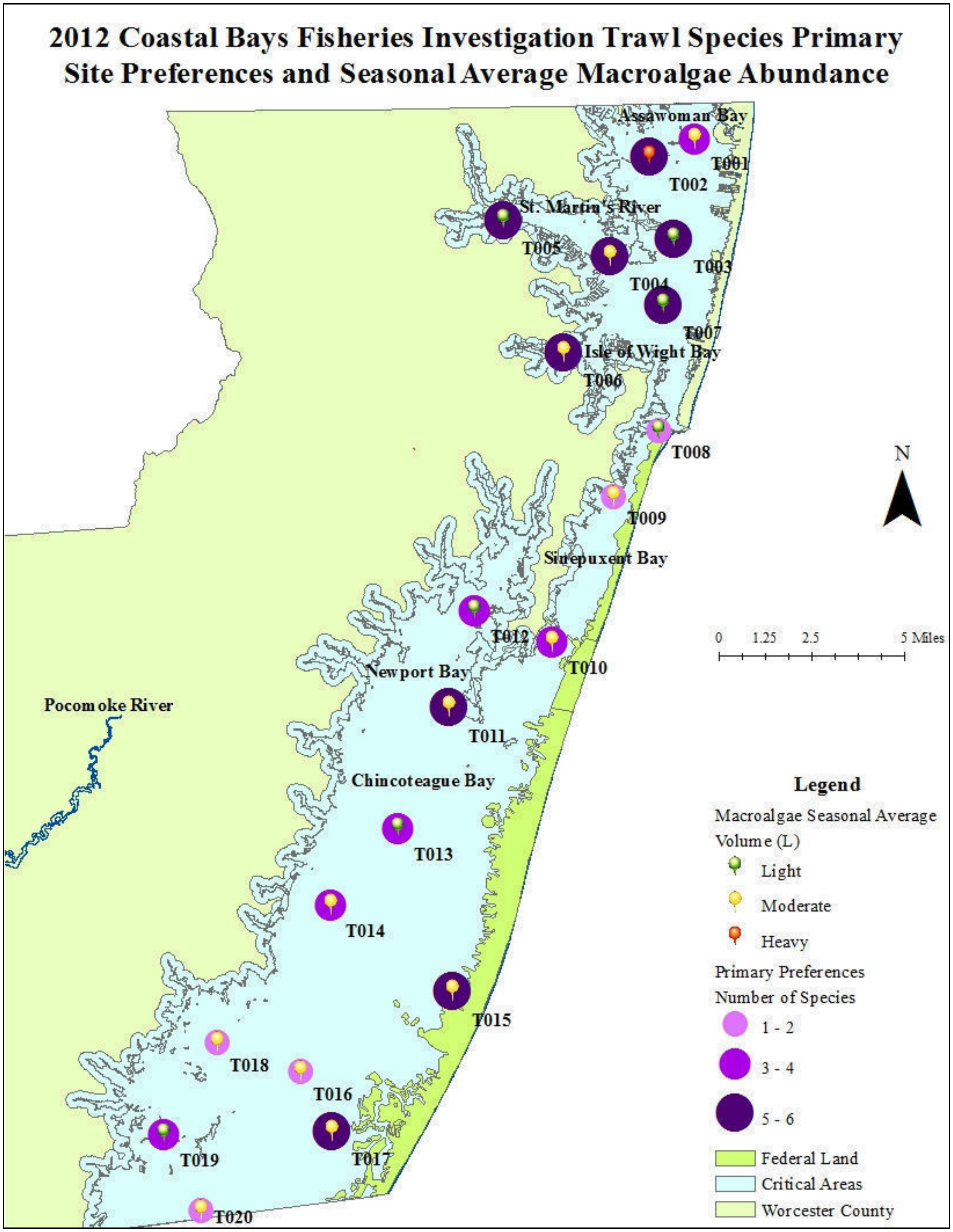


Figure 49. Coastal Bays Fisheries Investigation Trawl Survey species primary site preferences and seasonal average macroalgae abundance.

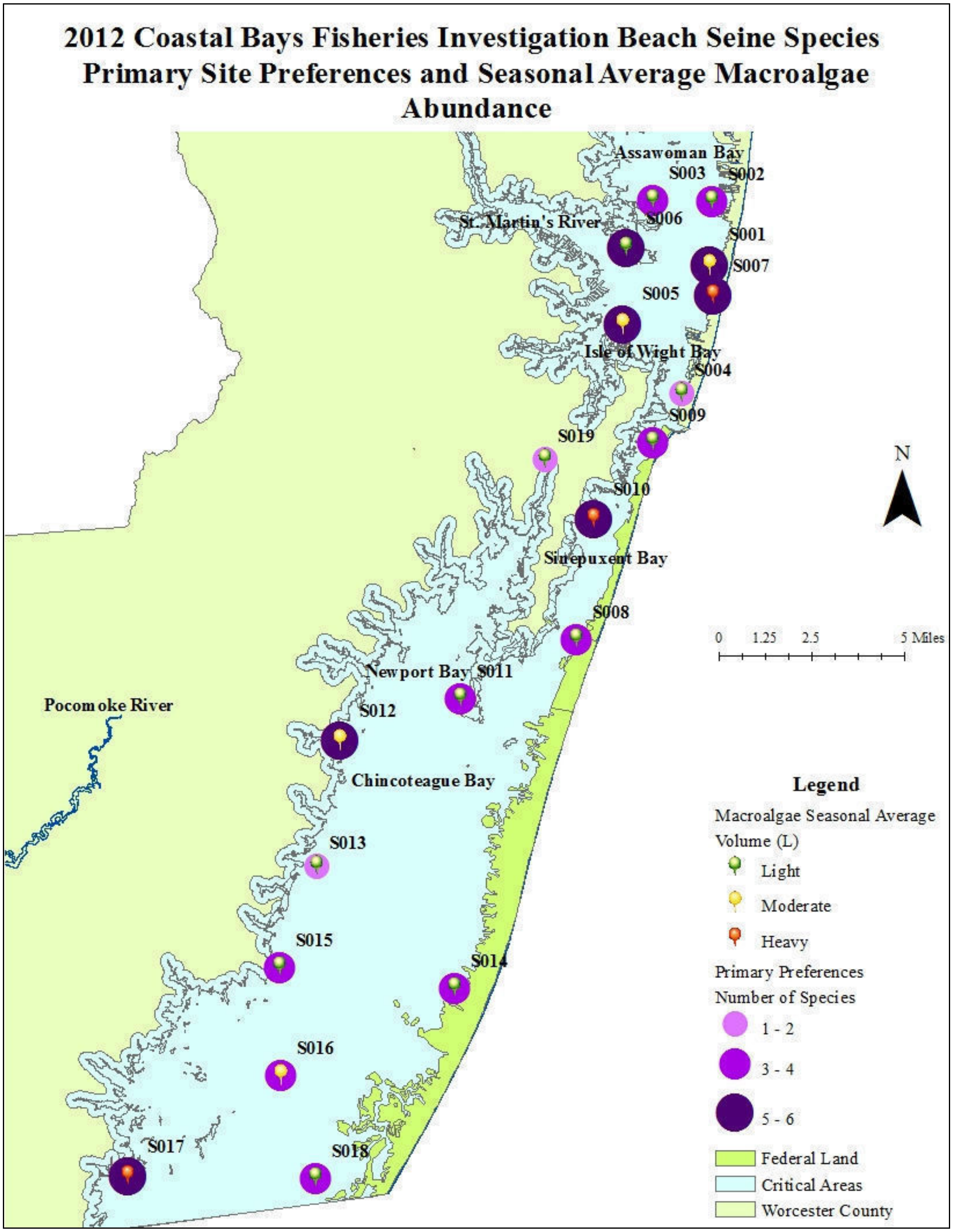


Figure 50. Coastal Bays Fisheries Investigation Beach Seine Survey species primary site preferences and seasonal average macroalgae abundance.

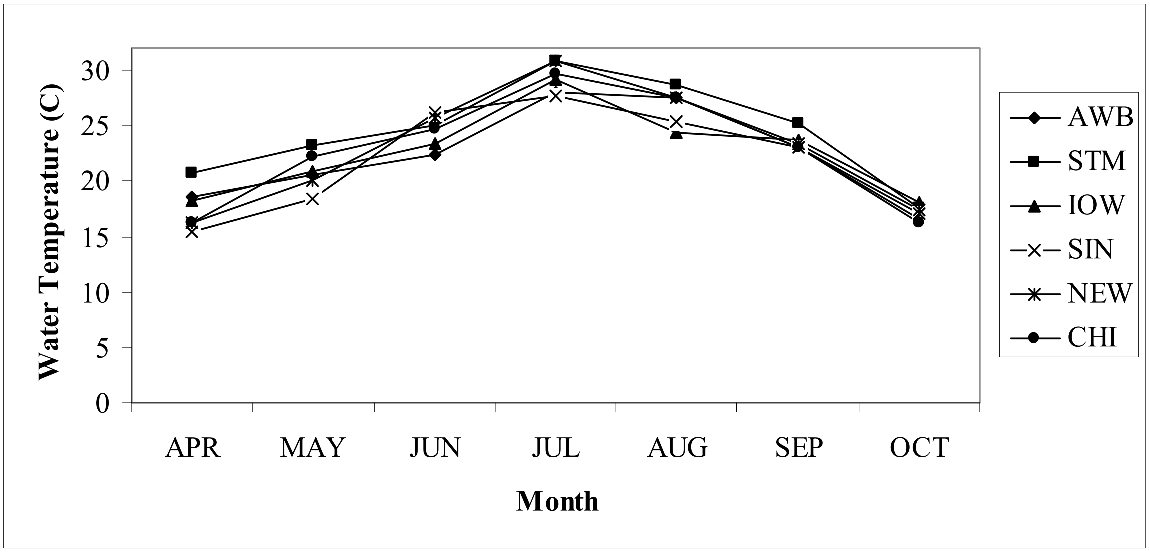


Figure 51. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

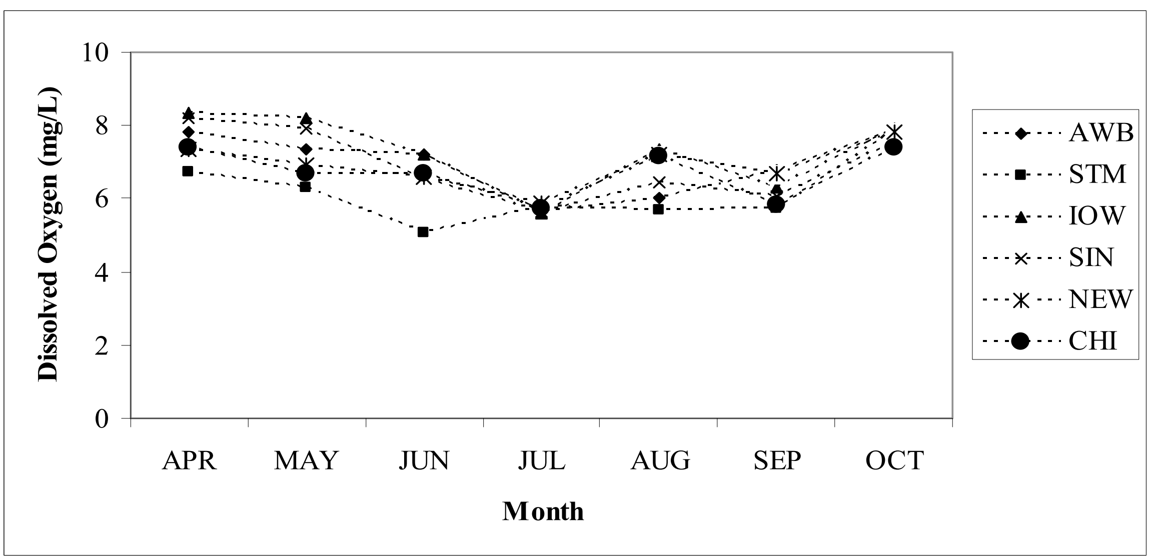


Figure 52. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

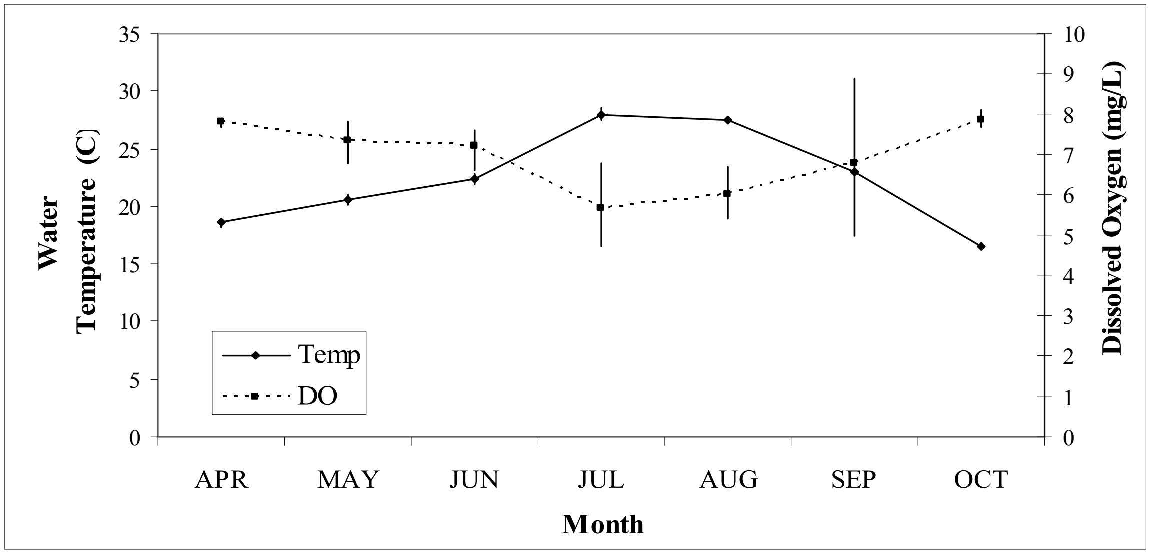


Figure 53. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Assawoman Bay. Error bars represent the range of values collected.

