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

2006 Report




Prepared by:
Angel Bolinger, Steve Doctor, Allison Luettel,
Mike Luisi, and Gary Tyler

Federal Aid Project No. F-50-R-15

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

Quarterly Performance Report____ Semi-Annual Performance Report ____
Annual Report __X__ Final Report _____
Proposal _____

Grantee: Maryland Department of Natural Resources – Fisheries Service

Grant No.: F-50-R

Segment No.: 15

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

Period Covered: July 1, 2005 through December 31,2006

Prepared By: ______________________________
Mike Luisi, Principal Investigator & Manager Atlantic Program Date

Approved By: ______________________________
Tom O'Connell, Assistant Director, Estuarine & Marine Division Date

Approved By: ______________________________
George L. Herlth, Jr., Appointing Authority Date

Date Submitted: March 30, 2007

Statutory Funding Authority: Sport Fish Restoration __X__
CFDA #15.605

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

Acknowledgements

Staff of the Atlantic Program would like to thank the MDNR Fisheries Service employees that assisted with the technical evolution of this project. Linda Barker and Alexi Sharov provided statistical expertise. Margaret McGinty suggested changes and additions to the seine and trawl field methods. Species identification assistance was provided by Jim Mowrer, Mitchell Tarnowski, and Butch Webb. Jim Casey provided institutional knowledge.

We would also like to extend our gratitude to the many volunteers from MDNR, AmeriCorps, and the Maryland Coastal Bays Program who assisted with field and voucher collection work. They survived the biting flies, down pouring rain, and mechanical problems with the boat. A special thanks to Brian Sturgis, National Park Service, who provided a ride back to the office when the boat conveniently broke down by his office. The mechanics at Goldsborough Marine located in Crisfield, MD provided excellent, prompt service to the boat's engine.

The CBFI Trawl and Beach Seine "Unsung Volunteer Hero" was Luke Whitman. He was still new to MDNR and had no idea what was going to be asked of him on a cool morning last June. Luke willingly wore a stranger's wetsuit and enthusiastically seined "The Ditch" in the pouring rain with no questions asked and without complaint. No short straw had to be drawn that day.

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

Without the participation of recreational anglers and sport fishing organizations there would be no Maryland Volunteer Angler Summer Flounder Survey. Many outdoor writers, marinas, and tackle shops helped promote the survey in their publications. Frances McFaden helped procure all of the printed materials.

Our administrative staff helped this project ride the waves.

Preface

Recent analyses of Coastal Bay Fisheries Investigations Trawl and Beach Seine Survey data have revealed some seasonal and temporal biases in the data collection (1972-1988) which significantly effect the analyses of the overall time series dataset (1972-2006). These biases were a result of prioritization of resources by the Maryland Department of Natural Resources coupled with limited staff availability and lack of funding.

Beginning in 1989, this survey was performed following a standardized sampling protocol, eliminating the biases of previous years. This report will highlight trends resulting from data collected during the standardized (1989-2006) time period. No historical (1972-1988) data will be included in the data analyses.

Table of Contents

Table of Contents (con't)

Chapter 1

Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey

Introduction:

This survey was developed to characterize fishes and their abundances in Maryland's Coastal Bays in order to 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 fishes although bycatch of crustaceans, mollusks, sponges, and macroalgae are common. Over 130 adult and juvenile species of fishes, 26 mollusks, and 11 macroalgae have been collected since 1972. This survey was designed to meet the following three objectives:

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

Methods:

Study Area

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

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

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

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

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

Data Collection

A 25 foot C-hawk with a 175 Mercury Optimax 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 Garmin e-Trex Legend C was used for navigation, marking sites, and monitoring speed.

Gears

Trawl

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

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

Seine

Seining sampled 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 week of June and September (Table 2, Figure 1). Occasionally, weather or mechanical issues required sampling to continue into the next month.

A 30.5 m X 1.8 m X 6.4 mm mesh (100 ft X 6 ft X 0.25 in. mesh) bag seine was used at 19 fixed sites in depths less than 1.1 m (3.5 ft.) along the shoreline. Most seine samples involved quarter-circle hauls covering about 117 m^2 (1,257 ft^2). However, some sites necessitated varying this routine to fit the available area and depth.

Water Quality and Physical Characteristics

For each sampling method, physical and chemical data were documented at each sampling location. Chemical parameters included: salinity, temperature, and dissolved oxygen (DO). Physical parameters included: wind direction and speed, water clarity (secchi disk), water depth, tide state, and weather condition. Data were recorded on a standardized project data sheet printed on Rite in the Rain All Weather paper (Appendices 1 and 2).

Salinity, water temperature, and DO were taken with a Yellow Springs Instrument (YSI) 30 at two locations, 30 cm below the surface and 30 cm from the bottom, at each trawl site. The YSI cord was marked in 1 ft intervals and the probe had a 26 ounce weight attached to it with a string that measured 30 cm. The weight was used to keep the probe at the proper depth and as vertical as possible. Chemical data were taken 30 cm below the surface for each seine site due to the shallow depth. 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 that day.

Water turbidity was measured with a secchi disk. Secchi readings were taken on the shaded side of the boat without the user wearing sunglasses. The secchi disk was lowered into the water until it could not be seen. Then it was raised until the black and white pattern could just be seen. The biologist then marked the position on the string with their fingers and measured the length (in centimeters, cm) 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 and direction were estimated by a biologist. Criteria used to estimate wind speed included wave size and appearance. Wind direction was determined by the direction of the waves and by checking the weather forecast for that day.

Tidal states were estimated by looking at fixed objects when possible, and checking the published tide tables for the sampled areas. Occasionally in Chincoteague Bay, this parameter was not recorded if tidal state could not be determined. Difficulties determining tide resulted from inlet influences in Ocean City, MD and Chincoteague, VA.

Sample Processing

Fishes and invertebrates were identified, counted, and measured using a wooden millimeter (mm) measuring board with a 90 degree right angle. A meter stick was used for species over 500 mm. Total length (TL) measurements were taken for most fishes (Table 3). At each site, a sub-sample of the first 20 fish of each species of commercial or recreational interest at each site were measured, and the rest were counted. Species of no recreational or forage significance were only counted. Large numbers of fishes of no recreational or forage significance or invertebrates such as comb jellies or grass shrimp were sometimes estimated volumetrically.

Blue crabs were measured for carapace width, sexed, and maturity status was determined (Table 4). 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, sponge, and macroalgae were measured volumetrically (liters, L) using calibrated containers with small holes in the bottom to drain the excess water (Table 4). Small quantities (generally ≤ 10) 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 species out of the total.

Unknown species were placed in Ziploc bags on ice or kept in a bucket of water and taken to the office for identification. Rare species were then kept as voucher specimens (Appendix 3).

Data Analysis

Statistical analyses were conducted on species that historically (1972–2005) represented 95 percent of 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 gamefish. Species rarely encountered (< 5% occurrence) and not considered recreationally important, including forage significance, were removed from the analyses.

Regression analyses were performed for individual species to determine significant trends over the time series (1989-2006). Catch data were transformed [$\log_e(x+1)$], where x represents the Catch Per Unit Effort (CPUE), and regressed by year for both trawl and beach seine data. One is added to all catches in order to transform zero catches, because the log of zero does not exist (Ricker 1975.) Significance was determined at $\alpha=0.05$.

The Geometric Mean (GM) was calculated to develop species specific annual trawl and beach seine indices of relative abundance (1989-2006). 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. It (GM) was calculated from the $\log_e(x+1)$ transformation of the catch data and presented with 95% Confidence Intervals (CIs). The GM and CIs were calculated as the anitlog [$\log_e$-mean(x+1)] and anitlog [$\log_e$-mean(x+1) $\pm$ standard error * (t value: $\alpha=0.05$, n-1)], respectively. A geometric grand mean was calculated for the time series (1989-2005) and used as a point estimate for comparison to the annual estimate of relative abundance.

In order to compare species specific seasonal trawl relative abundance, a chi-squared analysis was performed. Time series (1989-2005) trends were compared to annual (2006) trends in order to determine any significant difference in seasonal abundance. Significance was determined at $\alpha=0.05$. Monthly abundance indices were determined by first calculating the sum-CPUE by month for the time series (historical, standardized, or annual) using the raw (untransformed) catch data. Monthly percent-CPUE were calculated [(monthly sum CPUE)/(total CPUE)*100)] and use to represent the expected (historical or standardized) and observed (annual) values in the analysis. An online chi-squared calculator (http://schnoodles.com/cgi-bin/web_chi.cgi) was used to perform the test and it was accessed on March 5, 2007.

Results and Discussion:

Species: Atlantic Croaker (*Micropogonias undulatus*)

Results

Atlantic croakers were collected in 96 of 140 trawls (68.6%) and in 2 of 38 beach seines (5.3%). A total of 455 juvenile Atlantic croaker were collected in trawl (373 fish) and beach seine (82 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Atlantic croaker ranked 9th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 21.2 fish/hectare and 2.2 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl catch data [$\log_e(x+1)$] showed no significant trend (P=0.1172, Figure 2). Regression of beach seine catch data [$\log_e(x+1)$] showed a significant difference in relative abundance (P=0.0385, Figure 3).

Geometric mean indices of relative abundance were calculated and compared with the standardized 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. Indices for the 2006 trawl and beach seine were both equal to the standardized grand means (Figures 4 and 5).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=6, Figure 6).

Discussion

Regression analysis indicated variation without trend for trawl annual relative abundance whereas a significant trend was determined for beach seine catch data. Since Atlantic croaker spawn offshore, environmental conditions and ocean currents may be a factor influencing relative abundance (Murdy *et al* 1997).

Juvenile Atlantic croakers were more frequently caught in open water (trawl). Therefore trawl indices better represent a more accurate picture of changes in relative abundance when compared to beach seine indices. Since 1989, the trawl relative abundance estimates frequently (10 years) varied from the grand mean.

Management

In the mid-Atlantic, Atlantic croaker were managed by the State of Maryland in cooperation with ASMFC. Maryland's 2006 recreational Atlantic croaker regulations were comprised of a 25 fish creel and a 9 inch minimum size limit (Table 5). Commercial restrictions included a 9 inch minimum size and a season closure from January 1 to May 15, 2006.

Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Atlantic Menhaden (*Brevoortia tyrannus*)

Results

Atlantic menhaden were captured in 18 of 140 trawls (12.9%) and in 19 of 38 beach seines (50%). A total of 2,885 Atlantic menhaden were collected in trawl (198 fish) and beach seine (2,687 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Atlantic menhaden ranked 2nd out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 11.3 fish/hectare and 70.7 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] indicated significant trends (P=0.0236 and 0.0144, Figures 7 and 8, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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% CI of the GM indices of relative abundance were compared. The 2006 trawl and beach seine were both equal to the standardized grand means (Figures 9 and 10, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated no significant difference (P=0.20, df=6, Figure 11).

Discussion

Regression analysis indicated significant trends in the trawl and beach seine catch data; however, the variation among years makes it difficult to discern between an increasing or decreasing pattern. Significant changes in relative abundance may reflect a combination of environmental conditions and/or overfishing.

Atlantic menhaden were caught more often in near shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices. Since 1989, the beach seine relative abundance estimates occasionally (5 years) varied from the grand mean.

Management

In the mid-Atlantic, Atlantic menhaden were managed by the State of Maryland in cooperation with ASMFC. There were no recreational creel or size limits for this species in 2006. A Chesapeake Bay wide commercial harvest cap of 109,020 metric-tons were implemented in 2006 (Table 5, ASMFC 2006).

Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Atlantic Silverside (*Menidia menidia*)

Results

Atlantic silversides were captured in 8 of 140 (5.7%) trawls and in 35 of 38 beach seines (92.1%). A total of 1,370 Atlantic silversides were collected in trawl (95 fish) and beach seine (1,275 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Atlantic silversides ranked 5th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 5.4 fish/hectare and 33.68 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl catch data [$\log_e$(x+1)] showed no significant trend (P=0.3007, Figure 12). Regression of beach seine catch data [$\log_e$(x+1)] indicated a significant trend in relative abundance (P=0.0001, Figures 13).

GM indices of relative abundance were calculated and compared with the standardized 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% CI of the GM indices of relative abundance were compared. The 2006 trawl and beach seine indices were both equal to the standardized grand means (Figures 14 and 15, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=6, Figure 16).

Discussion

Regression analysis indicated variation without trend for trawl annual relative abundance whereas a significant trend was determined for beach seine catch data. Significant changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type.

Atlantic silversides were caught more frequently in near shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices. Since 1989, the beach seine relative abundance estimates seldom (2 years) varied from the grand mean.

Management

No management plan exists for Atlantic silverside. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Bay Anchovy (*Anchoa hepsetus*)

Results

Bay anchovies were captured in 90 of 140 trawls (64.3%) and in 22 of 38 beach seines (57.9%). A total of 6,369 bay anchovies were collected in trawl (5,430 fish) and beach seine (939 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Bay anchovies ranked 1st out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 309.3 fish/hectare and 24.7 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] indicated significant trends (P=0.0001 and 0.0001, Figures 17 and 18, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl and beach seine indices were both equal to the standardized grand means (Figures 19 and 20, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=6, Figure 21).

Discussion

Regression analysis indicated significant trends in the trawl and beach seine catch data; however, the variation among years makes it difficult to discern between an increasing or decreasing pattern. Significant changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type.