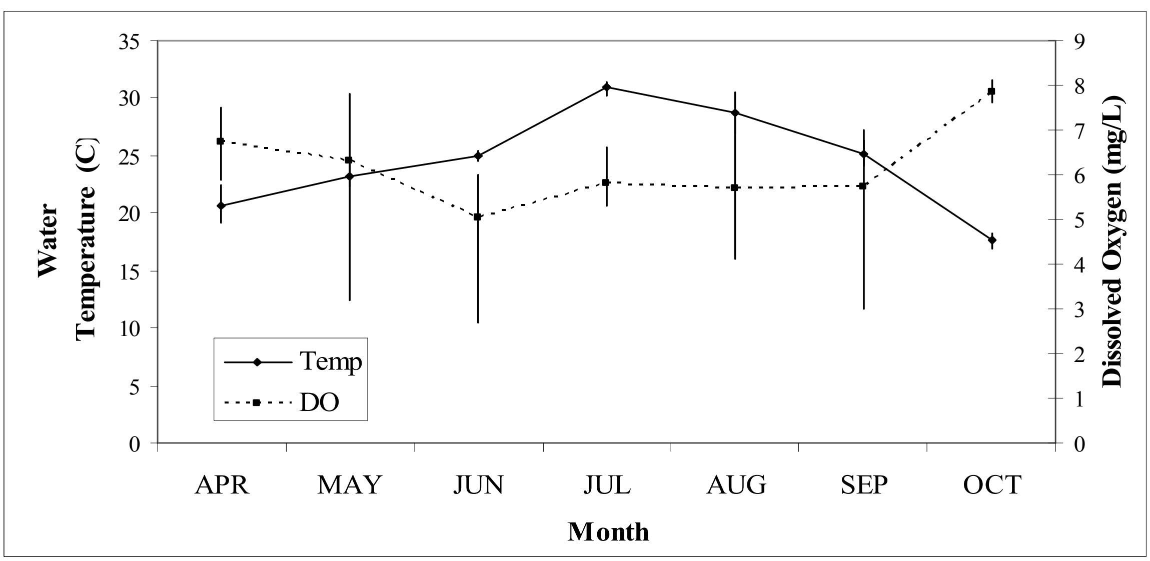


Figure 54. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in St. Martins River. Error bars represent the range of values collected.

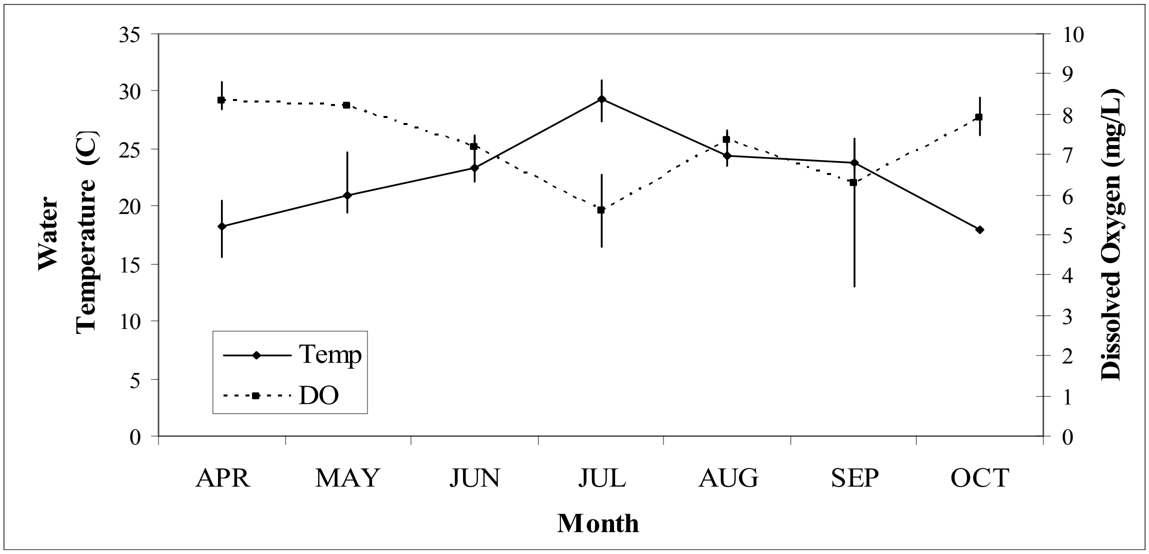


Figure 55. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Isle of Wight Bay. Error bars represent the range of values collected.

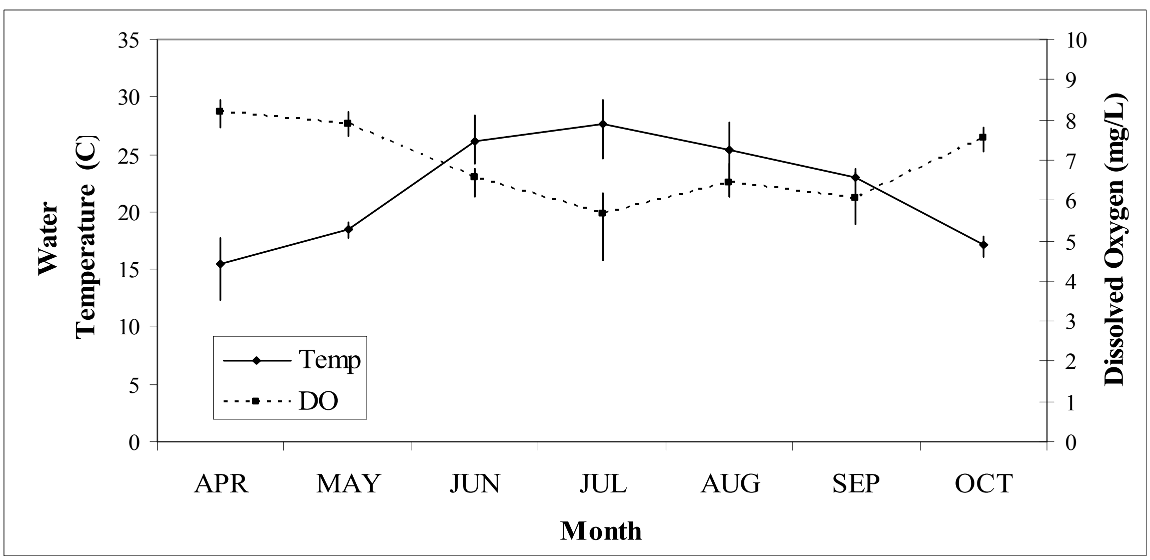


Figure 56. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Sinepuxent Bay. Error bars represent the range of values collected.

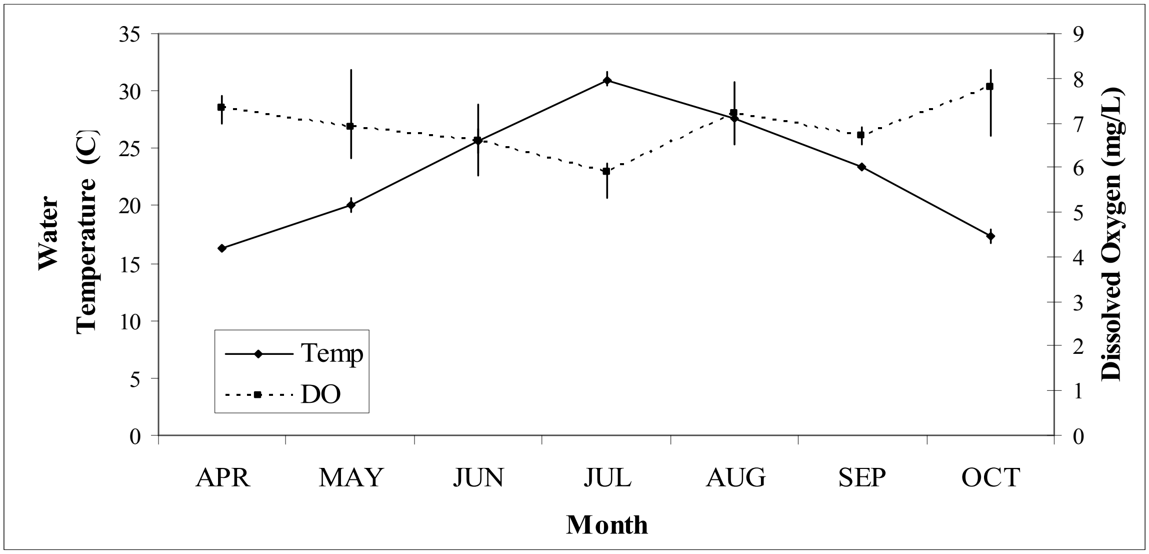


Figure 57. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Newport Bay. Error bars represent the range of values collected.

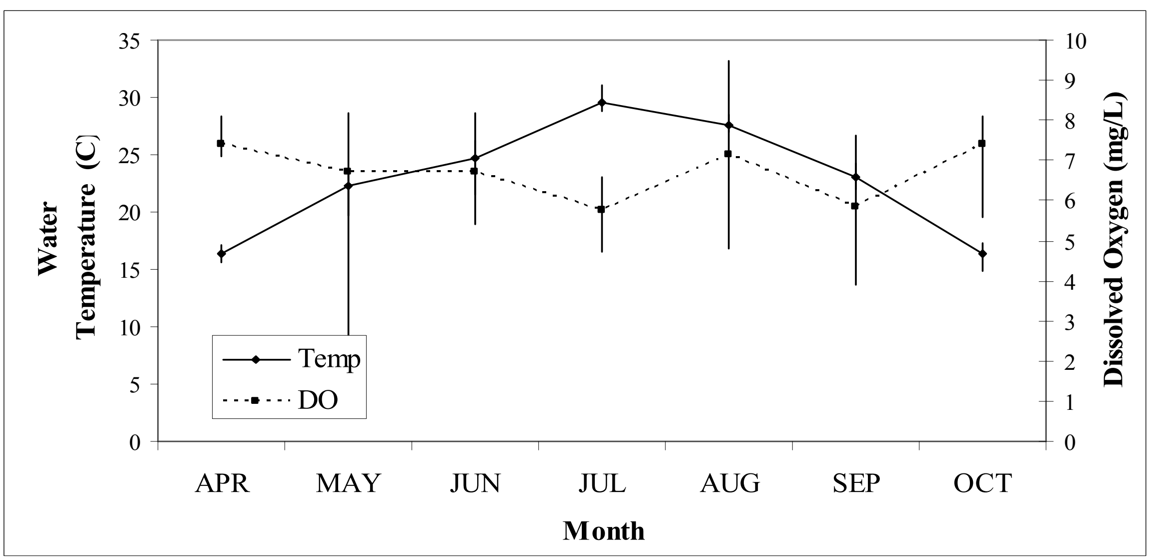


Figure 58. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in Chincoteague Bay. April DO values were not available due to equipment malfunction. Error bars represent the range of values collected.

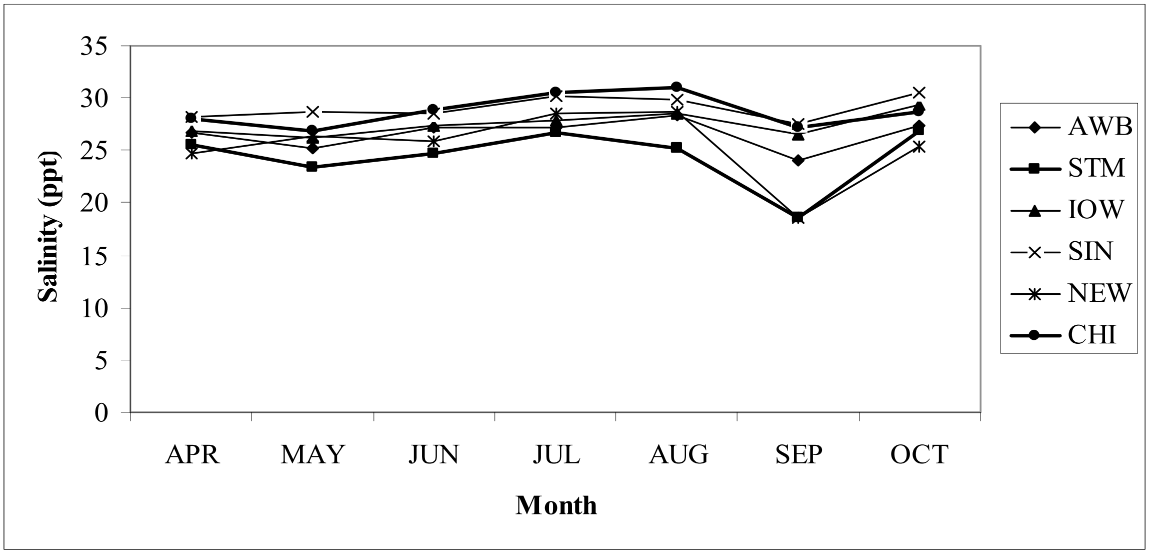


Figure 59. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

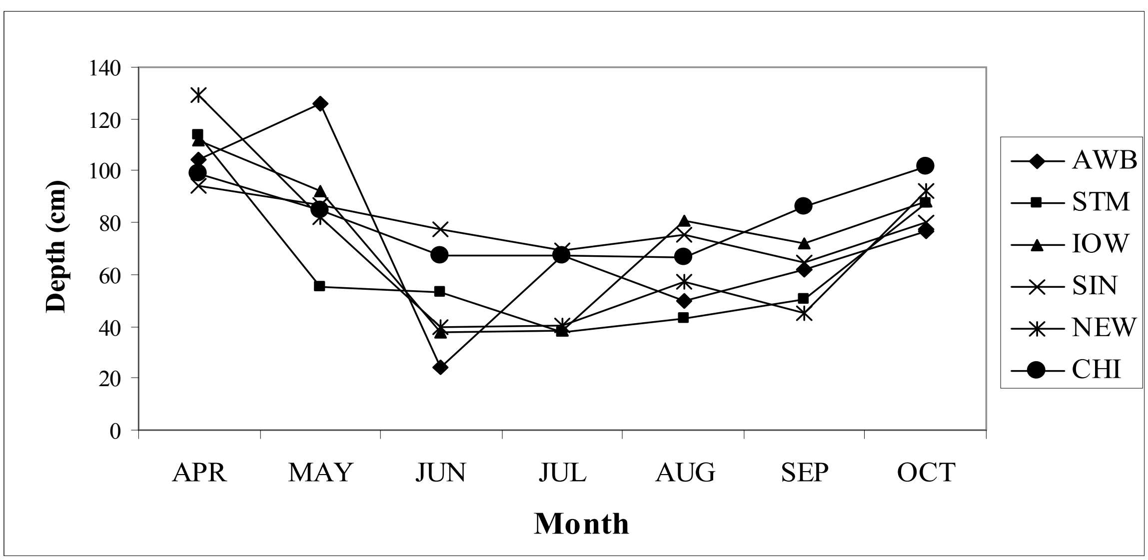


Figure 60. 2012 Coastal Bays Fisheries Investigations Trawl Survey mean turbidity (cm) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI).

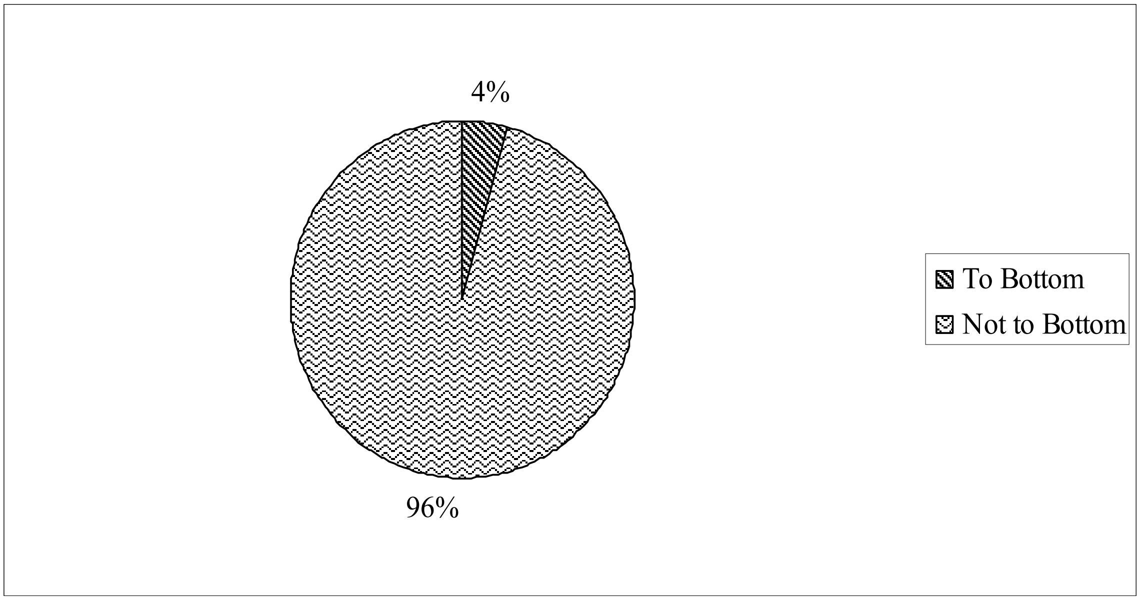


Figure 61. 2012 Coastal Bays Fisheries Investigation Trawl Survey total occasions Secchi disk reached to bottom during sampling.

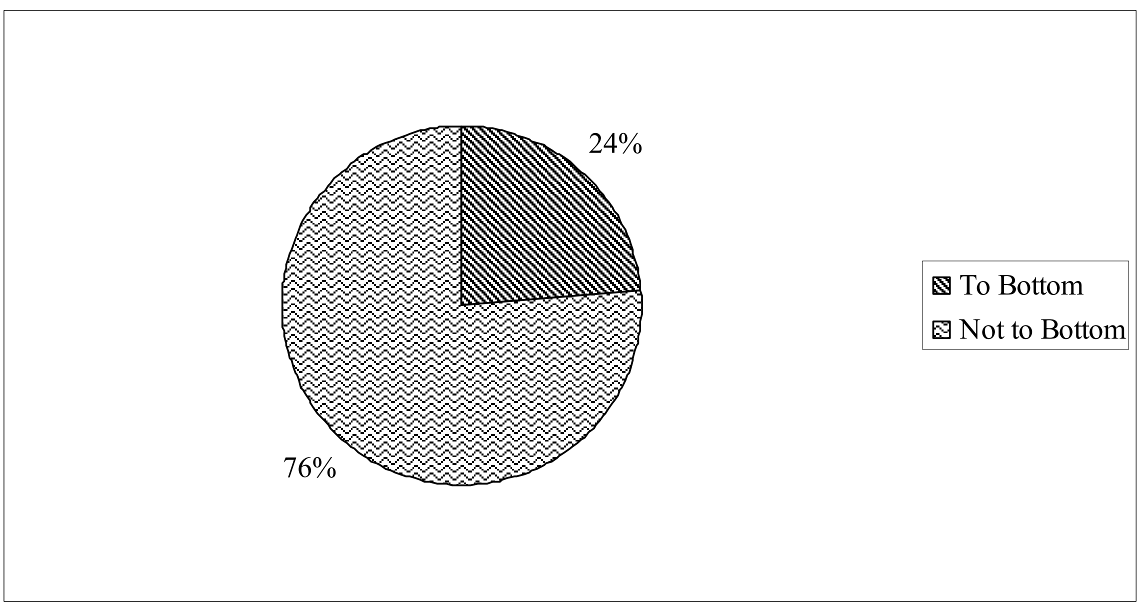


Figure 62. 2012 Coastal Bays Fisheries Investigations Beach Seine Survey total occasions Secchi disk reached bottom during sampling.

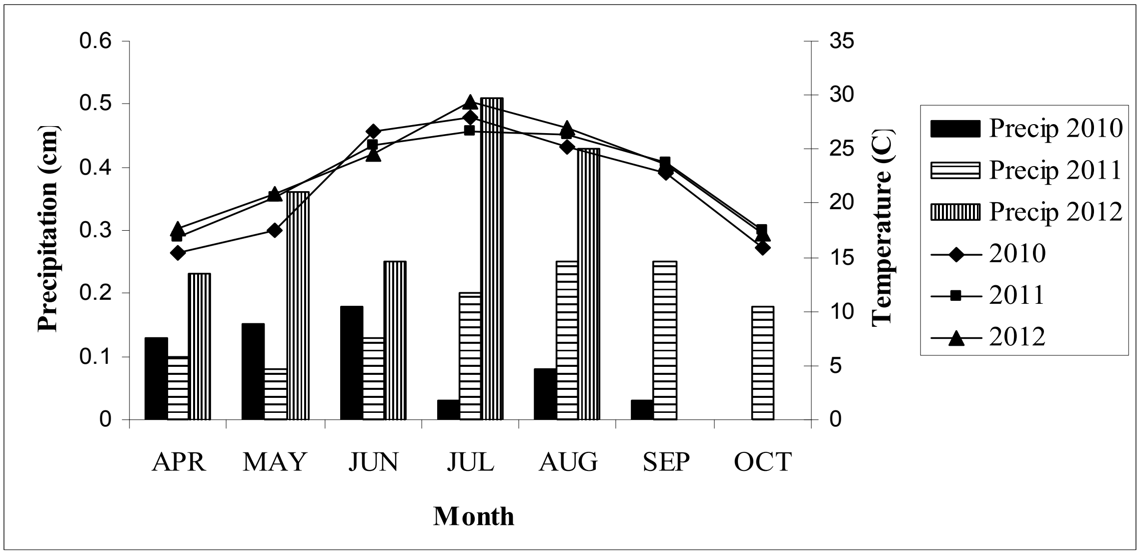


Figure 63. 2010-2012 Coastal Bays Fisheries Investigations Trawl Survey overall mean temperature (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI) compared to mean precipitation (cm) by month for the Ocean City Area.

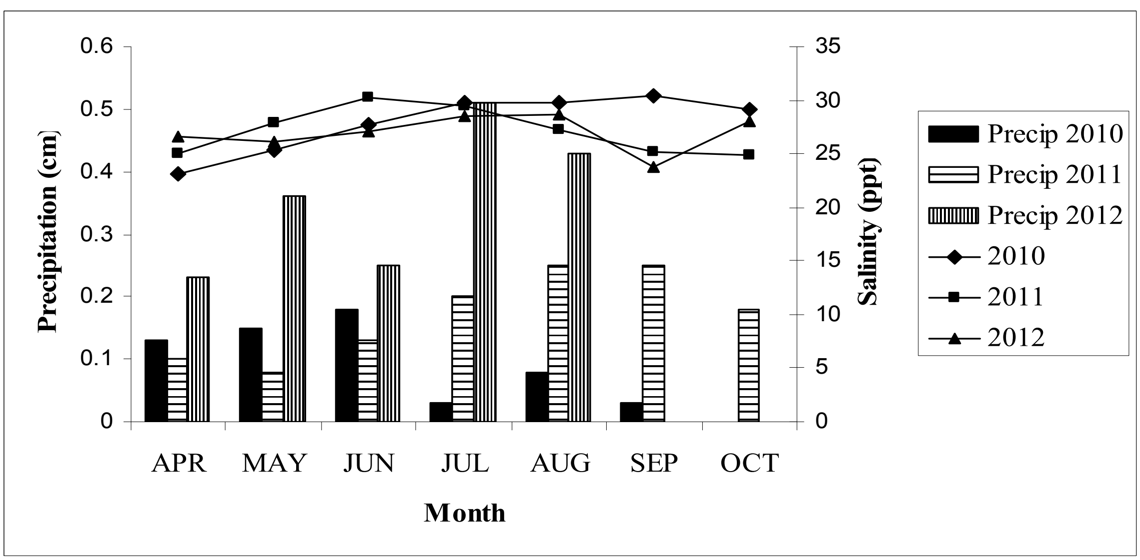


Figure 64. 2010-2012 Coastal Bays Fisheries Investigations Trawl Survey overall mean salinity (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI) compared to mean precipitation (cm) by month for the Ocean City Area.

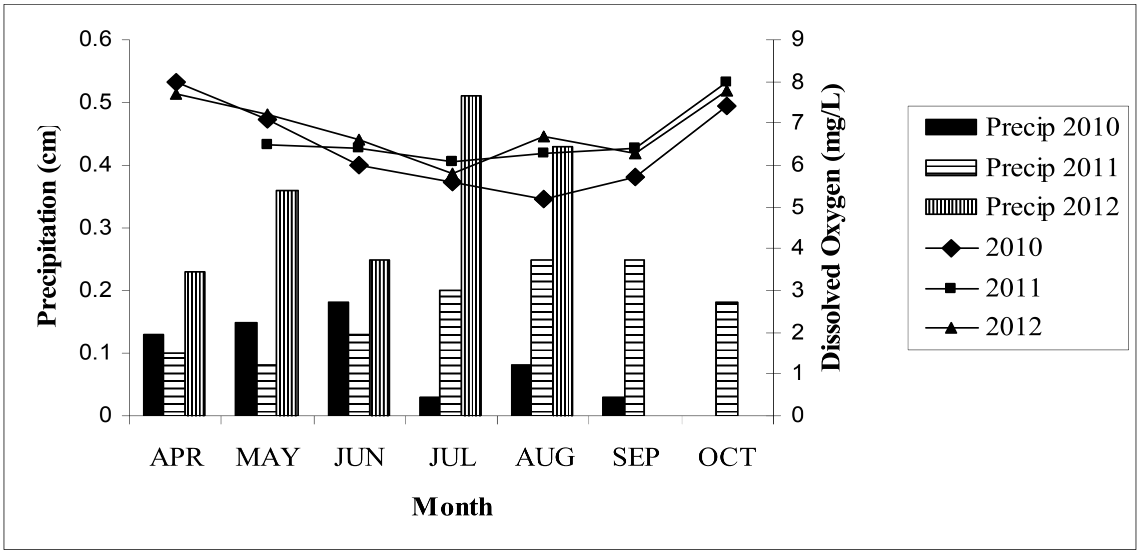


Figure 65. 2010-2012 Coastal Bays Fisheries Investigations Trawl Survey overall mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI) compared to mean precipitation (cm) by month for the Ocean City Area.