Bay anchovies were caught in both near shore and open water locations. Therefore, both indices represent an accurate picture of changes in relative abundance. Since 1989, the relative abundance estimates seldom (3 years trawl, 3 years beach seine) varied from the grand means.

Management

No management plan exists for bay anchovies. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Black Sea Bass (*Centropristis striata*)

Results

Black sea bass were collected in 38 of 140 trawls (27.1%) and 4 of 38 seines (10.5%). A total of 89 juvenile black sea bass were collected in trawl (82 fish) and beach seine (7 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Black sea bass ranked 17^{th} out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 4.7 fish/hectare and 0.2 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] showed no significant trends (P=0.3154 and 0.4578, Figures 22 and 23, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl and beach seine indices were both equal to the standardized grand means (Figures 24 and 25, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated no significant difference (P=1.0, df=6, Figure 26).

Discussion

Regression analysis indicated no significant trends in the trawl and beach seine catch data. 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 both near shore (beach seine) and open water (trawl) locations**;** however, since black seabass are structure oriented neither index accurately represents relative abundance. Since 1989, the relative abundance estimates frequently (10 years trawl, 4 years beach seine) varied from the grand means.

Management

In the mid-Atlantic, black sea bass were managed by the State of Maryland in cooperation with ASMFC, and the Mid-Atlantic Fishery Management Council (MAFMC). Maryland's 2006 recreational black sea bass regulations were comprised of a 25 fish creel and a 12 inch minimum size limit (Table 5). Commercial restrictions included an 11 inch minimum size and required landing permit which contained an Individual Fishing Quota (IFQ) issued by the State. Fishermen without a landing permit were permitted to land 50 pounds per day as bycatch.

Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Bluefish (*Pomatomus saltatrix*)

Results

Bluefish were collected in 6 of 140 trawls (4.3%) and in 20 of 38 beach seines (52.6%). A total of 124 juvenile bluefish were collected in trawl (6 fish) and beach seine (118 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Bluefish ranked 12th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 0.3 fish/hectare and 3.1 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [loge(x+1)] showed no significant trend (P=0.1565 and 0.5462, Figures 27 and 28, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl and beach seine indices both were equal to the standardized grand means (Figures 29 and 30, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=5, Figure 31).

Discussion

Regression analysis indicated no significant trends in the trawl and beach seine catch data. Changes in relative abundance may reflect a combination of environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type.

Bluefish were caught more frequently in near shore (beach seine) locations. Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl indices. Since 1989, the relative abundance estimates occasionally (4 years trawl, 5 years beach seine) varied from the grand means.

Management

In the mid-Atlantic, bluefish were managed by the State of Maryland in cooperation with ASMFC and the MAFMC. Maryland's 2006 recreational bluefish regulations were comprised of a 10 fish creel and an 8 inch minimum size limit (Table 5). Commercial restrictions included an 8 inch minimum size and no seasonal closures.

Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Hogchoker (*Trinectes maculatus*)

Results

Hogchokers were collected in 23 of 140 trawls (16.4%) and 1 of 38 seines (2.6%). A total of 137 hogchoker were collected in trawl (136 fish) and beach seine (1 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Hogchoker ranked 11th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 7.7 fish/hectare and 0.03 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl catch data [$\log_e(x+1)$] showed a significant difference in abundance (P=0.0232, Figure 32). Regression of beach seine catch data [$\log_e(x+1)$] indicated no significant trend in relative abundance (P=0.3331, Figure 33).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl index was equal to the standardized grand mean and the beach seine index was below the standardized grand mean (Figures 34 and 35, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.01, df=6, Figure 36).

Discussion

Regression analysis indicated a significant trend in trawl relative abundance although it has been steady for the past 10 years. No trend was apparent for beach seine catches, which was expected because few individuals were caught with that gear over the years. 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.

Hogchokers were caught more frequently in open water locations (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine indices. Since 1989, the relative abundance estimates seldom (2 years trawl, 4 years beach seine) varied from the grand means.

Management

No management plan exists for hogchokers. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Mummichog (*Fundulus heteroclitus*)

Results

Mummichogs were captured in 5 of 140 trawls (2.9%) and in 8 of 38 beach seines (21.1%). A total of 81 mummichogs were collected in trawl (31 fish) and beach seine (50 fish) samples conducted on Maryland's Coastal Bays in 2005 (Table 4). Mummichogs ranked 18th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 1.8 fish/hectare and 1.3 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] showed no significant trends (P=0.2249 and 0.2736, Figures 37 and 38, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl index was equal to the standardized mean and the beach seine index was below the grand mean (Figures 39 and 40, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=5, Figure 41).

Discussion

Regression analysis indicated no significant trends in the trawl and beach seine catch data. 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.

Mummichogs were caught more frequently in near shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl data. Since 1989, the relative abundance estimates seldom (2 years trawl, 4 years beach seine) varied from the grand means.

Management

No management plan exists for mummichogs. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Northern Searobin (*Prionotus carolinus*)

Results

Northern searobin were collected in 25 of 140 trawls (17.9%) and 0 of 38 seines (0%). A total of 112 juvenile northern searobin were collected in trawl samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Northern searobin ranked 13th out of 79 species in overall finfish abundance. The trawl CPUE was 6.4 fish/hectare.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] showed significant trends (P=0.0001 and 0.0001, Figures 42 and 43, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl index was equal to the grand mean and the beach seine index was below the standardized grand mean (Figures 44 and 45, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between standardized (1989-2005) and 2006 monthly relative trawl abundance. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated no significant difference (P=0.05, df=6, Figure 46).

Discussion

Regression analysis indicated a significant increasing trend in trawl relative abundance whereas a decreasing trend occurred in the beach seine catch data. 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.

Northern searobins were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data. Since 1989, the trawl relative abundance estimates frequently (6 years) varied from the grand mean.

Management

No management plan exists for northern searobins. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Pigfish (*Orthopristis chrysoptera*)

Results

Pigfish were collected in 10 of 140 trawls (7.1%) and in 10 of 38 beach seines (26.3%). A total of 101 juvenile pigfish were collected in trawl (41 fish) and beach seine (60 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Pigfish ranked 16th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 2.3 fish/hectare and 1.6 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] showed no significant trends (P=0.254 and 0.288, Figures 47 and 48, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl and beach seine indices were both equal to the standardized grand means (Figures 49 and 50, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=5, Figure 51).

Discussion

Regression analysis indicated no significant trends in the trawl and beach seine catch data; however, the second (trawl) and third (seine) highest relative abundance figures since 1989 were recorded. 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.

Pigfish were caught in both near shore (beach seine) and open water (trawl) locations. However, the trawl index may not accurately portray the relative abundance since historically few were caught in that gear. Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl data. Since 1989, the beach seine relative abundance estimates frequently (8 years) varied from the grand mean.

Management

No management plan exists for pigfish. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Silver Perch (*Bairdiella chrysoura*)

Results

Silver perch were captured in 48 of 140 trawls (34.3%) and in 17 of 38 beach seines (44.7%). A total of 2,138 silver perch were collected in trawl (821 fish) and beach seines (1,317 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Silver perch ranked 3rd out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 46.8 fish/hectare and 34.7 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl catch data [$\log_e$(x+1)] showed a significant trend (P=0.0001, Figure 52). Regression of beach seine catch data [$\log_e$(x+1)] indicated no significant trend in relative abundance (P=0.3622, Figure 53).

GM indices of relative abundance were calculated and compared with the standardized 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% CI of the GM indices of relative abundance were compared. The 2006 trawl index was above the standardized grand mean and the beach seine index was equal to the standardized grand mean (Figures 54 and 55, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=6, Figure 56).

Discussion

Regression analysis indicated a significant increasing trend in trawl relative abundance whereas no significant trend was determined for beach seine catch data. 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.

Silver perch were caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance. Since 1989, the relative abundance estimates seldom (4 years trawl, 0 years beach seine) varied from the grand means.

Management

No management plan exists for silver perch. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Smallmouth Flounder (*Etropus microstomus*)

Results

Smallmouth Flounder were collected in 20 of 140 trawls (14.1%) and zero of 38 seines (0%). A total of 105 smallmouth flounder were collected in trawl samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Smallmouth flounder ranked 15th out of 79 species in overall finfish abundance. The trawl CPUE was 6 fish/hectare.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl and beach seine catch data [$\log_e(x+1)$] showed significant trends (P=0.0001 and 0.0134, Figures 57 and 58, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl index was equal to the grand mean and the beach seine index was below the grand mean (Figures 59 and 60, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.010, df=6, Figure 61).

Discussion

Regression analysis indicated a significant trend in trawl relative abundance and a decreasing trend in the beach seine catch data. 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.

Smallmouth flounder were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data. Since 1989, the trawl relative abundance estimates occasionally (5 years trawl) varied from the grand mean.

Management

No management plan exists for smallmouth flounder. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Spot (*Leiostomus xanthurus*)

Results

Spot were collected in 68 of 140 trawls (48.6%) and 23 of 38 seines (60.5%). A total of 1385 spot were collected in trawl (747 fish) and beach seine (638 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Spot ranked 4th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 42.5 fish/hectare and 16.8 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl catch data [$\log_e(x+1)$] showed no significant trend (P=0.2084, Figure 62). Regression of beach seine catch data [$\log_e(x+1)$] showed a significant trend in relative abundance (P=0.0365, Figure 63).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl and beach seine indices were both equal to the standardized grand means (Figures 64 and 65, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated no significant difference (P=0.10, df=6, Figure 66).

Discussion

Regression analysis indicated variation without trend for trawl annual relative abundance. A significant trend was determined for beach seine catch data; however, the variation among years makes it difficult to discern between an increasing or decreasing pattern. Since spot spawn offshore, environmental conditions and ocean currents may be a factor influencing relative abundance (Murdy *et al* 1997).

Spot were caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance. Since 1989, the relative abundance estimates occasionally (3 years trawl, 9 years beach seine) varied from the grand means.

Management

In the mid-Atlantic, spot were managed by the State of Maryland in cooperation with ASMFC. There were no recreational or commercial creel, size limits, or harvest limits for this species in 2006. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Striped Killifish (*Fundulus majalis*)

Results

Striped killifish were collected in zero of 140 trawls (0%) and in 8 of 38 beach seines (21.1%). A total of 77 striped killifish were collected in beach seine (77 fish) samples conducted on Maryland's Coastal Bays in 2007 (Table 4). Striped killifish ranked 19^{th} out of 79 species in overall finfish abundance. The beach seine CPUE was 2.0 fish/haul.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] showed no significant trends (P=0.1765 and 0.5761, Figures 67 and 68, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl index was below the grand mean and the beach seine index was equal to the standardized grand mean (Figures 69 and 70, respectively).

Chi-squared analysis was not performed to determine if there was a significant difference between standardized (1989-2005) and 2006 monthly relative trawl abundance because zero fish were caught trawling. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Figure 71 shows a comparison of the 2006 and historical monthly relative abundance indices.

Discussion

Regression analysis indicated no significant trends in the trawl and beach seine catch data. 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.

Striped killifish were caught more frequently in near shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl data. Since 1989, the beach seine relative abundance estimates seldom (2 years) varied from the grand mean.

Since zero fish were caught in the trawl, the comparison of catch distribution by month appears different (flat line) from the historical. This was expected since killifish live near shore and are not well sampled with a trawl.

Management

No management plan exists for striped killifish. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Summer Flounder (*Paralichthys dentatus*)

Results

Summer flounder were collected in 96 of 140 trawls (68.6%) and 12 of 38 seines (31.6%). A total of 512 juvenile summer flounder collected in trawl (480 fish) and beach seine (32 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Summer flounder ranked 7th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 27.3 fish/hectare and 0.8 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] showed significant no trends (P=0.5215 and 0.0749, Figures 72 and 73, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl and beach seine indices were both equal to the standardized grand means (Figures 74 and 75, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated no significant difference (P=1.0, df=6, Figure 76).

Discussion

Regression analysis indicated no significant trends in the trawl and beach seine catch data. 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.

Summer flounder were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data. Since 1989, the trawl relative abundance estimates occasionally (8 years) varied from the grand mean.

Management

In the mid-Atlantic, summer flounder were managed by the State of Maryland in cooperation with ASMFC and the MAFMC. Maryland's 2006 recreational summer flounder regulations were comprised of a 4 fish creel and 15.5 inch minimum size limit in the Atlantic Ocean and Coastal Bays, and a 2 fish creel and 15 inch minimum size limit in the Chesapeake Bay (Table 5). Commercial restrictions included a 14 inch minimum size for all gears with the exception of hook-and-line which had a 15.5 inch minimum in the Atlantic Ocean and Coastal Bays and a 15 inch minimum in the Chesapeake Bay. Permitted fishermen in the Atlantic Ocean and Coastal Bays could harvest 5,000 pounds per day while non-permitted fishermen could land 200 or 50 pounds per day in the Atlantic/Coastal Bays and Chesapeake Bay, respectively.

Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Weakfish (*Cynoscion regalis*)

Results

Weakfish were collected in 29 of 140 trawls (20.7%) and 2 of 38 seines (5.3%). A total of 695 juvenile weakfish were collected in trawl (691 fish) and beach seine (4 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Weakfish ranked 6th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 39.4 fish/hectare and 0.1 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl catch data [$\log_e$(x+1)] showed a significant difference (P=0.0005, Figure 77). Regression of beach seine catch data [$\log_e$(x+1)] showed no significant trend in relative abundance (P=0.1183, Figure 78).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl and beach seine indices were both equal to the standardized grand means (Figures 79 and 80, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=6, Figure 81).

Discussion

Regression analysis indicated a significant trend in trawl annual relative abundance; however, the variation among years makes it difficult to discern between an increasing or decreasing pattern. No significant trend was determined for beach seine catch data. Significant changes in relative abundance may reflect a combination of overfishing, environmental conditions (nutrient levels, water temperature, salinity, and dissolved oxygen) and ecological changes including, shifts in species composition and habitat type. Also, some scientists believed that the large biomass of adult striped bass are foraging heavily on weakfish and consequently, having an effect on weakfish abundance. The weakfish/striped bass interaction may become pivotal in advancing multi-species management of fish stocks in the future.

Weakfish were caught more frequently in open water (trawl). Therefore, trawl indices represent a more accurate picture of changes in relative abundance when compared to beach seine data. Since 1989, the relative abundance estimates occasionally (6 years) varied from the grand mean.

Management

In the mid-Atlantic, weakfish were managed by the State of Maryland in cooperation with ASMFC. Maryland's 2006 recreational weakfish regulations were comprised of an 8 fish creel and a 13 inch minimum size limit (Table 5). Commercial regulations in 2006 restricted fisherman to a 12 inch minimum size and included a complicated array of season closures dependant upon the type of gear used and body of water being fished (i.e. Atlantic Ocean, Coastal Bays, and Chesapeake Bay).

Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: White Mullet (*Mugil curema*)

Results

White mullet were captured in zero of 140 trawls (0%) and in 8 of 38 beach seine samples (21.1%). A total of 108 juvenile white mullet were collected in beach seine samples conducted on Maryland's Coastal Bays in 2006 (Table 4). White mullet ranked 14th out of 79 species in overall finfish abundance. The beach seine CPUE was 2.8 fish/haul.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Both trawl and beach seine catch data [$\log_e(x+1)$] showed significant trends (P=0.0094 and 0.0181, Figures 82 and 83, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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% CI of the GM indices of relative abundance were compared. The 2006 trawl index was below the standardized grand mean and the beach seine index was equal to the standardized grand mean (Figures 84 and 85, respectively).

Chi-squared analysis was not performed to determine if there was a significant difference between standardized (1989-2005) and 2006 monthly relative trawl abundance because zero fish were caught trawling. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Figure 86 shows a comparison of the 2006 and historical monthly relative abundance indices.

Discussion

Regression analysis indicated significant trends in the trawl and beach seine catch data; however, the variation among years makes it difficult to discern between an increasing or decreasing pattern. 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.

White mullet were caught more frequently in near shore locations (beach seine). Therefore, beach seine indices represent a more accurate picture of changes in relative abundance when compared to trawl data. Since 1989, the beach seine relative abundance estimates seldom (3 years) varied from the grand mean.

Since zero fish were caught in the trawl, the comparison of catch distribution by month appears different (flat line) from the historical. This was expected since they were not well sampled with a trawl.

Management

No management plan exists for white mullet. There were no recreational or commercial creel, size limits, or harvest limits for this species. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Species: Winter Flounder (*Pseudopleuronectes americanus*)

Results

Winter Flounder were collected in 31 of 140 trawls (22.1%) and 10 of 38 seines (26.3%). A total of 387 juvenile winter flounder were collected in trawl (219 fish) and beach seine (168 fish) samples conducted on Maryland's Coastal Bays in 2006 (Table 4). Winter Flounder ranked 10th out of 79 species in overall finfish abundance. The trawl and beach seine CPUEs were 12.5 fish/hectare and 4.4 fish/haul, respectively.

Regression analysis was performed on standardized data (1989-2006) to determine if there was a trend in the annual relative abundance over the time series. Trawl and beach seine catch data [$\log_e(x+1)$] showed significant trends (P=0.0159 and 0.0004, Figures 87 and 88, respectively).

GM indices of relative abundance were calculated and compared with the standardized 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 2006 trawl index was above the standardized grand mean and the beach seine index was equal to the standardized grand mean (Figures 89 and 90, respectively).

Chi-squared analysis was performed to determine if there was a significant difference between the standardized (1989-2005) and 2006 monthly relative trawl abundance indices. Beach seine data were excluded from this analysis because sampling was restricted to June and September. Results indicated a significant difference (P=0.001, df=5, Figure 91).

Discussion

Regression analysis indicated significant trends in the trawl and beach seine catch data; however, the variation among years makes it difficult to discern between an increasing or decreasing pattern. 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.

Winter flounder were caught in both near shore (beach seine) and open water (trawl) locations. Therefore, both indices represent an accurate picture of changes in relative abundance. Since 1989, the relative abundance estimates occasionally (6 years trawl, 4 years beach seine) varied from the grand means.

The comparison of catch distribution by month shows an earlier peak in abundance in June instead of August, which was not typical. This peak may be weather related.

Management

In the mid-Atlantic, winter flounder were managed by the State of Maryland in cooperation with ASMFC. There were no recreational or commercial creel, size limits, or harvest limits for this species in 2006. Monitoring will continue in the CBFI Trawl and Beach Seine Survey.

Water Quality and Physical Characteristics

Analysis of the 2006 CBFI Trawl Survey water quality data showed an increase in the overall water temperature of the bays from April through July, with a high temperature of 31.4°C recorded in St. Martins River on July 19, 2006 (Table 6 and Figure 92). July was followed by cooler water temperatures from August to October. Overall, Sinepuxent Bay had the lowest average water temperature 20.1ºC, while St Martins River had the highest 22.1ºC. The lower water temperatures observed in Sinepuxent Bay were more than likely a result of its close proximity to the Ocean City Inlet (Atlantic Ocean), combined with its channel depth (>8 ft.) and relatively small surface area. Conversely, St. Martins River is located farther from the inlet and has a lower average channel depth (<5 ft.). High water temperatures in St. Martins River may also be the result of input from storm water runoff from its highly developed watershed (Ocean Pines community) and warmer freshwater tributaries.

Generally, DO levels in the coastal bays decreased from April to August (Table 6 and Figure 93). The lowest recorded level of 2.4 mg/L was collected on August 23, 2006 in St. Martins River. Typically, as water temperatures increase, DO levels drop as a result of temperatures effect on waters solubility property. Analysis of the 2006 CBFI Trawl Survey water quality data showed similar DO/water temperature trends throughout the bays (Figures 94-99). In St. Martins River, an exception to this trend was observed. As water temperatures increased from May to July, the average DO level also increased from 5.85 mg/L to 6.58 mg/L, respectively (Figure 95). Similar results were also recorded in Isle of Wight Bay in July (Figure 96). This occurrence is likely a result of weather conditions (sunlight=photosynthesis; wind=aeration) and time/location at which samples were taken.

Overall, the variation in salinity recorded throughout the bays was relatively consistent from April to July before a drop in the average was recorded bay wide in September (Table 6 and Figure 100). St. Martins River had the lowest average salinity (26.9 ppt), while Sinepuxent Bay had the highest (30.8 ppt). It was expected that Sinepuxent Bay would have the highest average salinity due to its close proximity to the Ocean City Inlet. On the other hand, St. Martins River is located much farther from the inlet and receives significant freshwater inputs from its headwater tributaries.

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.

Atlantic States Marine Fisheries Commission. November 2006. Addendum III to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Menhaden. Online <http://www.asmfc.org/>. Accessed on April 9, 2007.

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 In *Issues of Ecology*. Number 11. Ecological Society of America.

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

Luisi, Mike, Steve Doctor, and Staff of the MDNR Atlantic Program. 2005. *Investigation of Maryland's Coastal Bays and Atlantic Ocean Finfish Stocks 2004 Report.* Maryland Department of Natural Resources. Federal Aid Project Number F-50-R-14. Annapolis, MD.

Maryland Coastal Bays Program. 2005. *The Comprehensive Conservation and Management Plan for Maryland's Coastal Bays*. Online http://www.mdcoastalbays.org/. Accessed on February 16, 2007.

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.

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.

Wyneken, Jeanette. 2001. Sea Turtle Anatomy – Standard Measurements. Online. http://courses.science.fau.edu/~jwyneken/sta/SeaTurtleAnatomy-Standard_Measurements.pdf. Accessed November 29, 2006.

List of Tables

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)

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 S. 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	1/2 mile S. of Inlet, on mainland marsh edge, N. of pier		
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 N. 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, S. of mouth of Scarboro Cr.	38 09.340	75 16.426
S014	Chincoteague Bay	Cove at Winter Quarter on Assateague Is. (AKA behind Beacon Clumps, on Assateague Is.)	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.		

Table 3. Measurement types for fishes and invertebrates captured during the 2006 Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey.

Species	Measurement Type
Fishes (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 length
Turtles	Carapace length

Table 4. List of species collected in Maryland's Coastal Bays Trawl (T) and Seine (S) Surveys from April through October, 2006. Species are grouped (Finfish, Crustaceans, Mollusks, Other) and 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)**	**CPUE (S)**
Finfish Species						
Bay Anchovy	*Anchoa mitchilli*	6369	5430	939	309.3	24.7
Atlantic Menhaden	*Brevoortia tyrannus*	2885	198	2687	11.3	70.7
Silver Perch	*Bairdiella chrysoura*	2138	821	1317	46.8	34.7
Spot	*Leiostomus xanthurus*	1385	747	638	42.5	16.8
Atlantic Silverside	*Menidia menidia*	1370	95	1275	5.4	33.6
Weakfish	*Cynoscion regalis*	695	691	4	39.4	0.1
Summer Flounder	*Paralichthys dentatus*	512	480	32	27.3	0.8
Brown Bullhead	*Ameiurus nebulosus*	484	0	484	0	12.7
Atlantic Croaker	*Micropogonias undulatus*	455	373	82	21.2	2.2
Winter Flounder	*Pseudopleuronectes americanus*	387	219	168	12.5	4.4
Hogchoker	*Trinectes maculatus*	137	136	1	7.7	<0.1
Bluefish	*Pomatomus saltatrix*	124	6	118	0.3	3.1
Northern Searobin	*Prionotus carolinus*	112	112	0	6.4	0
White Mullet	*Mugil curema*	108	0	108	0	2.8
Smallmouth Flounder	*Etropus microstomus*	105	105	0	6.0	0
Pigfish	*Orthopristis chrysoptera*	101	41	60	2.3	1.6
Black Sea Bass	*Centropristis striata*	89	82	7	4.7	0.2
Mummichog	*Fundulus heteroclitus*	81	31	50	1.8	1.3
Striped Killifish	*Fundulus majalis*	77	0	77	0	2.0
Pinfish	*Lagodon rhomboides*	67	1	66	0.1	1.7
Atlantic Needlefish	*Strongylura marina*	64	0	64	0	1.7
Striped Anchovy	*Anchoa hepsetus*	54	35	19	2.0	0.5
Oyster Toadfish	*Opsanus tau*	34	14	20	0.8	0.5
Southern Kingfish	*Menticirrhus americanus*	30	25	5	1.4	0.1
Dusky Pipefish	*Syngnathus floridae*	29	17	12	1.0	0.4

Table 4. Con't.

Common Name	**Scientific Name**	**Total Number Collected**	**Number Collected (T)**	**Number Collected (S)**	**CPUE (T)**	**CPUE (S)**
Northern Puffer	*Sphoeroides maculatus*	27	15	12	0.9	0.3
Naked Goby	*Gobiosoma bosc*	27	23	4	1.3	0.2
Sheepshead Minnow	*Cyprinodon variegatus*	26	0	26	0	0.7
Golden Shiner	*Notemigonus crysoleucas*	21	0	21	0	0.6
Spotted Hake	*Urophycis regia*	21	21	0	1.2	0
Rainwater Killifish	*Lucania parva*	19	0	19	0	0.5
American Eel	*Anguilla rostrata*	19	8	11	0.5	0.3
Butterfish	*Peprilus triacanthus*	19	19	0	1.1	0
Carp	*Cyprinus carpio*	18	0	18	0	0.5
Harvestfish	*Peprilus alepidotus*	17	0	17	0	0.4
Northern Pipefish	*Syngnathus fuscus*	17	15	2	0.9	0.1
Striped Mullet	*Mugil cephalus*	15	0	15	0	0.4
Cownose Ray	*Rhinoptera bonasus*	13	0	13	0	0.3
Inshore Lizardfish	*Synodus foetens*	13	10	3	0.6	0.1
Striped Burrfish	*Chilomycterus schoepfii*	12	10	2	0.6	0.1
Northern Kingfish	*Menticirrhus saxatilis*	12	10	2	0.6	0.1
Blackcheek Tonguefish	*Symphurus plagiusa*	10	4	6	0.2	0.2
Striped Cusk Eel	*Ophidion marginatum*	10	10	0	0.6	0
Spotfin Mojarra	*Eucinostomus argenteus*	9	2	7	0.1	0.2
Windowpane	*Scophthalmus aquosus*	9	9	0	0.5	0
Striped Searobin	*Prionotus evolans*	9	9	0	0.5	0
Southern Stingray	*Dasyatis americana*	8	2	6	0.1	0.2
Pumpkinseed	*Lepomis gibbosus*	7	0	7	0	0.2
Smooth Butterfly Ray	*Gymnura micrura*	7	5	2	0.3	0.1
Tautog	*Tautoga onitis*	6	1	5	0.1	0.1
Striped Blenny	*Chasmodes bosquianus*	5	0	5	0	0.1
Scup	*Stenotomus chrysops*	5	5	0	0.3	0
Lined Seahorse	*Hippocampus erectus*	5	5	0	0.3	0

Table 4. Con't.

Common Name	**Scientific Name**	**Total Number Collected**	**Number Collected (T)**	**Number Collected (S)**	**CPUE (T)**	**CPUE (S)**
Black Drum	*Pogonias cromis*	4	0	4	0	0.1
Gag	*Mycteroperca microlepis*	4	0	4	0	0.1
Green Goby	*Microgobius thalassinus*	4	4	0	0.2	0
Northern Sennet	*Sphyraena borealis*	3	0	3	0	0.1
Clearnose Skate	*Raja eglanteria*	3	3	0	0.2	0
Blenny Family	*Blenniidae*	2	0	2	0	0.1
Stickleback Family	*Gasterosteidae*	2	0	2	0	0.1
Spotted Seatrout	*Cynoscion nebulosus*	2	0	2	0	0.1
Banded Killifish	*Fundulus luciae*	2	0	2	0	0.1
Common Halfbeak	*Hyporhamphus unifasciatus*	2	0	2	0	0.1
Striped Bass	*Morone saxatilis*	2	0	2	0	0.1
Spadefish	*Chaetodipterus faber*	1	0	1	0	<0.1
Ladyfish	*Elops saurus*	1	0	1	0	<0.1
Northern Stargazer	*Astroscopus guttatus*	1	0	1	0	<0.1
Black Crappie	*Pomoxis nigromaculatus*	1	0	1	0	<0.1
Red Drum	*Sciaenops ocellatus*	1	0	1	0	<0.1
Mosquitofish	*Gambusia affinis*	1	0	1	0	<0.1
Slashcheek Goby*	*Ctenogobius pseudofasciatus*	1	1	0	0.1	0
Butterfly Ray Genus	*Gymnura*	1	1	0	0.1	0
Atlantic Cutlassfish	*Trichiurus lepturus*	1	1	0	0.1	0
Feather Blenny	*Hypsoblennius hentz*	1	1	0	0.1	0
Lookdown	*Selene vomer*	1	1	0	0.1	0
Bluespotted Cornetfish	*Fistularia tabacaria*	1	1	0	0.1	0
Crevalle Jack	*Caranx hippos*	1	1	0	0.1	0
White Perch	*Morone americana*	1	1	0	0.1	0
	Total Finfish	**18,326**	**9,858**	**8,468**		

Table 4. Con't.

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	Estimated Count (T)	Estimated Count (S)	CPUE (T)	CPUE (S)
<u>Crustacean Species</u>**								
Blue Crab	*Callinectes sapidus*	6697	5673	1024			323.1	26.9
Sand Shrimp	*Crangon septemspinosa*	2328	2271	57	3085	100	129.3	1.5
Grass Shrimps	*Palaemonetes spp.*	639	122	517	985	100	6.9	13.6
Lady Crab	*Ovalipes ocellatus*	143	113	30			6.4	0.8
Brown Shrimp	*Farfantepenaeus aztecus*	88	82	6			4.7	0.2
Mantis Shrimp	*Squilla empusa*	88	88	0			5.0	0
Long-Clawed Hermit Crab	*Pagurus longicarpus*	59	42	17			2.4	0.4
Lesser Blue Crab	*Callinectes similis*	56	51	5			2.9	0.1
Mud Crab Family	*Panopeidae*	38	35	3			1.9	0.1
Spider Crab Genus	*Libinia*	23	23	0			1.3	0
Broad-Clawed Hermit Crab	*Pagurus pollicaris*	8	5	3			0.3	0.1
Rock Crab	*Cancer irroratus*	3	3	0			0.2	0
Hermit Crab Genus	*Pagurus*	2	1	1			0.1	<0.1
Six-Spined Spider Crab	*Libinia dubia*	1	1	0			0.1	0
Bigclaw Snapping Shrimp	*Alpheus heterochaelis*	1	1	0			0.1	0
Mud Shrimp	*Callianassa atlantica*	1	1	0			0.1	0
	Total Crustaceans	**10,175**	**8,512**	**1,663**	**4,070**	**200**		

Table 4. Con't.

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	Estimated Count (T)	Estimated Count (S)	CPUE (T)	CPUE (S)
Mollusk Species**								
Blue Mussel	*Mytilus edulis*	250	250	0			14.2	0
Stout Razor Clam	*Tagleus plebeius*	39	5	34			0.3	0.9
Mudsnail Genus	*Nassarius*	16	5	11			0.3	0.3
Bruised Nassa	*Nassarius vibex*	12	9	3			0.5	0.1
Dwarf Surfclam	*Mulinia lateralis*	12	12	0			0.7	0
Squid Family	*Loliginidae*	9	9	0			0.5	0
Long-finned Squid	*Loligo pealeii*	6	6	0			0.3	0
Nudibranch Order	*Nudibranchia*	5	5	0	150		0.3	0
Barnacle Infraclass	*Cirripedi*	4	3	1			0.2	<0.1
Lemon Drop	*Doriopsilla pharpa*	4	4	0			0.2	0
Atlantic Oyster Drill	*Urosalpinx cinerea*	4	4	0			0.2	0
Hard Shell Clam	*Mercenaria mercenaria*	3	1	2			0.1	0.1
Brief Squid	*Lolliguncula brevis*	2	2	0			0.1	0
Green Jackknife Clam	*Solen viridis*	1	1	0			0.1	0
Thick-Lipped Oyster Drill	*Eupleura caudata*	1	1	0			0.1	0
Channeled Whelk	*Busycon canaliculatum*	2	2	0			0.1	0
Eastern White Slipper Shell	*Crepidula plana*	1	1	0			0.1	0
	Total Mollusks	**371**	**320**	**51**	**150**			

Table 4. Con't.

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	Est. Count (T)	Est. Count (S)	Spec. Vol. (L) (T)	Spec. Vol. (L) (S)	Est. Vol. (L) (T)	Est. Vol. (L) (S)	CPUE (T)	CPUE (S)
<u>Other Species</u>**												
Sea Nettle	*Chrysaora quinquecirrha*	659	592	67			17.5		1		33.7	1.8
Sea Squirt	*Mogula manhattensis*	114	14	100	5,500				.5		0.8	2.6
Comb Jelly	*Beroe spp.*	85	81	4			240.75	18.5	166.5	7.5	4.6	0.1
Common Sea Cucumber	*Thyone briareus*	32	23	9							1.3	0.2
Horseshoe Crab	*Limulus polyphemus*	18	16	2							0.9	0.1
Forbes Sea Star	*Asterias forbesi*	14	14	0							0.8	0
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	13	1	12							0.1	0.3
Moon Jelly	*Aurelia aurita*	12	12	0							0.7	0
Sponge Class	*Demospongiae*	2	1	1			6.58		3.75		0.1	<0.1
Snapping Turtle	*Chelydra serpentina serpentina*	1	0	1							0	<0.1
Sea Anemones Order	*Actiniaria*	1	1	0							0.1	0
Sand Dollar	*Echinarachnius parma*	1	1	0							0.1	0

Table 4. Con't.

Common Name	Scientific Name	Total Number Collected	Number Collected (T)	Number Collected (S)	Est. Count (T)	Est. Count (S)	Spec. Vol. (L) (T)	Spec. Vol. (L) (S)	Est. Vol. (L) (T)	Est. Vol. (L) (S)	CPUE (T)	CPUE (S)
Other Species cont.												
Lion's Mane Jelly	*Cyanea capillata*	1	1	0							0.1	0
Mushroom Cap Jelly	*Rhopilema verrilli*				66							
Boring Sponge	*Cliona celata*						127		1.5			
Bryozoan Class	*Gymnolaemata*						76.8	1.5	53.75	14.5		
Goldstar Tunicate									.25			
Sea Pork Bryozoan							.6					
	Total Other	**953**	**757**	**196**	**5,566**		**469.23**	**20**	**227.25**	**22**		

Table 4. Con't.

<u>Submerged Aquatic Vegetation and Macro Algal Species</u>**	**Scientific Name**	**Specific Volume (L) (T)**	**Specific Volume (L) (S)**	**Estimated Volume (L) (T)**	**Estimated Volume (L) (S)**
Eel Grass	*Zostera marina*	5	13	0	0.25
Gracilara Genus		220.25	194	157.25	28.25
Agardhiella	*Agardhiella tenera*	127.5	0	38.25	0.25
Chaetomorpha Genus		11.25	14	4.75	0
Cladophora Genus		9	54.5		
Enteromorpha Genus		0.5	9.5	0	25.5
Polysiphonia Genus		1.5	0	0.25	4
Champia Genus		9		29.25	
Ceramium		3	19.25	0.25	0
Ulva Genus		49	6.75	23.75	0
Green Fleece	*Codium fragile*		0.75		8.75
<u>Fucus</u>		0	0.75	0.25	0
	Total Macroalgae	**436**	**312.5**	**254**	**67**

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

Table 5. Summary of Maryland Recreational & Commercial Regulations for 2006.

Recreational

Species	**Area**	**Minimum Size Limit (inches)**	**Creel (person/day)**	**Closures**
Atlantic Croaker	All Waters[A]	9	25	
Black Sea Bass	Chesapeake Bay[B]	12	25	Dec 1-Dec 31
	Coastal Waters[C]	12	25	
Bluefish	All Waters[A]	8	10	
Summer Flounder	Chesapeake Bay[B]	15	2	
	Coastal Waters[C]	15.5	4	
Weakfish	All Waters[A]	13	8	

Commercial

Species	**Area**	**Minimum Size Limit (inches)**	**Commercial Season, Days, Times, & Area Restrictions**	**Special Conditions/Comments**
Atlantic Croaker		9	Mar 16-Dec 31	CLOSED Jan 1-Mar 15
Atlantic Menhaden		None	None	Harvest cap of 109,020 metric-tons
Black Sea Bass		11	Landing Permit Required	Individual IFQ issued. Individual without a landing permit 50 lbs.
Bluefish		8	OPEN YEAR ROUND	
Summer Flounder	Ocean	14 Hook & Line 15.5	Annual Quota	Individual IFQ issued. Individual without a permit: 100lbs./day
	Bay	14 Hook & Line 15	Annual Quota	All fishermen: 50 lbs./day
Weakfish		12	**Chesapeake Bay**: Aug 5-Sep 30 **Ocean**: <u>All gear except trawl</u>: Mar 25-Apr 26, & Sep 2-Nov14; Sun closed. <u>Trawl</u>: Oct 18-Dec 25; Sat & Sun closed.	Trawl mesh min. 3 ¾" stretched; Gill net mesh min. 3" stretched. Chesapeake Bay Hook & Line season is closed Oct 1. Hook & Line may not land by-catch during closed weakfish season. During a closed weakfish season, 150 lbs./day of legal sized by-catch is permitted for any gear other than hook & line provided that at least equal poundage of other species is landed.

[A]: Includes Atlantic Ocean, Coastal Bays, Chesapeake Bay, & all tributaries
[B]: Includes Chesapeake Bay & all tributaries
[C]: Includes Atlantic Ocean & Coastal Bays

Table 6. Coastal Bays Fisheries Investigations 2006 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:	17.3	19.2	20.4	30.7	27.3	23.12	10.5
		(17.1-17.5)	(19.0-19.4)	(20.3-20.4)	(30.2-31.2)	(27.1-27.4)	(22.7-23.4)	(10.5-10.6)
	Bottom:	17.5	19.1	20.4	29.4	26.9	23.0	10.5
		(17.5-17.6)	(18.9-19.4)	(20.3-20.6)	(28.9-29.9)	(26.6-27.2)	(22.6-23.4)	(10.4-10.6)
DO (mg/L)	Surface:	7.2	6.7	6.2	6.6	5.3	6.2	9.5
		(6.9-7.6)	(6.6-7.1)	(5.8-6.7)	(6.2-7.0)	(4.8-5.9)	(5.6-6.7)	(9.4-9.6)
	Bottom:	6.6	6.5	6.2	4.7	4.2	6.2	9.5
		(6.2-7.1)	(6.3-6.7)	(5.4-6.8)	(4.1-5.5)	(3.9-4.4)	(5.6-6.6)	(9.4-9.7)
Salinity (ppt)	Surface:	27.4	29.5	29.3	28.9	31.6	26.2	26.9
		(24.9-29.0)	(28.9-30.3)	(28.7-30.3)	(28.9-29.9)	(31.5-31.8)	(25.5-27.6)	(25.5-28.4)
	Bottom:	29.1	29.5	29.5	29.0	31.6	26.4	27.1
		(28.5-29.8)	(28.9-30.3)	(28.8-30.3)	(28.6-29.5)	(31.5-31.7)	(25.5-27.9)	(25.9-28.5)
Secchi (cm)		N/A	59.0	N/A	38.5	53.8	116.0	237.0
			(44.0-74.0)		(36.0-43.0)	(42.3-69.0)	(75.0-187.0)	(213.0-256.0)
				Saint Martins River (Sites: T004 and T005)				
Temp (°C)	Surface:	18.5	20.1	26.8	30.9	27.9	21.0	10.2
		(17.8-19.2)	(19.5-20.6)	(26.1-27.4)	(30.3-31.4)	(27.8-28.0)	(20.7-21.3)	(9.9-10.4)
	Bottom:	18.7	20.0	26.8	30.3*	27.1	21.3	10.2
		(17.9-19.4)	(19.5-20.5)	(26.1-27.5)		(26.9-27.3)	(20.7-21.8)	(9.9-10.5)
DO (mg/L)	Surface:	7.8	6.1	6.5	6.7	5.7	6.5	9.6
		(7.6-7.9)	(5.7-6.4)	(6.3-6.7)	(6.4-7.0)	(5.3-6.2)	(6.4-6.7)	(9.2-9.9)
	Bottom:	8.0	5.6	6.1	6.46*	3.0	4.8	9.7
		(8.0-8.1)	(5.1-6.2)	(6.0-6.3)		(2.4-3.5)	(4.7-4.9)	(9.3-10.1)
Salinity (ppt)	Surface:	26.9	27.2	26.6	26.8	29.5	25.2	24.6
		(24.6-29.2)	(25.2-29.2)	(24.4-28.8)	(25.3-28.2)	(27.9-31.1)	(22.2-28.2)	(21.5-27.7)
	Bottom:	26.9	27.6	26.6	28.3*	29.8	26.3	24.6
		(24.4-29.3)	(25.9-29.2)	(24.4-28.8)		(28.5-31.1)	(24.2-28.4)	(21.5-27.7)
Secchi (cm)		N/A	92.5	38.5	46.0	40.0	72.5	153.0
			(85.0-100.0)	(28.0-49.0)	(28.0-64.0)	(30.0-50.0)	(55.0-90.0)	(94.0-212.0)