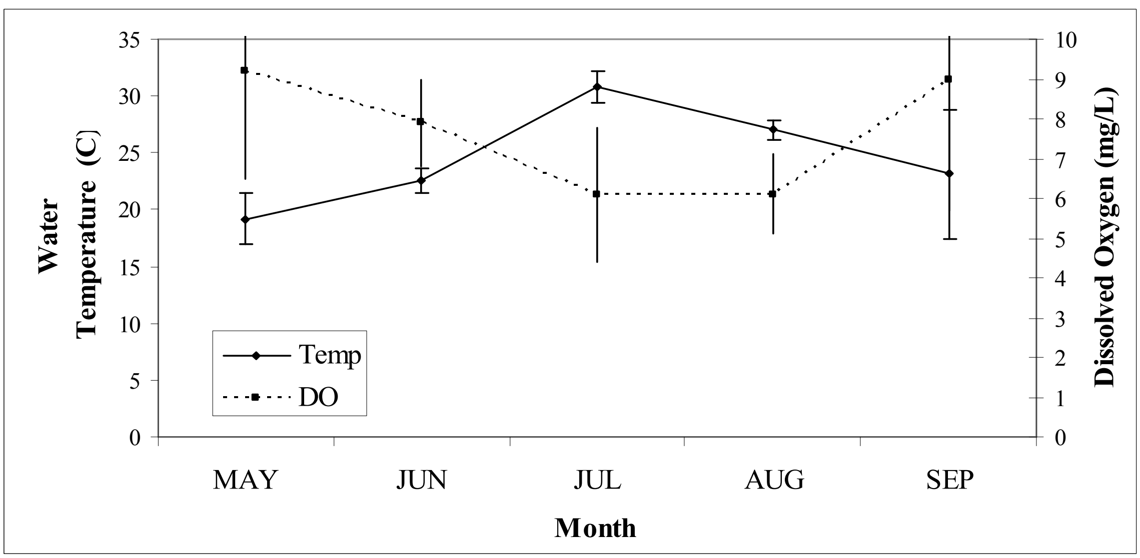


Figure 66. 2012 Coastal Bays Fisheries Investigations Pilot SAV Habitat Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in the Chincoteague Bay.

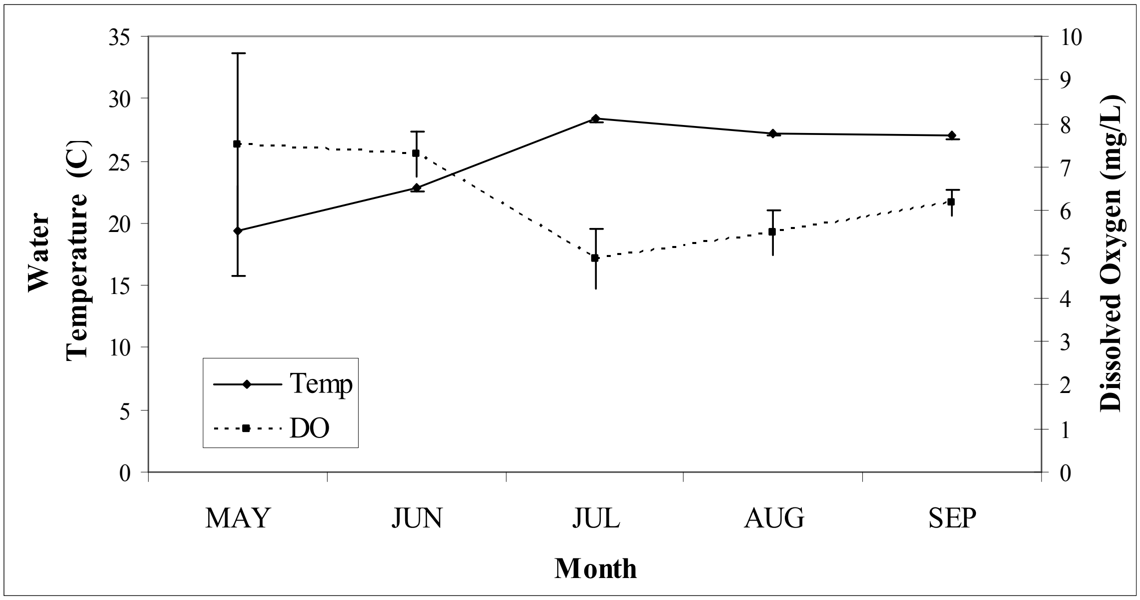


Figure 67. 2012 Coastal Bays Fisheries Investigations Pilot SAV Habitat Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in the Northern Bays.

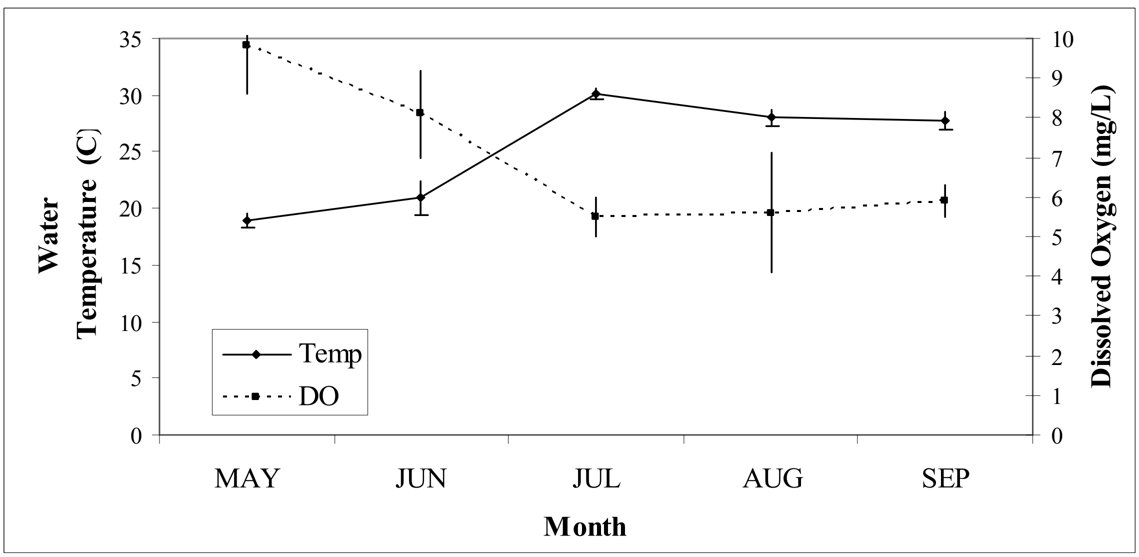


Figure 68. 2012 Coastal Bays Fisheries Investigations Pilot SAV Habitat Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in the Sinepuxent Bay East.

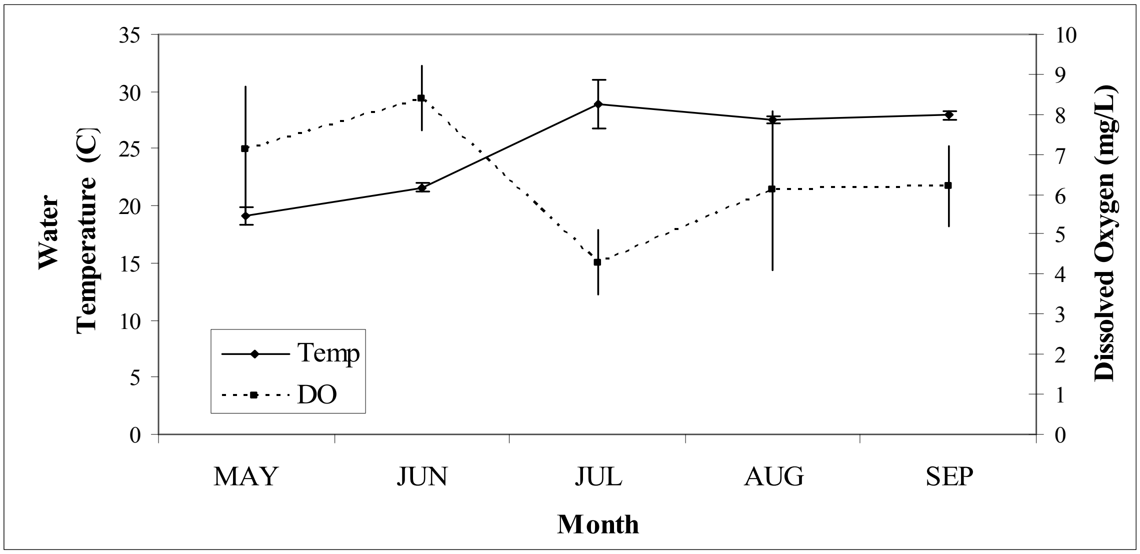


Figure 69. 2012 Coastal Bays Fisheries Investigations Pilot SAV Habitat Survey mean water temperature (C) and dissolved oxygen (mg/L) by month in the Sinepuxent Bay West.

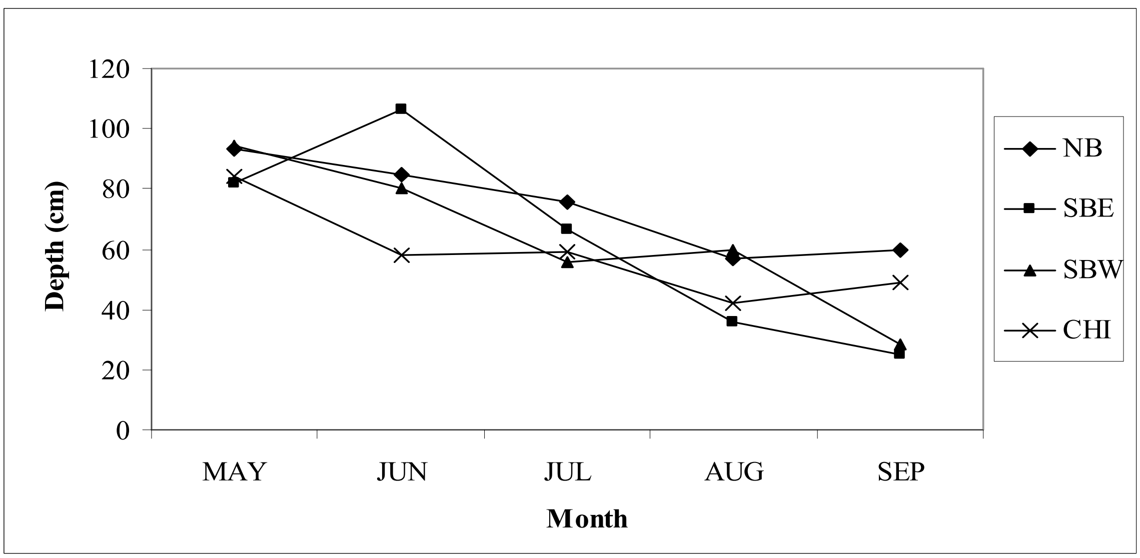


Figure 70. 2012 Coastal Bays Fisheries Investigations Pilot SAV Habitat Survey mean turbidity (cm) by month for the Northern Bays (NB), Sinepuxent Bay East (SBE), Sinepuxent Bay West (SBW), and Chincoteague Bay (CHI).

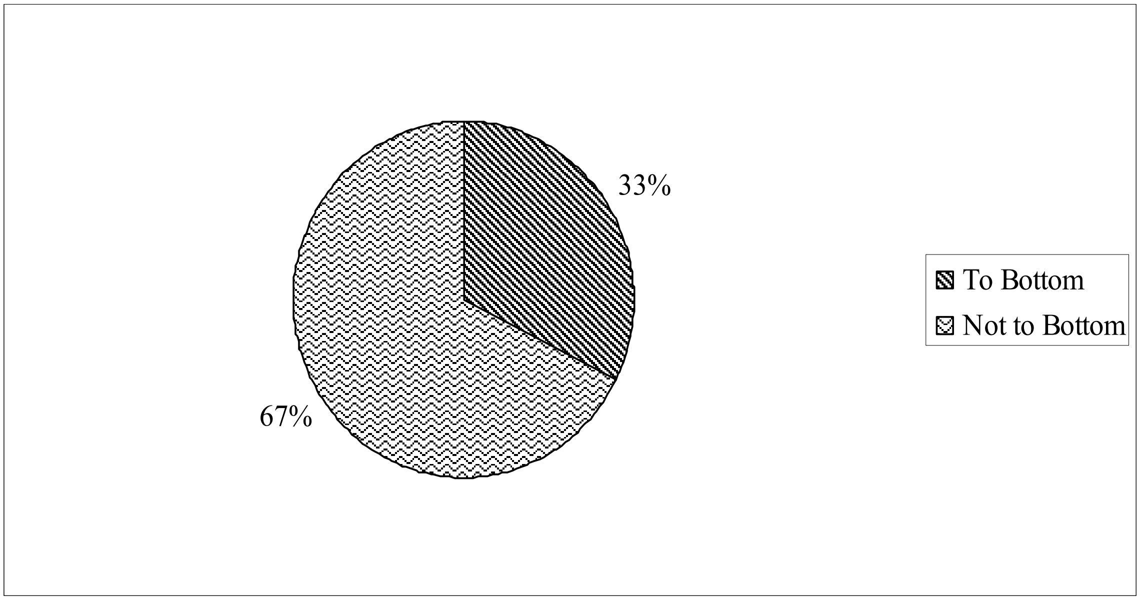


Figure 71. 2012 Coastal Bays Fisheries Investigation Pilot SAV Habitat Survey total occasions Secchi disk reached to bottom.