* = Only one measurement collected

Table 6 (con't). Coastal Bays Fisheries Investigations 2006 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:	17.7	18.8	24.1	29.6	27.9	21.7	12.5
		(16.8-18.6)	(17.2-20.4)	(18.7-29.5)	(28.3-30.8)	(26.3-29.4)	(20.2-23.2)	(9.6-15.3)
	Bottom:	17.9	19.0	24.1	29.2	27.4	22.2	12.5
		(17.0-18.8)	(17.3-20.6)	(18.6-29.5)	(27.9-30.5)	(25.6-29.2)	(21.2-23.2)	(9.8-15.2)
DO (mg/L)	Surface:	6.2	6.3	6.1	6.2	7.5	5.2	9.3
		(5.9-6.6)	(5.5-7.1)	(5.5-6.8)	(5.7-6.6)	(6.4-8.6)	(4.1-6.3)	(8.7-10.0)
	Bottom:	5.6	6.3	6.3	5.1	5.7	5.4	9.4
		(4.7-6.6)	(5.6-7.1)	(5.8-6.8)	(4.7-5.4)	(5.5-5.8)	(4.7-6.1)	(8.8-10.0)
Salinity (ppt)	Surface:	27.7	29.3	28.4	28.7	30.8	23.2	27.8
		(27.4-27.9)	(27.4-31.2)	(26.2-30.5)	(27.4-30.0)	(30.4-31.1)	(18.3-28.0)	(24.2-31.3)
	Bottom:	29.2	29.4	28.3	28.8	30.8	25.8	28.0
		(27.9-30.4)	(27.5-31.3)	(26.2-30.4)	(27.7-29.9)	(30.4-31.1)	(23.6-28.0)	(24.6-31.3)
Secchi (cm)		N/A	114.0	41*	45.8	49.5	90.5	194.0
			(100.0-128.0)		(38.5-53.0)	(25.0-74.0)	(64.0-117.0)	(115.0-273.0)
Sinepuxent Bay (Sites: T008, T009, and T010)								
Temp (°C)	Surface:	16.8	18.6	21.9	23.5	25.3	22.4	13.6
		(15.2-18.4)	(18.1-19.0)	(18.1-26.6)	(20.7-26.5)	(22.9-27.2)	(21.6-23.7)	(11.0-15.0)
	Bottom:	16.4	18.6	19.5	23.6	25.3	22.4	13.6
		(14.8-18.4)	(18.0-18.9)	(18.1-20.9)	(20.8-26.5)	(22.9-27.2)	(21.6-23.8)	(11.0-14.9)
DO (mg/L)	Surface:	7.6	7.3	6.7	6.5	5.4	6.2	12.2
		(7.3-8.0)	(7.0-7.5)	(6.0-7.0)	(5.0-8.5)	(4.7-6.1)	(5.8-6.9)	(11.7-13.2)
	Bottom:	7.6	7.4	6.9	6.7	5.2	6.4	12.6
		(7.1-8.1)	(7.1-7.5)	(6.8-7.0)	(5.3-8.7)	(4.7-6.2)	(6.1-7.0)	(12.1-13.4)
Salinity (ppt)	Surface:	31.0	31.4	30.9	30.6	32.0	29.4	30.5
		(30.9-31.0)	(31.4-31.6)	(30.7-31.3)	(29.9-31.2)	(30.8-33.4)	(28.2-30.2)	(28.8-31.3)
	Bottom:	31.0	31.5	30.8	30.6	32.1	29.5	30.5
		(31.0-31.0)	(31.5-31.6)	(30.7-30.8)	(29.9-31.2)	(30.8-33.4)	(28.2-30.2)	(28.8-31.4)
Secchi (cm)		N/A	48.0	24.8	46.0	99.7	78.0	185.3
			(38.0-60.0)	(14.0-35.5)	(35.0-62.0)	(46.0-178.0)	(70.0-90.0)	(91.0-243.0)

* = Only one measurement collected

Table 6 (con't). Coastal Bays Fisheries Investigations 2006 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:	19.2 (18.9-19.5)	18.5 (18.1-18.9)	*	27.2 (26.9-27.4)	27.6 (27.4-27.8)	20.1 (20.0-20.2)	10.2 (9.9-10.5)
	Bottom:	18.7 (18.3)	18.4 (18.2-18.5)	*	27.2 (27.0-27.4)	27.6 (27.4-27.8)	20.8 (20.3-21.3)	10.8 (10.3-11.2)
DO (mg/L)	Surface:	7.6 (7.5-7.7)	7.1 (6.5-7.6)	*	6.4 (6.3-6.4)	5.3 (4.9-5.6)	7.6 (6.9-8.3)	14.5 (14.3-14.6)
	Bottom:	7.4 (7.1-7.7)	6.9 (6.3-7.5)	*	6.6 (6.3-6.8)	5.3 (5.0-5.5)	5.8 (5.7-5.9)	12.9 (12.6-13.3)
Salinity (ppt)	Surface:	28.0 (18.3-19.1)	30.0 (28.9-31.0)	*	29.5 (28.3-30.6)	32.7 (32.7-32.7)	25.2 (23.7-26.7)	23.3 (20.1-26.5)
	Bottom:	28.2 (27.4-29.0)	30.1 (28.9-31.2)	*	29.6 (28.3-30.9)	32.7 (32.6-32.7)	26.4 (25.7-27.0)	25.0 (22.2-27.8)
Secchi (cm)		*	29.0 (25.0-33.0)	32.5 (27.0-38.0)	30.7 (24.0-37.4)	29.5 (25.0-34.0)	54.0 (50.0-58.0)	74.0 (63.0-85.0)
				Chincoteague Bay (Sites: T013, T014, T015, T016, T017, T018, T019 and T020)				
Temp (°C)	Surface:	18.6 (17.3-19.7)	18.8 (17.4-20.1)	26.5 (26.1-27.1)	27.6 (26.6-28.3)	25.8 (22.7-28.0)	20.8 (19.3-21.8)	17.0 (16.4-18.1)
	Bottom:	18.5 (17.2-19.6)	18.9 (17.3-20.2)	26.3 (26.0-26.7)	27.4 (26.6-28.4)	25.8 (22.6-27.9)	20.7 (19.4-21.7)	16.9 (27.9)
DO (mg/L)	Surface:	7.2 (6.7-7.6)	7.2 (6.4-8.1)	6.7 (5.1-7.5)	6.1 (5.5-6.8)	5.5 (4.3-7.5)	6.4 (5.1-7.5)	6.8 (6.6-7.2)
	Bottom:	7.3 (6.9-8.0)	7.0 (6.1-8.2)	6.4 (4.4-7.5)	5.9 (5.5-6.9)	5.5 (4.3-7.2)	6.1 (4.0-6.7)	6.8 (6.5-7.6)
Salinity (ppt)	Surface:	30.6 (29.2-32.2)	31.9 (31.1-33.2)	31.5 (30.3-32.8)	30.3 (28.9-31.4)	31.8 (29.5-33.1)	28.9 (27.8-29.9)	27.9 (26.8-29.4)
	Bottom:	30.6 (29.2-32.4)	32.1 (31.1-33.3)	31.7 (30.8-32.8)	30.3 (28.9-31.3)	31.9 (29.4-33.9)	28.8 (27.8-29.9)	28.0 (26.8-29.3)
Secchi (cm)		*	43.2 (34.0-64.0)	43.6 (26.0-60.0)	39.1 (33.0-45.0)	44.4 (28.0-70.0)	63.5 (47.0-84.0)	118.4 (61.0-274.0)

* = Only one measurement collected

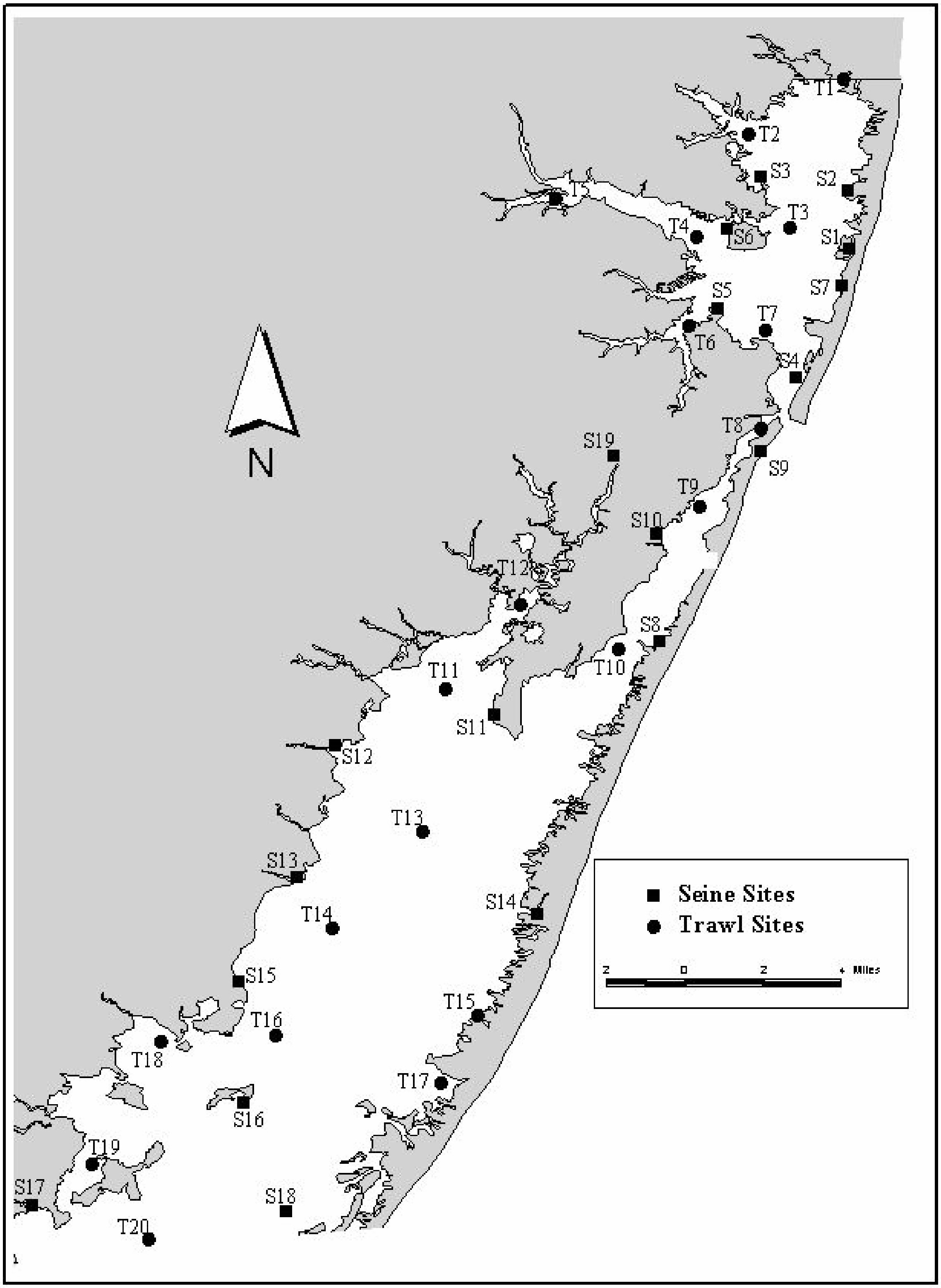


Figure 1. Site locations for the 2006 Coastal Bays Fishery Investigations Trawl and Beach Seine Survey.