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
Commercial sampling trips were conducted on June 27, July 10, August 21, September 26, October 9 and November 5.

Gear and Location
Sampling was conducted on commercial trawlers targeting Horseshoe Crabs. The net used was a standard Summer Flounder bottom trawl net with a 15.24 cm mesh net body, with a 13.97 cm cod end. The head and foot rope widths for all outings were 18.3 m and 24.4 m, respectively. Long Range Navigation (LORAN) and GPS 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 ratio of male to female crabs, 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 equipment and weather, wind direction, and wind speed (knots) were estimated by the sampler. Data were recorded on a standardized data sheet (Appendix 5). Staff biologists consulted the *Peterson Field Guide-Atlantic Seashore*

(1978) and *Peterson Field Guide-Atlantic Coast Fishes* (1986) for assistance in species identification.

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

Results:
Trawl time varied, with time ranging between 8 and 85 minutes. Water temperature ranged from a high of 26.9 C in July to a low of 13.9 C in November. Depth over the course of the surveys varied and ranged from 11.3 m to 21.4 m (Table 1).

From the first sampling trip in June, 91 individual animals were counted and 87 were measured. Five species were represented. For July's trip, 10 species and 182 individual animals were counted. This trip generated measurements for 168 animals. During the August trip, 110 animals were counted, representing 13 species. Measurements for 98 animals were collected. On September 26, 158 animals were counted from 14 species and 133 measurements were taken. Ninety-one animals were measured during the October trip and 97 animals were counted. Seven species were represented. For the final trawl in November, 233 animals were counted representing 16 species with measurements obtained for 187 of them (Table 2). Predominant species encountered from all the trawls were Horseshoe Crabs (*Limulus polyphemus*), Summer Flounder (*Paralichthys dentatus),* Clearnose Skate *(Raja eglanteria),* Atlantic Croaker *(Micropogonias undulates),* Spot *Leiostomus xanthurus),* Nine-spined Spider Crab *(Libinia emarginata),* and Knobby Whelk (*Busycon carica*; Table 3).

From all trips combined, a total of 79 Summer Flounder were measured. Lengths ranged in size from 304 mm to 595 mm (Figure 1). The mode was 418 mm and the mean was 457.5 mm.

From June to November, prosomal lengths were collected for 534 Horseshoe Crabs (Figure 2). There were 247 females with a mean carapace width 207 mm and 287 males with a mean carapace width of 190.1 mm.

A total of 44 Knobby Whelks were collected over the course of the trawling season. Lengths ranged from 111 mm to 230 mm with a mean length of 177.7 mm (Figure 3). The widths spanned from 54 mm to 122 mm returning a mean of 96.3 mm.

Discussion:
The length frequency plot for Summer Flounder shows a nearly 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 show a separation between a juvenile cohort and the adult population. The majority of males measured fall between 181 to 230 mm (n=203). From 90 mm to 190 mm, the number of females (n=109) and males (n=106) is nearly equal. Only one male Horseshoe Crab was represented above 240 mm and the females comprised the remainder of the 250 mm to 330mm length groups (Figure 2).

The Knobby Whelk length distribution for 2012 shows a reasonably wide distribution, though the number of samples is low (n=44). The majority of Knobby Whelk landed are also well above the minimum size of 152.4mm (Figure 3).

References:

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

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

List of Tables

List of Figures

Table 1. Depth range for each survey trip.

Date of Trip	Depth Range (m)
June 27, 2012	11.3-11.9
July 10, 2012	12.2-15.2
August 21, 2012	15.1-15.5
September 26, 2012	19.5-20.7
October 9, 2012	15.5-16.2
November 5, 2012	20.4-21.4

Table 2. Trip date, number of species, number of animals counted and number of measurements per trip.

Trip Date	Number of Species	Number of Animals Counted	Number of Animals Measured
June 27	5	91	87
July 10	10	182	168
August 21	13	110	98
September 26	14	158	133
October 9	7	97	91
November 5	16	233	187

Table 3. List of species collected in sub-sampled commercial offshore trawls from June through November 2012 by the Maryland Department of Natural Resources, n= 871. Species were grouped (Finfish, Crustaceans, Mollusks, and Other) and listed by order of extrapolated total number, n=17,461 (numbers under total number column are extrapolated: number of individuals multiplied by X factor.) The actual number of animal counts was 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*	977	34
Spot	*Leiostomus xanthurus*	777	28
Summer Flounder	*Paralichthys dentatus*	574	79
Atlantic Croaker	*Micropogonias undulatus*	514	18
Spiny Dogfish	*Squalus acanthias*	180	12
Southern Kingfish	*Menticirrhus americanus*	171	12
Weakfish	*Cynoscion regalis*	32	3
Northern Puffer	*Sphoeroides maculatus*	30	4
Little Skate	*Leucoraja erinacea*	30	1
Smooth Butterfly Ray	*Gymnura micrura*	5	5
Cownose Ray	*Rhinoptera bonasus*	4	4
Spiny Butterfly Ray	*Gymnura altavela*	2	2
Striped Burrfish	*Chilomycterus schoepfii*	1	1
Butterfish	*Peprilus triacanthus*	1	1
Windowpane Flounder	*Scophthalmus aquosus*	1	1
Southern Stingray	*Dasyatis americana*	1	1
Red Drum	*Sciaenops ocellatus*	1	1
	Total Finfish	**3,301**	**207**
Crustacean Species			
Portly Spider Crab	*Libinia emarginata*	716	23
Rock Crab	*Cancer irroratus*	324	12
Blue Crab	*Callinectes sapidus*	167	6
Flatclaw Hermit Crab	*Pagurus pollicaris*	30	1
	Total Crustaceans	**1,237**	**42**
Mollusc Species			
Eastern White Slipper Shell	*Crepidula plana*	750	25
Knobby Whelk	*Busycon carica*	636	44
Channeled Whelk	*Busycotypus canaliculatus*	158	17
Convex Slipper Shell	*Crepidula convexa*	20	1
	Total Molluscs	**1,564**	**87**
Other Species			
Horseshoe Crab	*Limulus polyphemus*	11339	534
Hairy Sea Cucumber	*Sclerodactyla briareus*	20	1
	Total Other	**11,359**	**535**

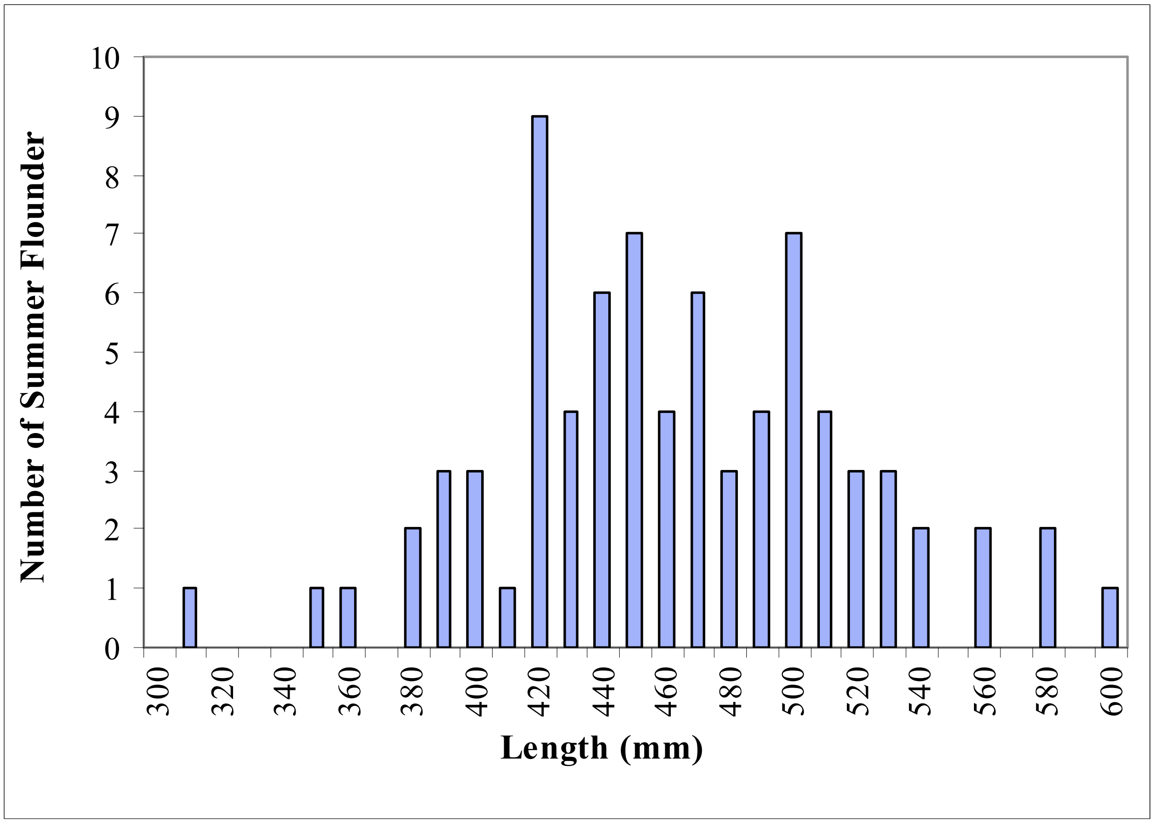


Figure 1. Summer Flounder (*Paralichthys dentatus)* length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources between June and November 2012, n= 79. Data were derived from six trawl trips taken at different water depths.

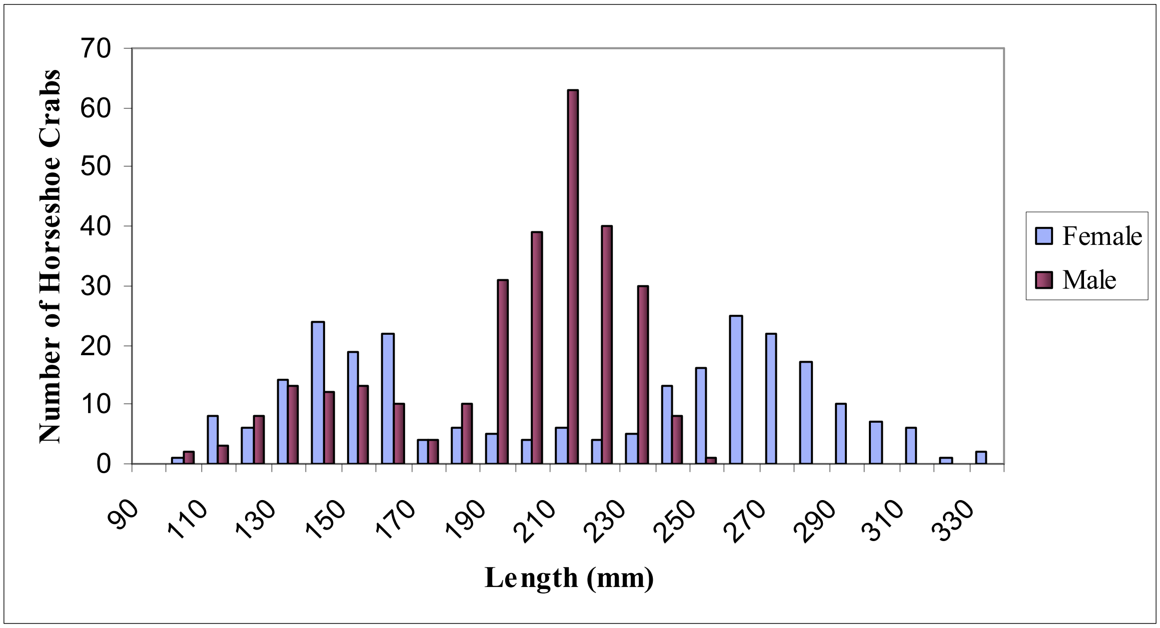


Figure 2. Horseshoe Crabs (*Limulus polyphemus*) length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources between June to October 2012, n= 534. Data were derived from six trawl trips taken at different water depths.

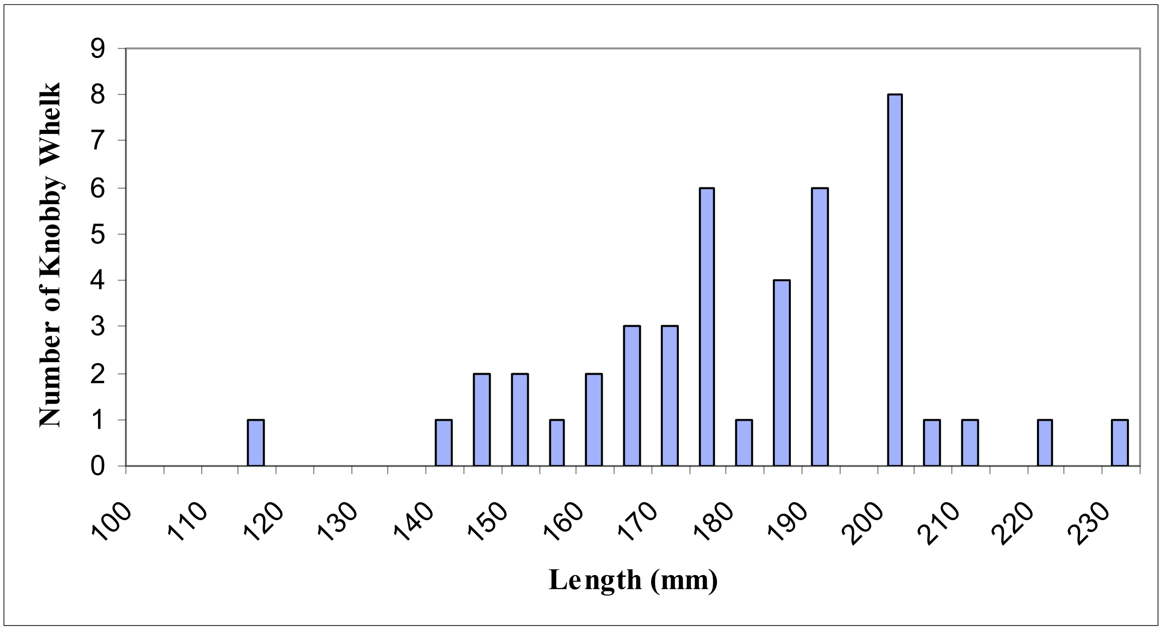


Figure 3. Knobby Whelks (*Busycon carica*) length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources between June to November 2012, n= 44. Data were derived from six trawl trips taken at different water depths.

Chapter 3
2012 Seafood Dealer Catch Monitoring

Introduction:
Dockside data have been collected 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. Data from the previous four seasons of commercial Weakfish sampling are included in this report for comparison to 2012 as few fish were available for measurements in 2011. In addition to Weakfish and Atlantic Croaker (*Micropogonias undulates*), Bluefish (*Pomatomus saltatrix*) were also sampled.

Methods:

CBFI staff evaluated the data needs for Seafood Dealer Catch Monitoring in 2012. Staff determined the species of immediate need and wrote a protocol for each species. The 2012 Seafood Dealer Catch Monitoring reflected those changes and updates. Weakfish remained a top priority because of their scarcity and data was highly important. Atlantic Croaker and Spot were also priority species. All of those species were purchased because otoliths were needed for age analysis. Beginning in 2012, Bluefish were a priority species.

Fish were obtained from two Ocean City seafood dealers, Martin's Fish Market and Southern Connection Ocean City. MDNR staff had regular dialog with dealer contacts regarding the arrival status of target species.

Atlantic Croaker and Weakfish
These species were purchased from the fish market. Once purchased, these fish were transferred to the Matapeake Work Center to be processed by the Migratory Species Project staff.

Bluefish
Bluefish were weighed (kg) and measured (mm) for total length and fork length at the dealer. Data on gear type was also recorded. No otoliths were removed from Bluefish and no sex determination was made.

Results and Discussion:

Weakfish
Fifty-one Weakfish were intercepted at a local packing house for 2012. During 2011, Weakfish were rarely seen at the coastal packing houses and zero Weakfish were sampled. For 2009, 2010 and 2012 the average ages for the coastal sampled Weakfish were, 1.2 years and 1.4 years and 1.5 years (Table 1). All Weakfish sampled from Ocean City in 2012 were above the minimum commercial size (Figure 1).

While there are 2012 preliminary harvest numbers presented for the three species in this report, such numbers can change so they are not appropriate for calculation of averages or other comparisons.

Based on the 2009 stock assessment, Weakfish stocks are at an all time low and considered depleted. Natural mortality has recently increased and ASMFC passed Addendum IV to Amendment IV of the Weakfish FMP in 2009 to address the current low levels of Weakfish by reducing commercial and recreational harvest (ASMFC, 2009). Records indicated a harvest of 378 pounds for all of Maryland in 2011. This catch is far beneath the mean yearly harvest of 1929 to 2010 (627,669 pounds) and represents an 82.40% decrease from 2010 harvest of 2,148 pounds. Both the Coastal Bays and Atlantic Ocean were responsible for the majority (87.04%) of Maryland commercial landings in 2011. The Chesapeake Bay produced 6.35% of the harvest. For 6.61%, the source was unknown. Figure 2 demonstrates the decline in weakfish landings since 1955. Landings were affected by stricter regulations for Maryland waters implemented in 2010 to comply with Addendum IV (Rickabaugh, 2012). In 2010, commercial regulations changed to a bycatch for the Chesapeake Bay of 50 pounds and in the Atlantic Ocean bycatch was set at 100 pounds. No Weakfish are to be harvested by commercial hook and line in the Coastal Bays or Ocean. Recreational anglers were allowed only one fish. Previously, recreational anglers were allotted 6 fish per person and bycatch for the commercial fishermen was 150 pounds per vessel/day or trip for both the Atlantic Ocean the Chesapeake Bay if fishing during a closed Weakfish season with gear other than hook and line.

The preliminary harvest number from 2012 is 992 pounds total with most being caught along the coast (Rickabaugh, 2012b). The interception of such a small sample (51 fish) from the coastal fishery for 2012 may not be unexpected considering the reduction of total commercial landings over the previous years.

A total of 51 Weakfish were sampled from commercial gillnets. These fish had a mean length of 351.27 mm (range 315-424 mm, 95% CI: ± 0.20; Table 2) and a mean weight of 436.90 g (range 255-686 g, 95% CI: ± 0.76; Table 3). The majority of female fish were in the 341 to 370 mm range (Figure 1).

For 2010, a total of 115 Weakfish were sampled from commercial trawls. These fish had a mean length of 330.3 mm (range 297-385 mm, 95% CI: ± 3.69) and a mean weight of 365.2 g (range 243-580 g, 95% CI: ± 13.65; Tables 2 and 3). A total of 41 Weakfish were sampled from the commercial trawl harvest in 2009. These fish had a mean length of 364.3 mm (ranges 330-392 mm, 95% CI: ± 4.84). Mean weight was 551.4 g (range 346-726 g, 95% CI: ± 24.95).

Atlantic Croaker

Ninety-one Atlantic Croakers were intercepted at a local packing house in 2012. Ages ranged from 1 to 4 years (Table 4). The sex for five of these fish is not known. The mean length was 257.36 mm (range 229-305 mm, 95% CI: ± 0.09). Mean weight was

212.40 (range 141-337, 95% ± 0.23; Table 5). The majority of Atlantic Croakers sampled from Ocean City for 2012 were above the minimum commercial size except for one 229 mm specimen. The length frequency was highest for males from 261 mm to 265 mm (13 fish). The female length frequency was highest for females in the 251 to 255 mm range (12 fish; Figure 3).

Recent data show that for 2011, the majority of product originated in the Chesapeake Bay (76.88%) and the Atlantic coast (ocean and coastal bays combined) was responsible for 23.12%. The preliminary harvest estimate for 2012 is 861,791 pounds, but this number is subject to change (Rickabaugh, 2012b). A commercial harvest of 704,019 pounds for 2011 shows a 30.39% increase over the 2010 results which were 490,067 pounds.

The 2010 ASMFC benchmark assessment states that the Atlantic Croaker stock is not being overharvested (ASMFC, 2010). Commercial harvest data (Rickabaugh, 2012a) for both the Chesapeake Bay and Maryland's Atlantic coast shows great fluctuation over the years. From 1955 to 2011 more Atlantic Croakers were harvested from the Chesapeake Bay as opposed to the Atlantic coast. For nearly two decades beginning in the mid-seventies, more of these fish were harvested from the Atlantic coast. During the mid-nineties through 2011, the trend reversed and more Atlantic Croakers were harvested from the Bay (Figure 4). This warrants further monitoring efforts at the Ocean City packing houses in future years.

Bluefish

Based on data needs for larger Bluefish lengths in coastal stock assessments, commercially caught Bluefish were sampled for total length, fork length and weight for the first time in 2012. Data from Rickabaugh (March 12, 2013a) indicate far more Bluefish have been harvested from the Chesapeake Bay as opposed to the Atlantic coast and the adjacent bays since the 1955. Harvests in Maryland increased significantly starting in the 1970s through the 1990s (Figure 5). For 2011, the harvest was 70,383 pounds representing a 33.43 % decrease from a 2010 harvest of 105,731 pounds. The majority of harvest came from the Atlantic coast (76.08%) in 2011.

The preliminary harvest for 2012 is 87,587 pounds. A total of 45 Bluefish were sampled. Age and sex were not determined for samples. For total length, the mean was 774.93 (range 471-890mm, 95% ± 0.64) (Table 6). One fish (471 mm) was excluded from the graph as the majority was considerably larger (Figure 6). The size range of 751 to 760 mm had the most individuals (7 fish) of all the ranges. Fork length was also collected, for all but 14 fish (Figure 7). Mean weight was 4160 g (range 3100-6900 g) with a 95 % confidence interval of ± 7.88g. Total length is reported in Table 6, since Bluefish was the only species where fork length was collected.

References:

ASMFC 2009. Addendum IV to Amendment 4 to the Weakfish Fishery Management Plan. Washington DC.

ASMFC. 2010. Atlantic Croaker 2010 Benchmark Stock Assessment. Washington DC.

Rickabaugh Jr., Harry W. 2012. Maryland Weakfish (Cynoscion regalis) Compliance Report to the Atlantic States Marine Fisheries Commission- 2011. Maryland Department of Natural Resources. Maryland Department of Natural Resources. Annapolis, Maryland.

Rickabaugh, Harry. Personal Communication. 12 Mar. 2013a. Email.

Rickabaugh, Harry. Personal Communication. 12 Mar. 2013b. Email

List of Tables

List of Figures

Table 1. The number, average age and year range for Weakfish sampled along Maryland's coast from 2007 to 2012.

Year	Number Sampled	Average Age	Year Range
2007	217	2.0	1-4
2008	94	1.4	1-3
2009	41	1.2	1-2
2010	115	1.4	1-3
2011	0	NA	NA
2012	51	1.5	1-3

Table 2. Weakfish length ranges and confidence intervals from 2007 to 2012.

Year	Mean Length (mm)	Range	CI
2007	343.0	269-532	± 4.84
2008	354.3	280-495	± 8.90
2009	364.3	330-392	± 4.84
2010	330.3	297-385	± 3.69
2011	0		
2012	351.3	315-424	± 0.20

Table 3. Weakfish weight ranges and confidence intervals from 2007 to 2012.

Year	Average Weight (g)	Range	CI
2007	425.0	250-1600	± 22.75
2008	496.0	265-1220	± 41.26
2009	551.4	346-726	± 24.95
2010	365.2	243-580	± 13.65
2011	0		
2012	436.86	255-686	± 0.76

Table 4. The number, average age, and year range for Atlantic Croaker sampled along Maryland's coast 2012.

Year	Number Sampled	Average Age	Year Range
2012	91	3.0	1-4

Table 5. Atlantic Croaker length and weight range and confidence intervals for 2012.

Average Length (g)	Range	CI	Average Weight (g)	Range	CI
257.36	229-305	± 0.09	212.40	141-337	± 0.23

Table 6. Bluefish length and weight range and confidence intervals for 2012

Average Length (g)	**Range**	**CI**	**Average Weight (g)**	**Range**	**CI**
774.93	471-890	± 0.62	4,160	3100-6900	± 7.88

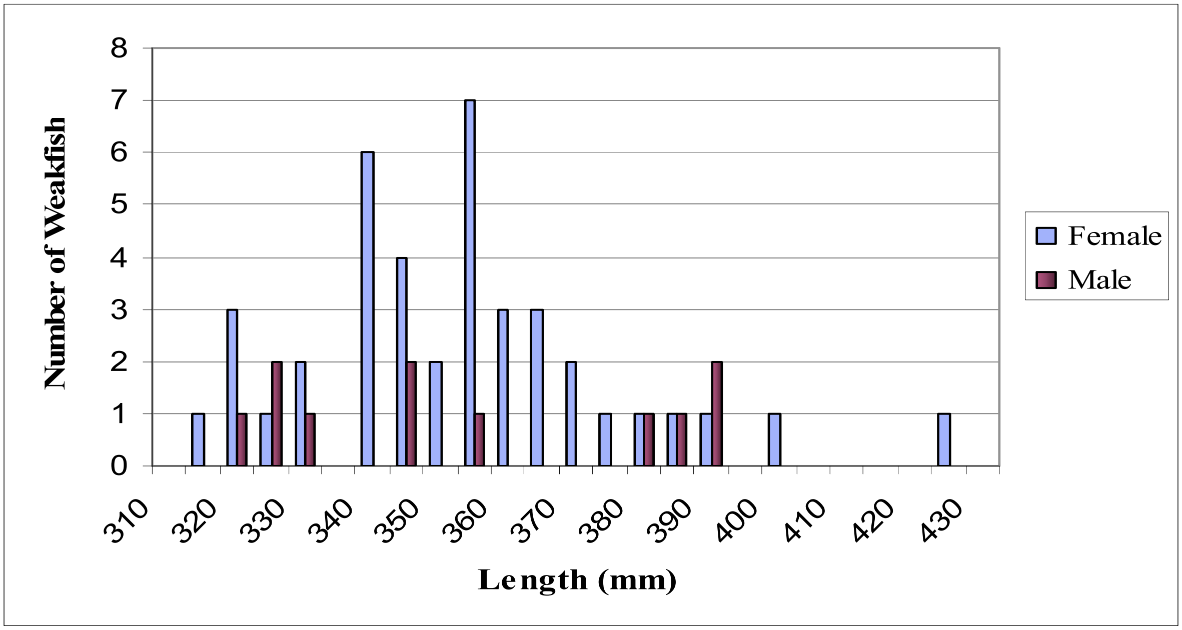


Figure 1. Weakfish (*Cynoscion regalis)* male versus female length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources in 2012, n= 51.