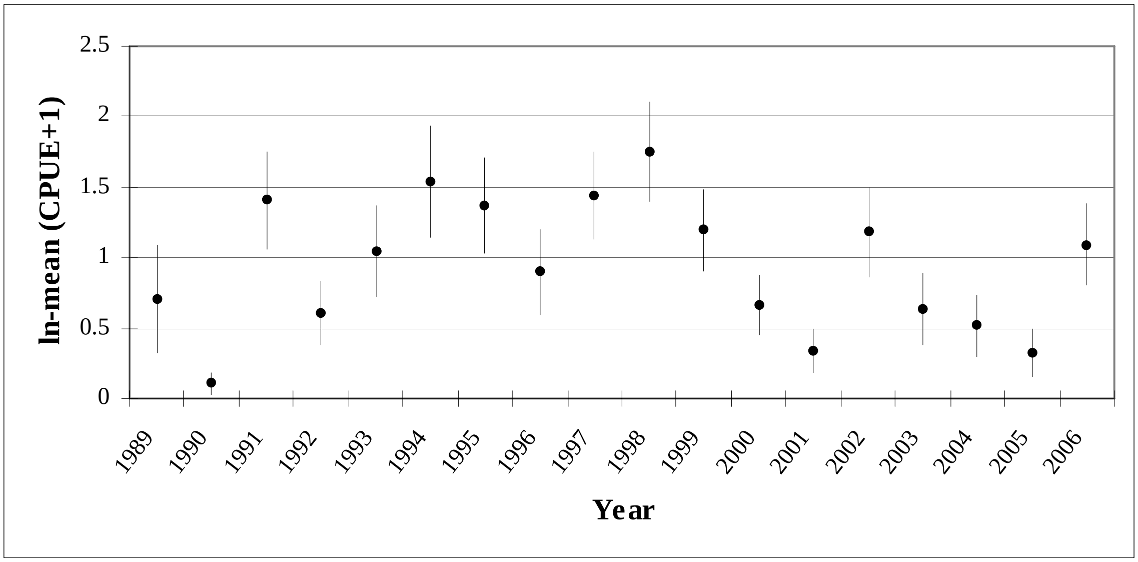


Figure 2. Atlantic croaker trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

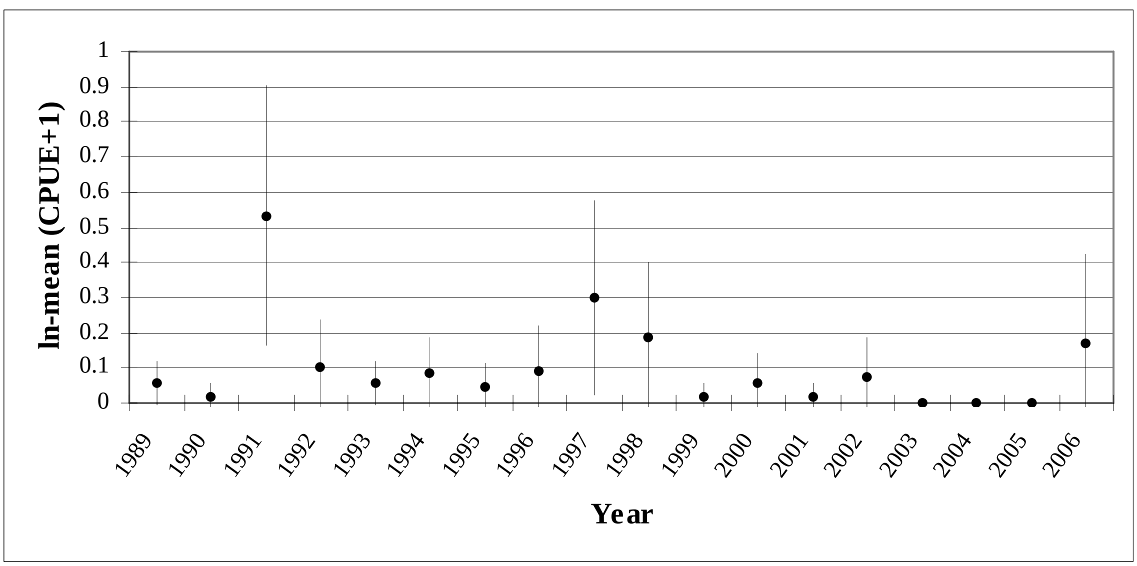


Figure 3. Atlantic croaker beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

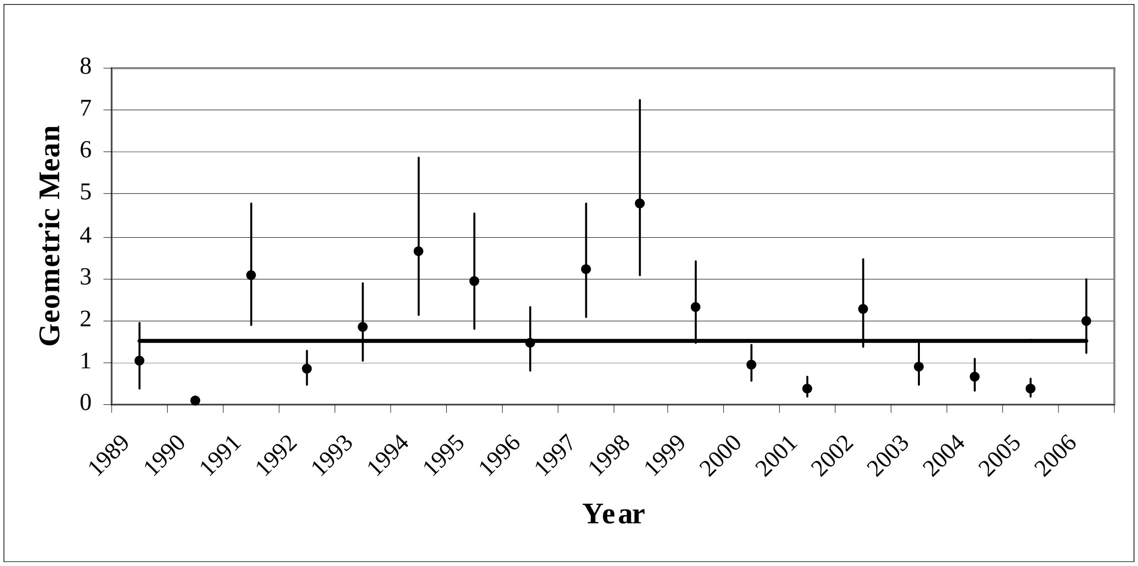


Figure 4. Atlantic croaker trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

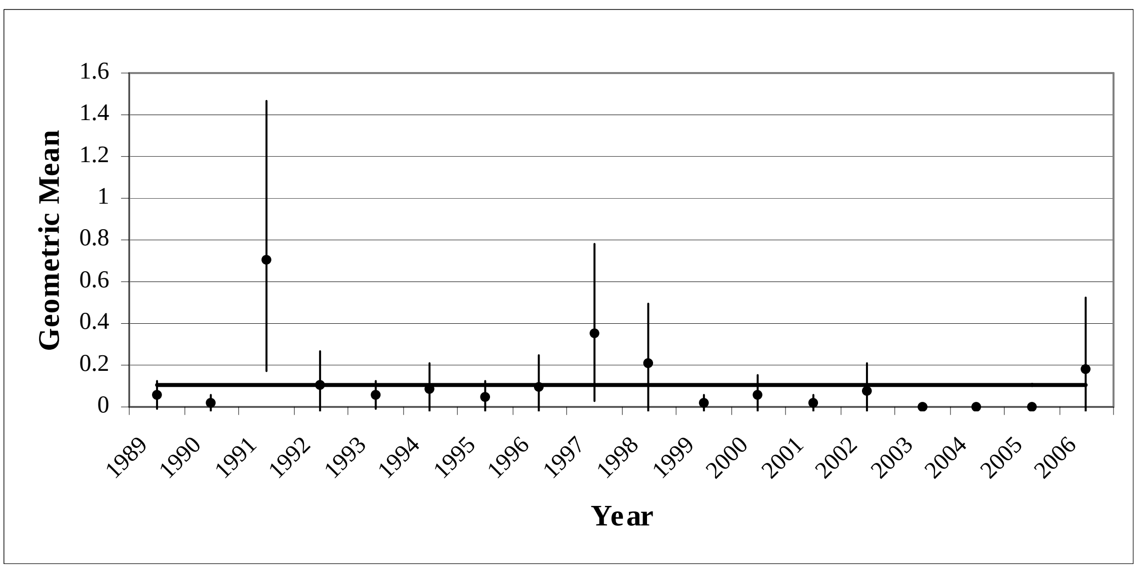


Figure 5. Atlantic croaker beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

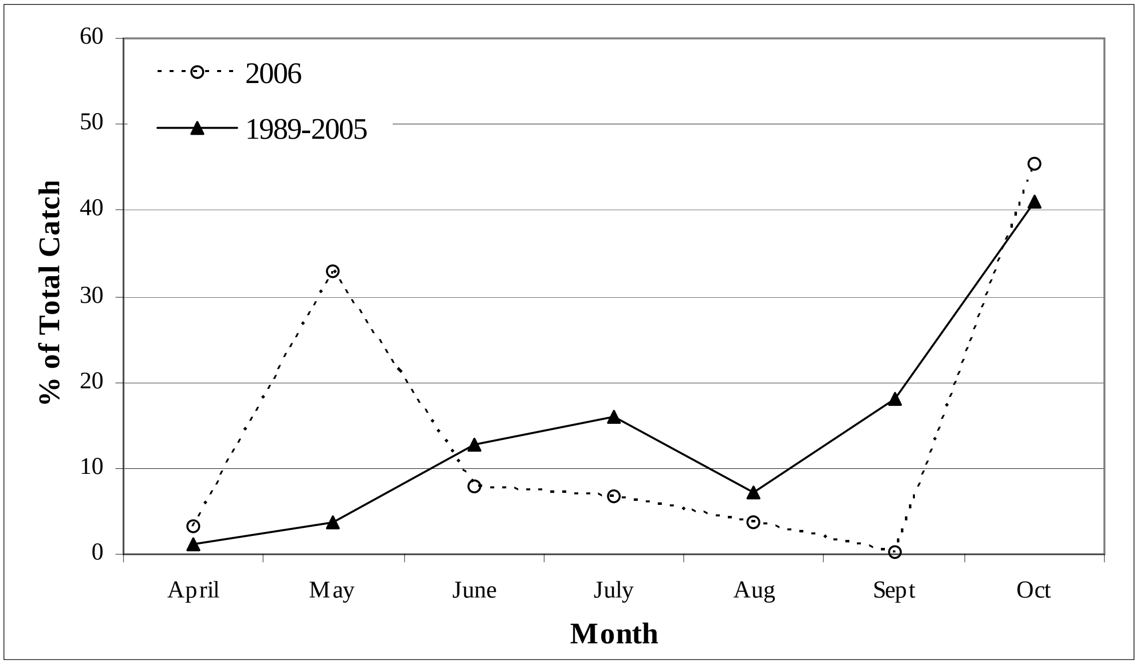


Figure 6. Comparison of the standardized (1989-2005) and 2006 seasonal Atlantic croaker trawl percent catch by month.

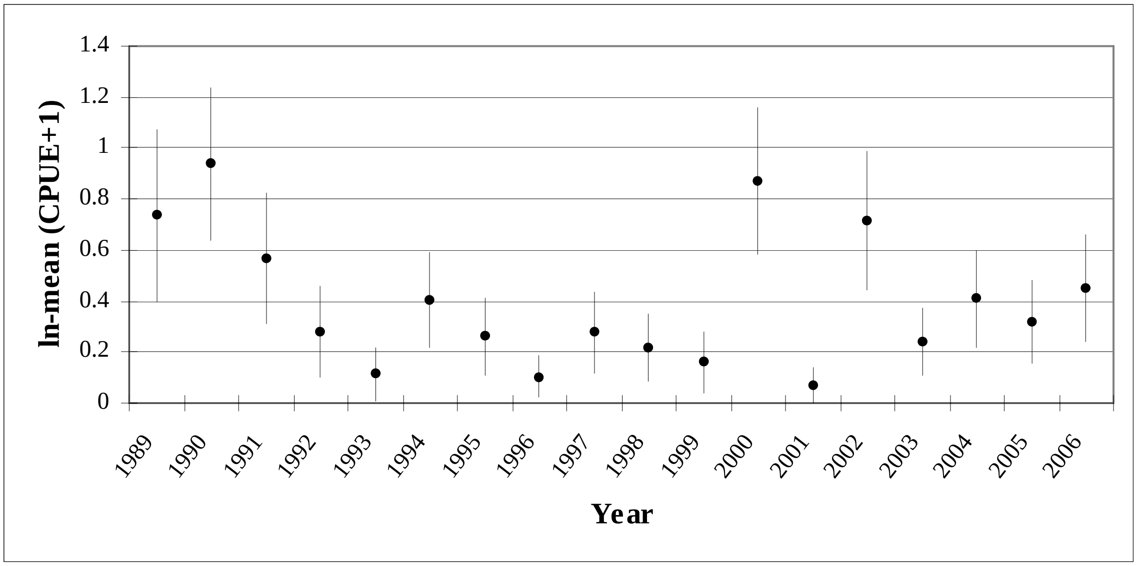


Figure 7. Atlantic menhaden trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