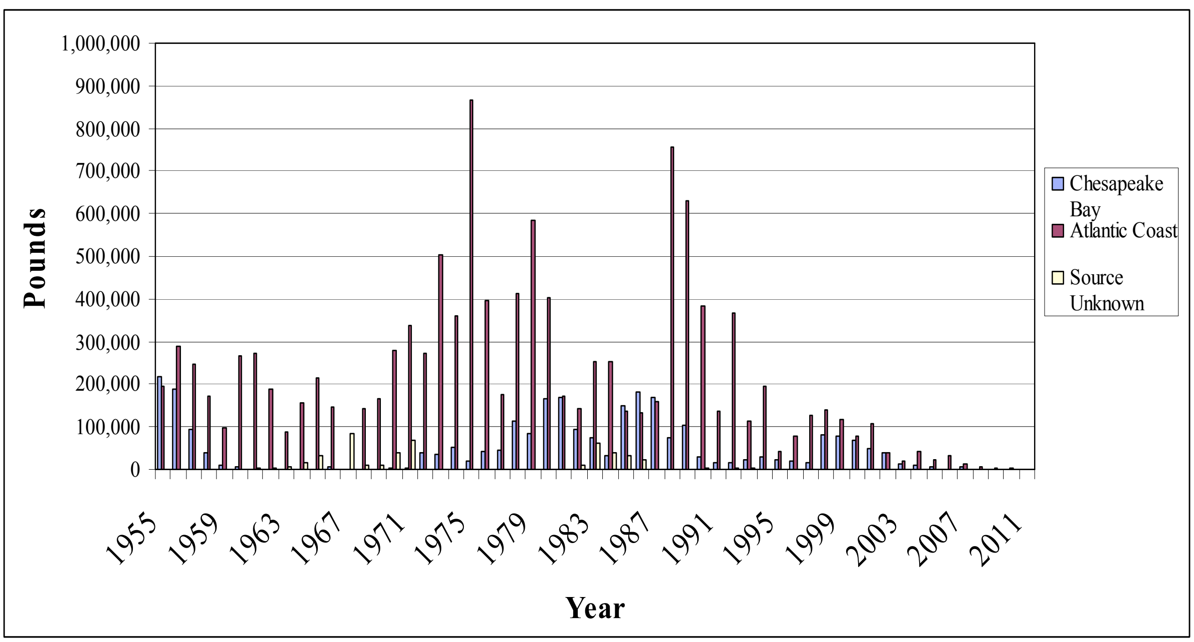


Figure 2. Weakfish (*Cynoscion regalis)* harvest from 1955 through 2011.

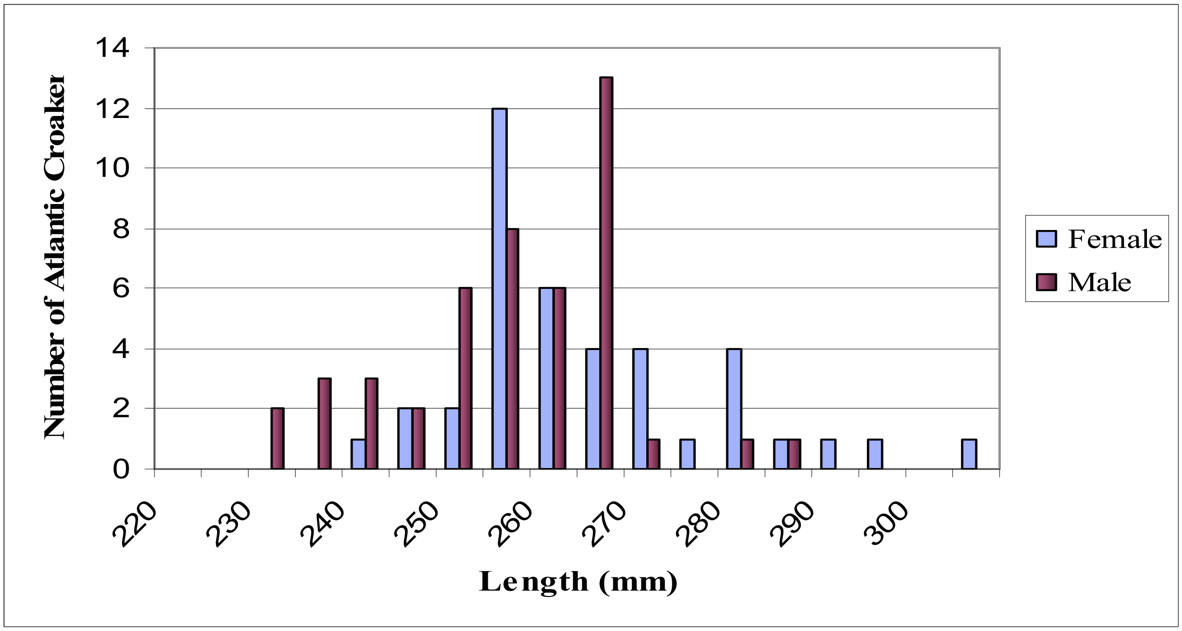


Figure 3. Atlantic Croaker (*Micropogonias undulatus)* male versus female length frequency from commercial gillnet sub-sampled by the Maryland Department of Natural Resources in 2012, n= 86. The sex for 5 is unknown.

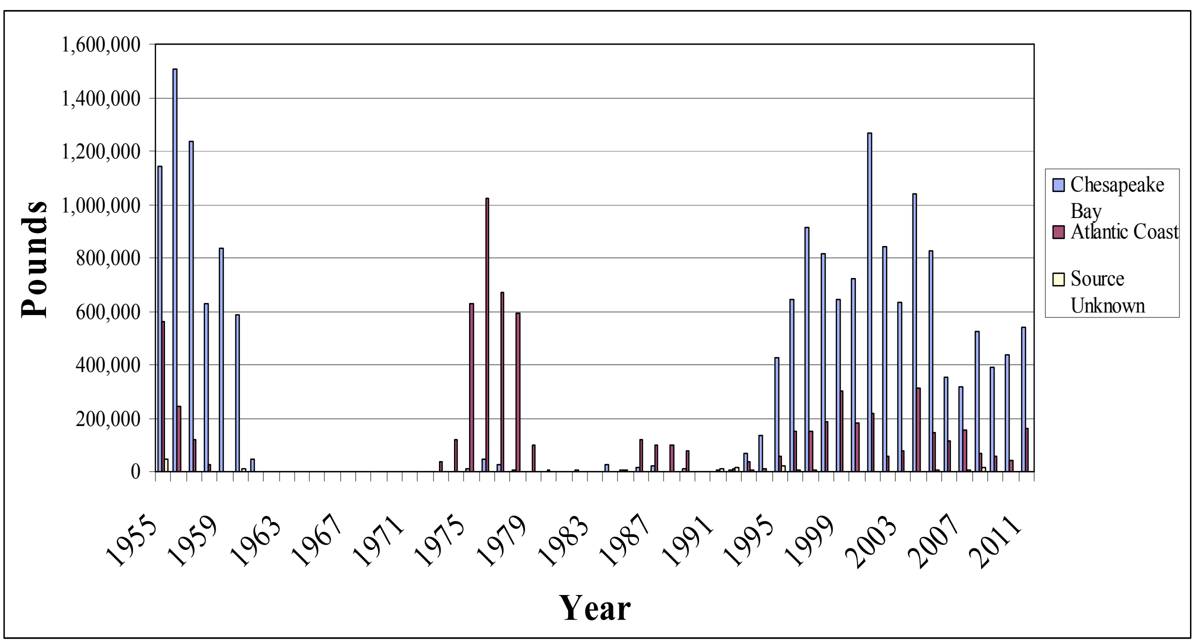


Figure 4. Atlantic Croaker (*Micropogonias undulatus)* Harvest from 1955 through 2011.

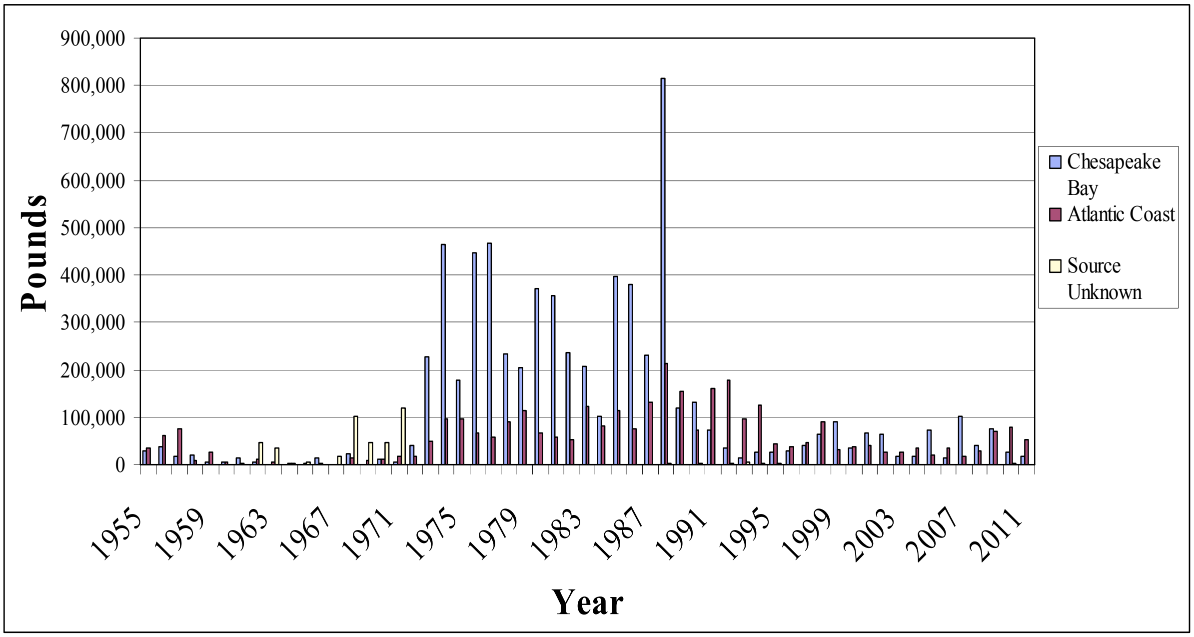


Figure 5. Bluefish (*Pomatomus saltatrix)* Harvest from 1955 through 2011.

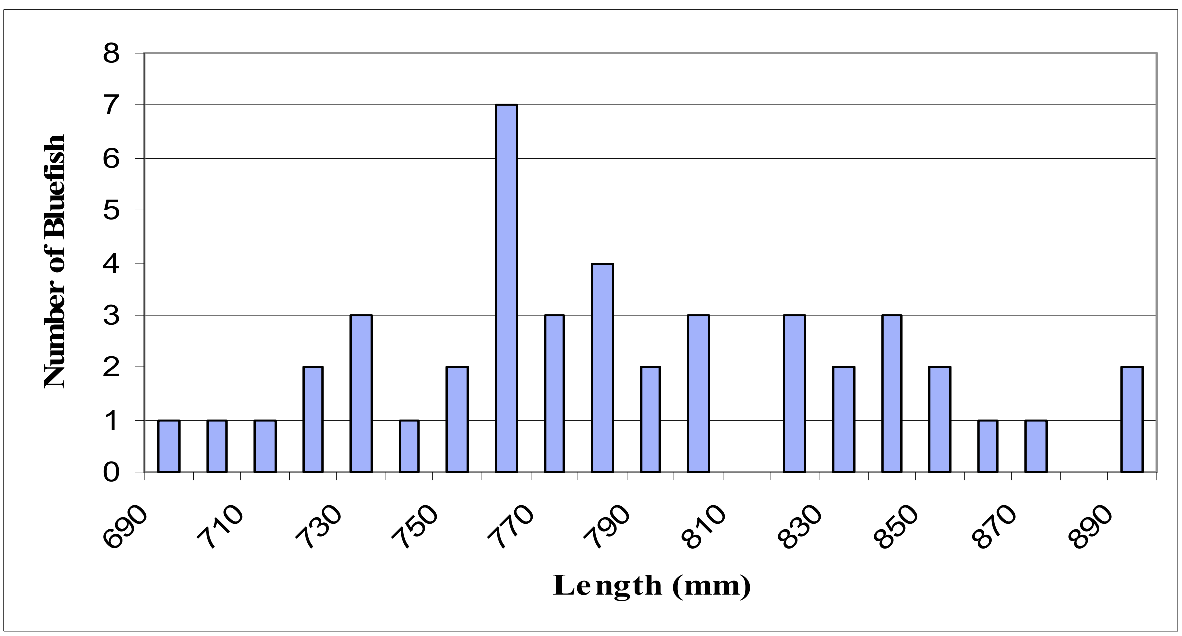


Figure 6. Bluefish (*Pomatomus saltatrix)* total length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources in 2012, n= 45.

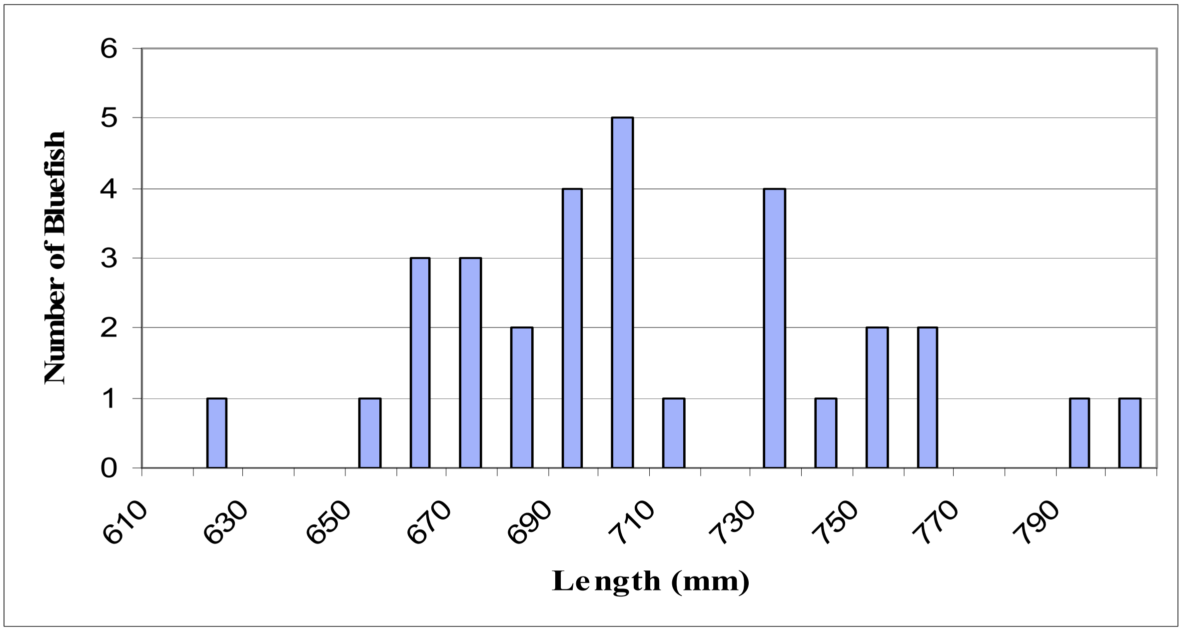


Figure 7. Bluefish (*Pomatomus saltatrix)* fork length frequency from commercial offshore trawls sub-sampled by the Maryland Department of Natural Resources in 2012, n= 31.

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#
_______/______/2012			

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

21 L Bucket Cnt

Comments

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

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

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

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

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

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

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

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

MD DNR Coastal Bays Beach Seine Data Sheet

Appendix 2.

Date (MM/DD/YYYY) ______/______/2012	Start Time (12 hr)	Collector	Set#
Site# S0	**Station Description**		
Seine Length: 100 foot 50 foot		**Temp (°C)**	**Sal (ppt)**
Waypoint Start	**Waypoint Stop**	**DO (mg/L)**	**Secchi (cm)**
Latstrt 38° .	**Latstop** 38° .	**Weather**	**Tide**
Longstrt 75° .	**Longstop** 75° .	**Depth (ft)**	**Est. % Net Open**
%SAV – Choose One 0–No SAV in sample area 1-up to 25% 2-26-50% 3-51%-75%, 4-76%-100% 5-SAV present 6-Undeterminable – give reason		**Bottom Type** 1. 2. Use N/A for line 2 if only 1 type	**Wind Direction & Speed (Knots)** @

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

Weather Codes
0 ≡ clear, no clouds
1 ≡ partly cloudy
2 ≡ overcast
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

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

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

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

MD DNR Coastal Bays Beach Seine Data Sheet

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

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

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

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

Species Name	Counts	Total

Species Name	Counts	Total

Appendix 3.

Summary of the Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey Voucher Collection through 2012

The CBFI voucher collection currently holds 82 species representing 50 families for a total of 230 specimens (Table 1). No new species or fishes were added in 2012 although corrections to the table were made.

Recommendations

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

Table 1. Species list for the CBFI voucher collection, n=230.

Family	Scientific Name	Common Name	Number of Specimens
Achiridae	*Trinectes maculatus*	Hogchoker	3
Anguillidae	*Anguilla rostrata*	American Eel	2
Atherinopsidae	*Membras martinica*	Rough Silverside	8
Atherinopsidae	*Menidia beryllina*	Inland Silverside	4
Atherinopsidae	*Menidia menidia*	Atlantic Silverside	2
Belonidae	*Strongylura marina*	Atlantic Needlefish	3
Blenniidae	*Hypsoblennius hentz*	Feather Blenny	1
Carangidae	*Caranx crysos*	Blue Runner	6
Carangidae	*Caranx hippos*	Crevalle Jack	2
Carangidae	*Selene setapinnis*	Atlantic Moonfish	1
Catostomidae	*Erimyzon oblongus*	Creek Chubsucker	3
Centrarchidae	*Lepomis gibbosus*	Pumpkinseed	2
Centrarchidae	*Pomoxis nigromaculatus*	Black Crappie	1
Clupeidae	*Alosa pseudoharengus*	Alewife	2
Clupeidae	*Brevoortia tyrannus*	Atlantic Menhaden	3
Clupeidae	*Clupea harengus harengus*	Atlantic Herring	5
Clupeidae	*Dorosoma cepedianum*	Gizzard Shad	2
Cynoglossidae	*Symphurus plagiusa*	Blackcheek Tonguefish	1
Cyprinidae	*Cyprinus carpio*	Common Carp	2
Cyprinidae	*Notemigonus crysoleucas*	Golden Shiner	4
Cyprinodontidae	*Cyprinodon variegatus*	Sheepshead Minnow	1
Dasyatidae	*Dasyatis americana*	Southern Stingray	2
Diodontidae	*Chilomycterus schoepfii*	Striped Burrfish	3
Elopidae	*Elops saurus*	Ladyfish	1
Engraulidae	*Anchoa hepsetus*	Striped Anchovy	7
Engraulidae	*Anchoa mitchilli*	Bay Anchovy	3
Fistulariidae	*Fistularia tabacaria*	Bluespotted Cornetfish	2
Fundulidae	*Fundulus diaphanus*	Banded Killifish	5
Fundulidae	*Fundulus majalis*	Striped Killifish	4
Fundulidae	*Lucania parva*	Rainwater Killifish	2
Gasterosteidae	*Apeltes quadracus*	Fourspine Stickleback	1
Gasterosteidae	*Gasterosteus aculeatus*	Threespine Stickleback	6
Gerreidae	*Eucinostomus argenteus*	Spotfin Mojarra	2
Gobiidae	*Ctenogobius pseudofasciatus*	Slashcheek Goby	1
Gobiidae	*Gobiosoma bosc*	Naked Goby	3
Gobiidae	*Microgobius thalassinus*	Green Goby	6
Gymnuridae	*Gymnura micrura*	Smooth Butterfly Ray	1
Haemulidae	*Orthopristis chrysoptera*	Pigfish	4
Hemiramphidae	*Hyporhamphus unifasciatus*	Halfbeak	5
Ictaluridae	*Ameiurus nebulosus*	Brown Bullhead	3

Table 1. Species list for the CBFI voucher collection, n=230.

Family	Scientific Name	Common Name	Number of Specimens
Labridae	*Tautoga onitis*	Tautog	1
Labridae	*Tautogolabrus adspersus*	Cunner	1
Lutjanidae	*Lutjanus griseus*	Gray Snapper	3
Monacanthidae	*Stephanolepis hispida*	Planehead Filefish	2
Moronidae	*Morone americana*	White Perch	1
Mugilidae	*Mugil cephalus*	Striped Mullet	1
Mugilidae	*Mugil curema*	White Mullet	2
Ophidiidae	*Ophidion marginatum*	Striped Cusk-eel	2
Paralichthyidae	*Etropus microstomus*	Smallmouth Flounder	8
Paralichthyidae	*Paralichthys dentatus*	Summer Flounder	2
Phycidae	*Urophycis regia*	Spotted Hake	3
Pleuronectidae	*Pseudopleuronectes americanus*	Winter Flounder	1
Poeciliidae	*Gambusia affinis*	Mosquitofish	1
Pomatomidae	*Pomatomus saltatrix*	Bluefish	3
Priacanthidae	*Pristigenys alta*	Short Bigeye	2
Rachycentridae	*Rachycentron canadum*	Cobia	2
Sciaenidae	*Bairdiella chrysoura*	Silver Perch	3
Sciaenidae	*Cynoscion nebulosus*	Spotted Seatrout	1
Sciaenidae	*Cynoscion regalis*	Weakfish	3
Sciaenidae	*Leiostomus xanthurus*	Spot	4
Sciaenidae	*Menticirrhus americanus*	Southern Kingfish	6
Sciaenidae	*Menticirrhus saxatilis*	Northern Kingfish	2
Sciaenidae	*Micropogonias undulatus*	Atlantic Croaker	3
Sciaenidae	*Pogonias cromis*	Black Drum	1
Scombridae	*Scomberomorus maculatus*	Spanish Mackerel	2
Scophthalmidae	*Scophthalmus aquosus*	Windowpane	1
Serranidae	*Centropristis striata*	Black Sea Bass	5
Serranidae	*Mycteroperca microlepis*	Gag	2
Sparidae	*Archosargus probatocephalus*	Sheepshead	3
Sparidae	*Stenotomus chrysops*	Scup	3
Sparidae	*Lagodon rhomboides*	Pinfish	2
Sphyraenidae	*Sphyraena borealis*	Northern Sennet	1
Stromateidae	*Peprilus paru*	Harvestfish	4
Stromateidae	*Peprilus triacanthus*	Butterfish	5
Syngnathidae	*Hippocampus erectus*	Lined Seahorse	1
Syngnathidae	*Syngnathus floridae*	Dusky Pipefish	2
Syngnathidae	*Syngnathus fuscus*	Northern Pipefish	5
Synodontidae	*Synodus foetens*	Inshore Lizardfish	3
Tetraodontidae	*Sphoeroides maculatus*	Northern Puffer	4
Trichiuridae	*Trichiurus lepturus*	Atlantic Cutlassfish	1
Triglidae	*Prionotus carolinus*	Northern Searobin	4
Triglidae	*Prionotus evolans*	Striped Searobin	5
		Total	**230**

MD DNR Coastal Bays Pilot SAV Habitat Survey Data Sheet

Appendix 4.

Date (MM/DD/YYYY)	Start Time (12 hr)	Collector	Set#
______/______/2012			
Zone: **NB SE** **SW CB**	**Grid Number/Site Description**		
	Seine Length: 50 foot **Distance of Haul: 35 meters**	**Temp (°C)**	**Sal (ppt)**
Waypoint Start	**Waypoint Stop**	**DO (mg/L)**	**Secchi (cm)**
Latstrt **38° .**	**Latstop** **38° .**	**Weather**	**Tide**
Longstrt **75° .**	**Longstop** **75° .**	**Depth (ft)**	**Est. % Net Open**
%SAV Present 1 – up to 25% 2 – 26%-50% 3 – 51%-75% 4 – 76%-100%	**SAV Species Present:** **1.** **2.** **Circle Dominant Species**	**Bottom Type** **1.** **2.** **SAV not an option**	**Wind Direction & Speed (Knots)** @

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

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

Bottom Type Codes
S ≡ Sand M ≡ mud
O ≡ shell R ≡ rubble
G ≡ gravel C ≡ clay
A = SAV NT ≡ not taken
N/A if only one type

Miscellaneous
Collector ≡ person taking data
Tot ≡ total
Cts ≡ Counts
Spp ≡ Species
WTR ≡ Water
Specvol ≡ Actual vol. measured in Liters (L)
Estimatevol ≡ Visual volume estimate in L
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
Oil Skins

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

List species collected for vouchers & quantities

21 L Bucket Cnt

Comments:

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

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

MD DNR Coastal Bays Pilot SAV Habitat Survey Data Sheet

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

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

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

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

Species Name	Counts	Total

Species Name	Counts	Total

Appendix 5.

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

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

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

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