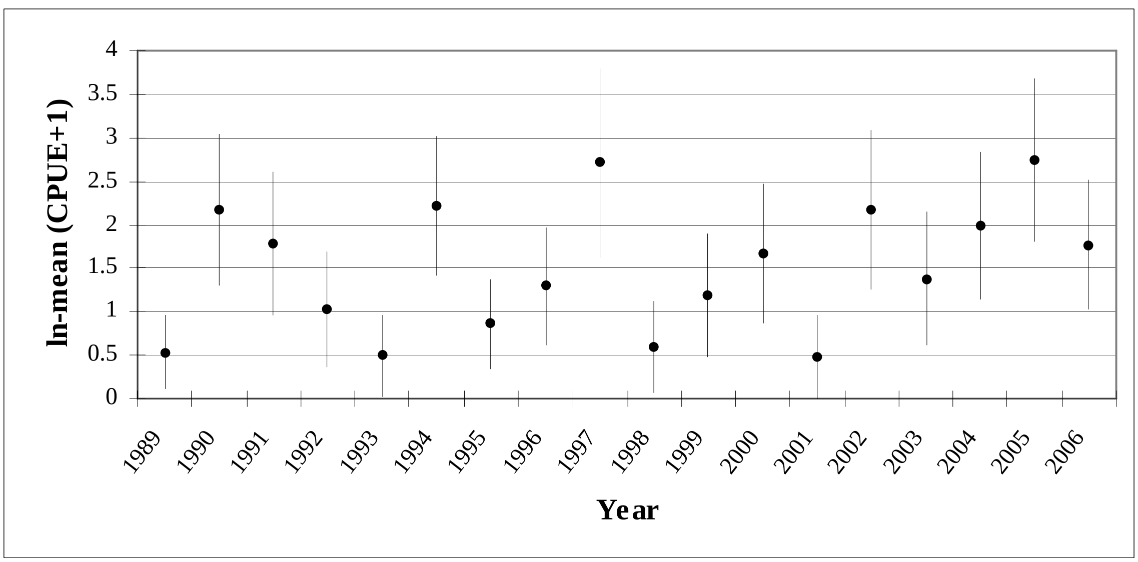


Figure 8. Atlantic menhaden beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

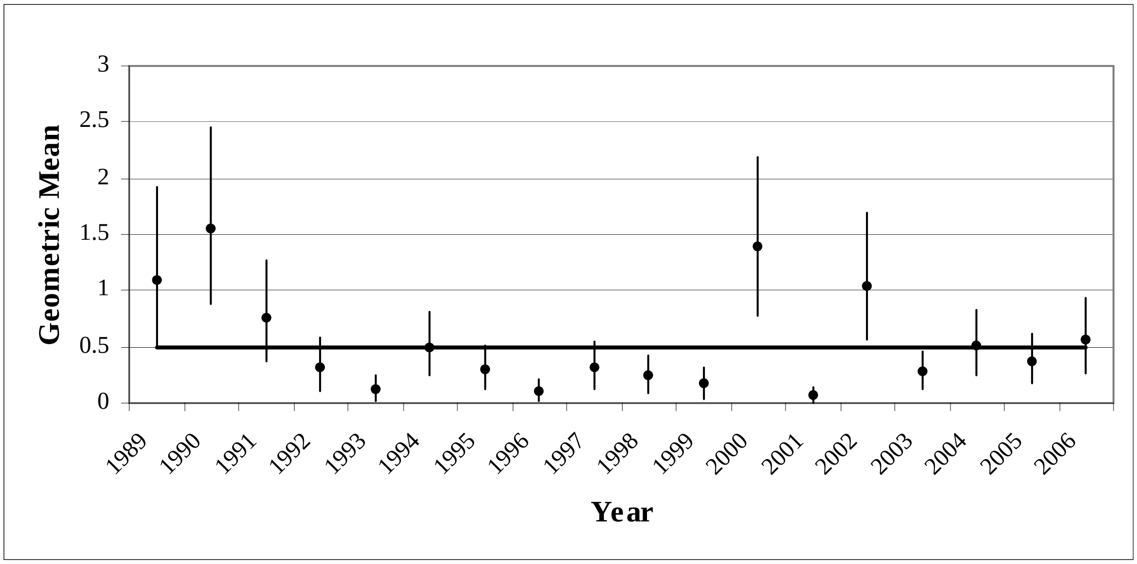


Figure 9. Atlantic menhaden trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

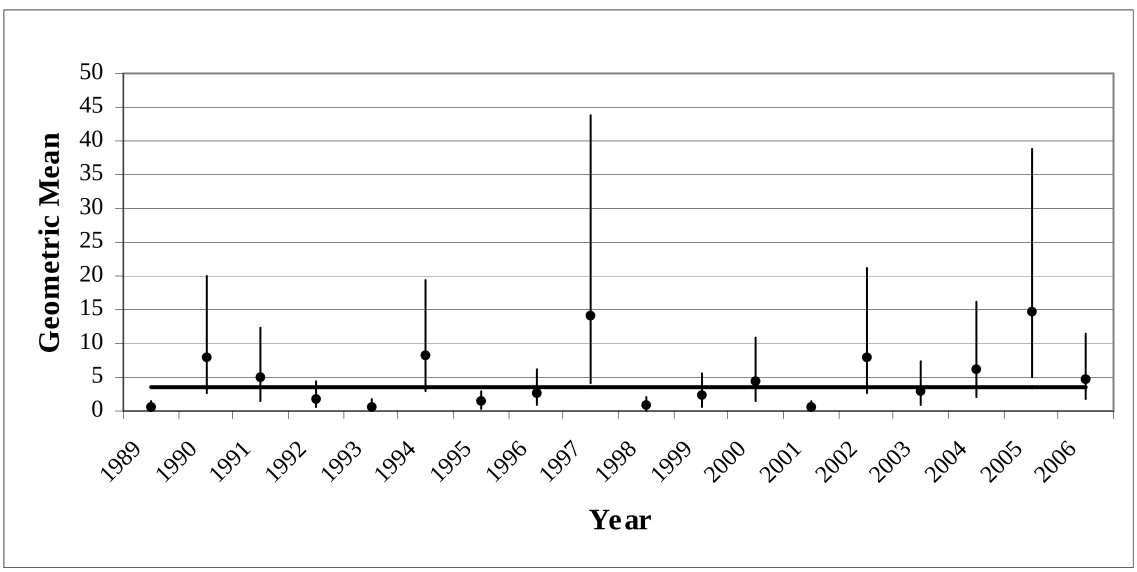


Figure 10. Atlantic menhaden beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

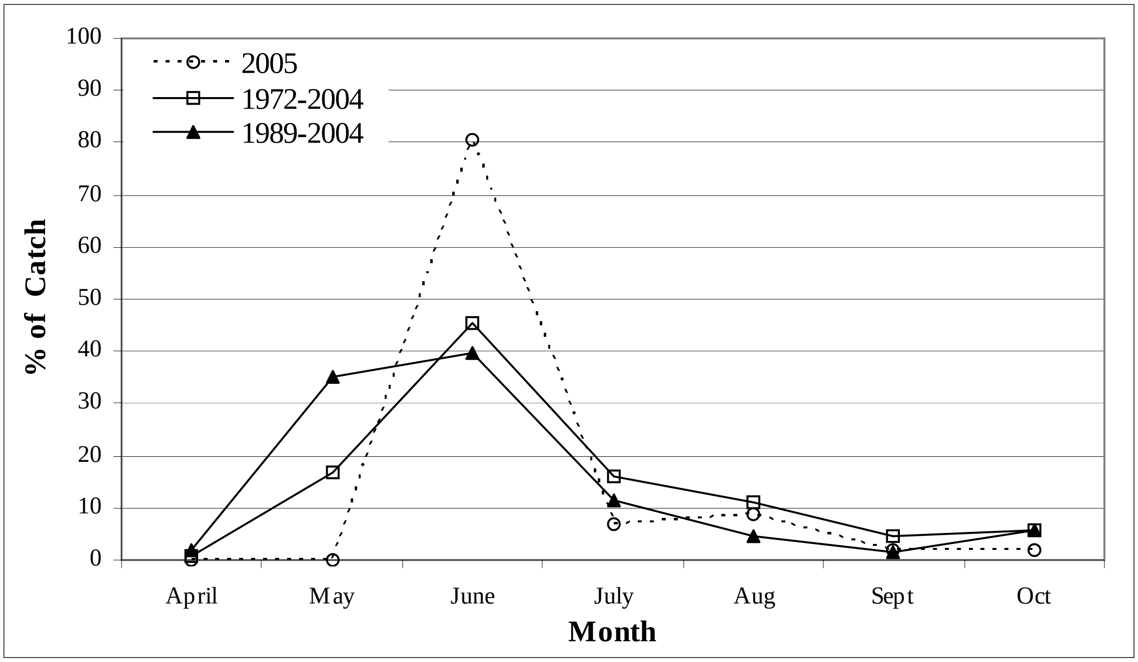


Figure 11. Comparison of the standardized (1989-2005) and 2006 seasonal Atlantic menhaden trawl percent catch by month.

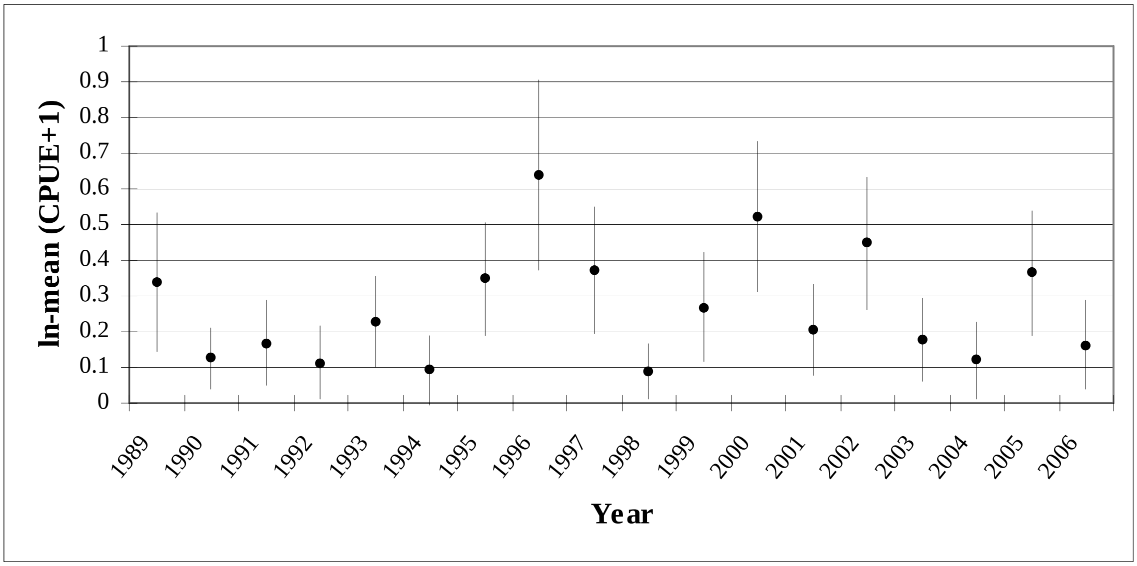


Figure 12. Atlantic silverside trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

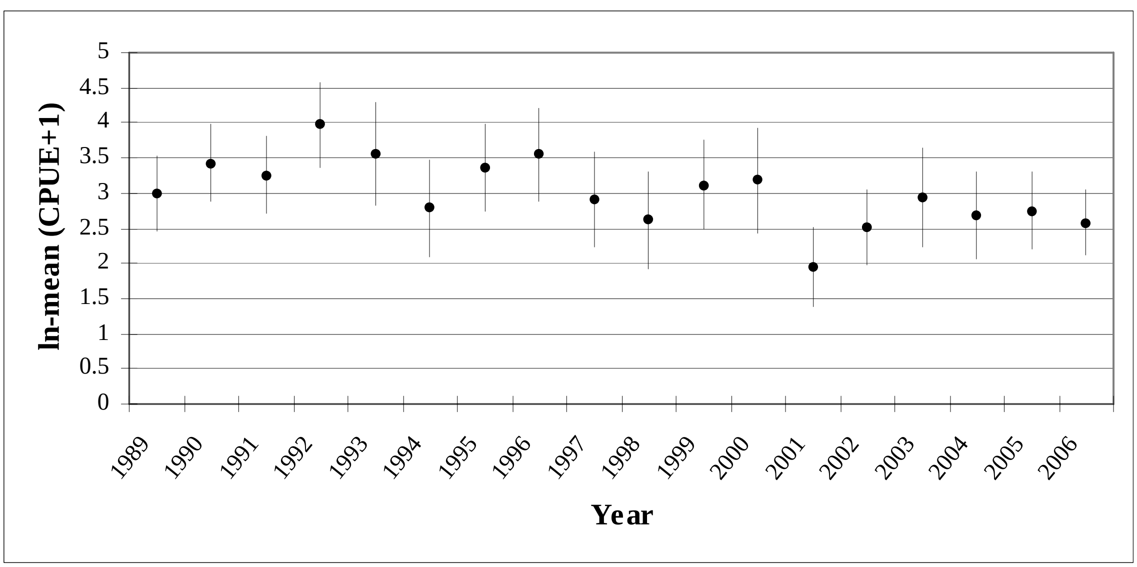


Figure 13. Atlantic silverside beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

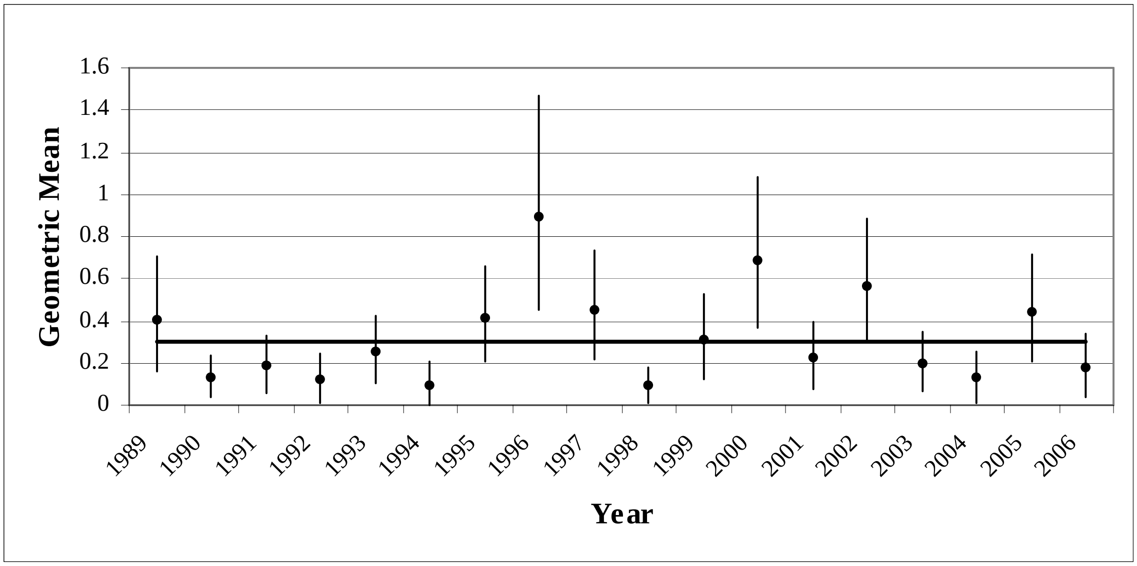


Figure 14. Atlantic silverside trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

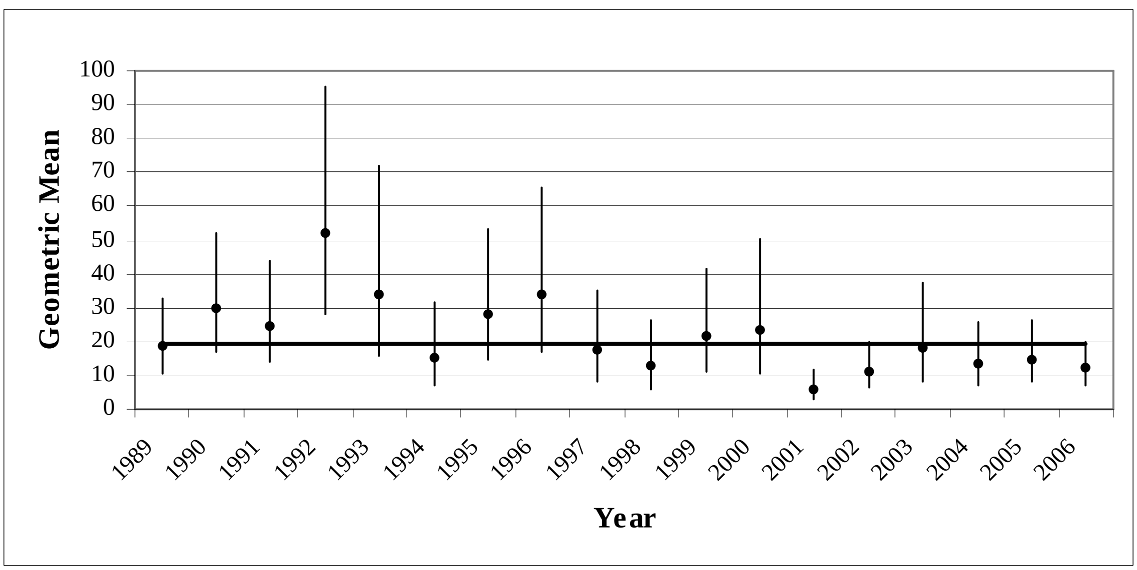


Figure 15. Atlantic silverside beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

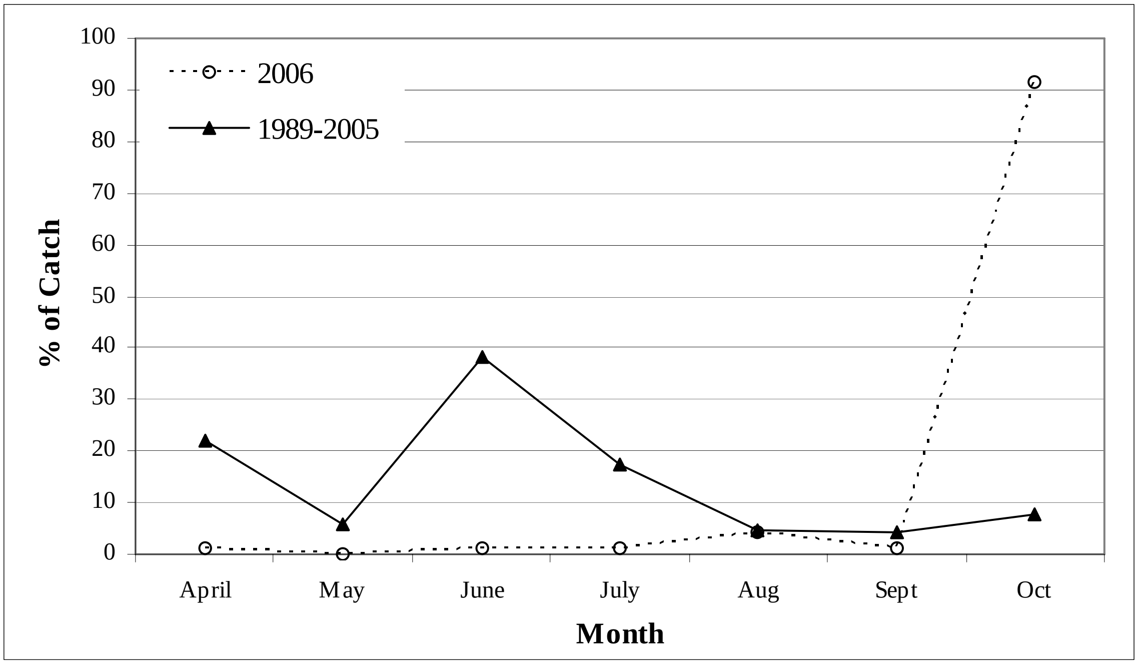


Figure 16. Comparison of the standardized (1989-2005) and 2006 seasonal Atlantic silverside trawl percent catch by month.

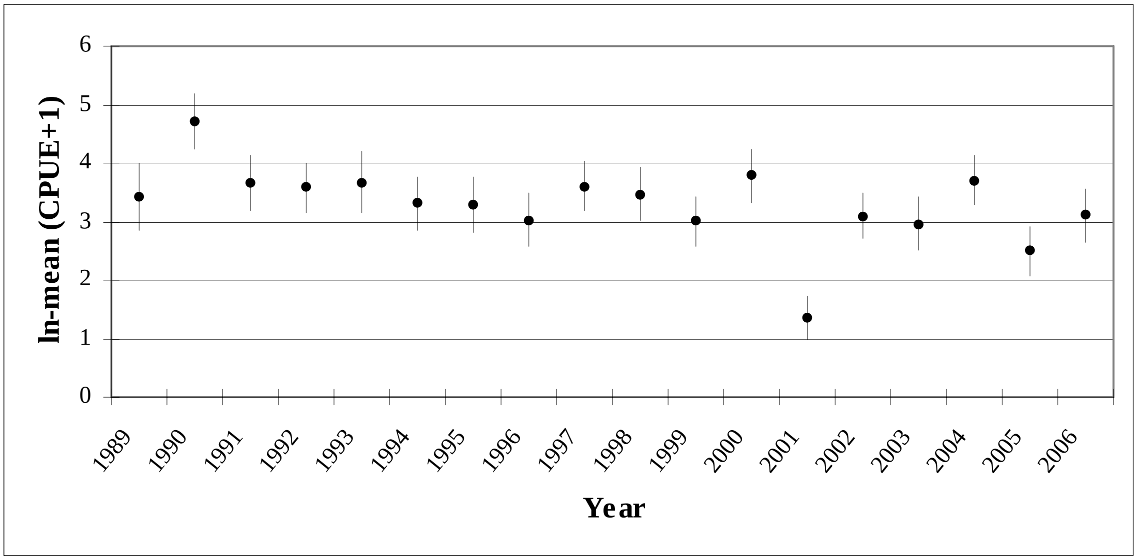


Figure 17. Bay anchovy trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

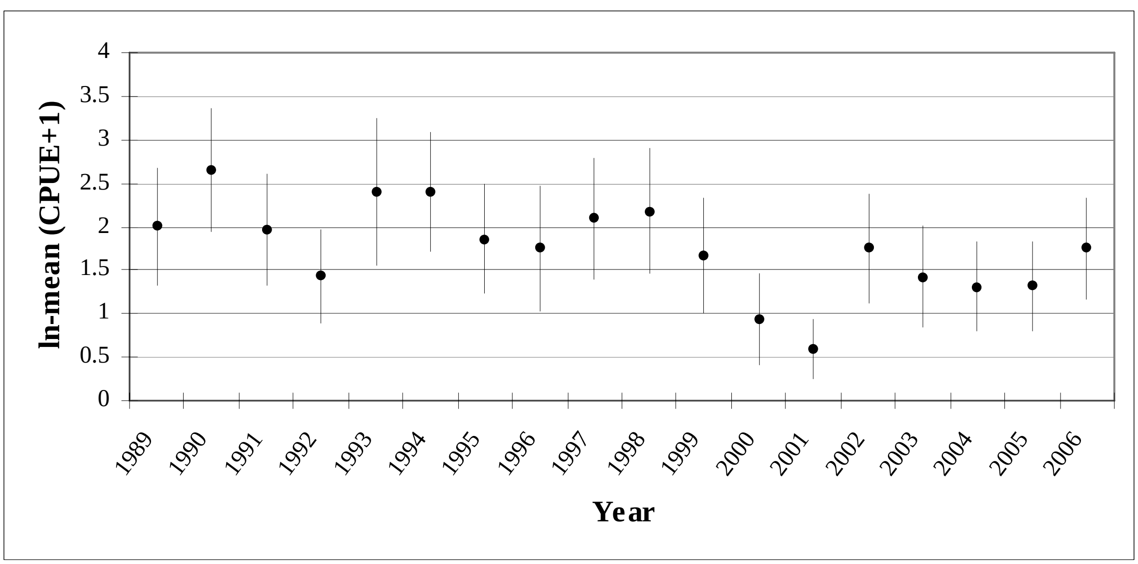


Figure 18. Bay anchovy beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

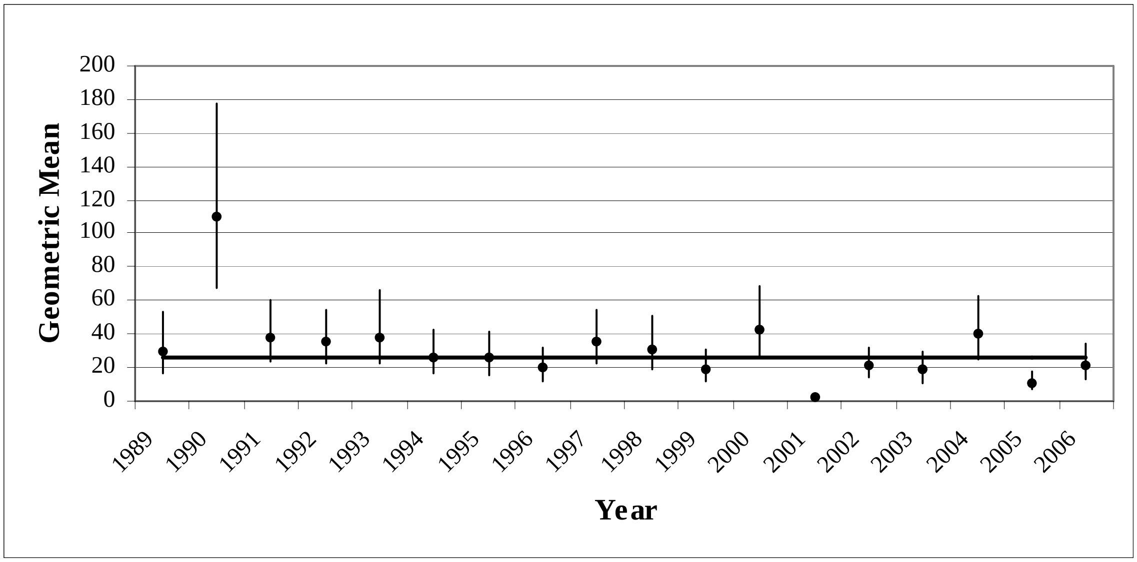


Figure 19. Bay anchovy trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

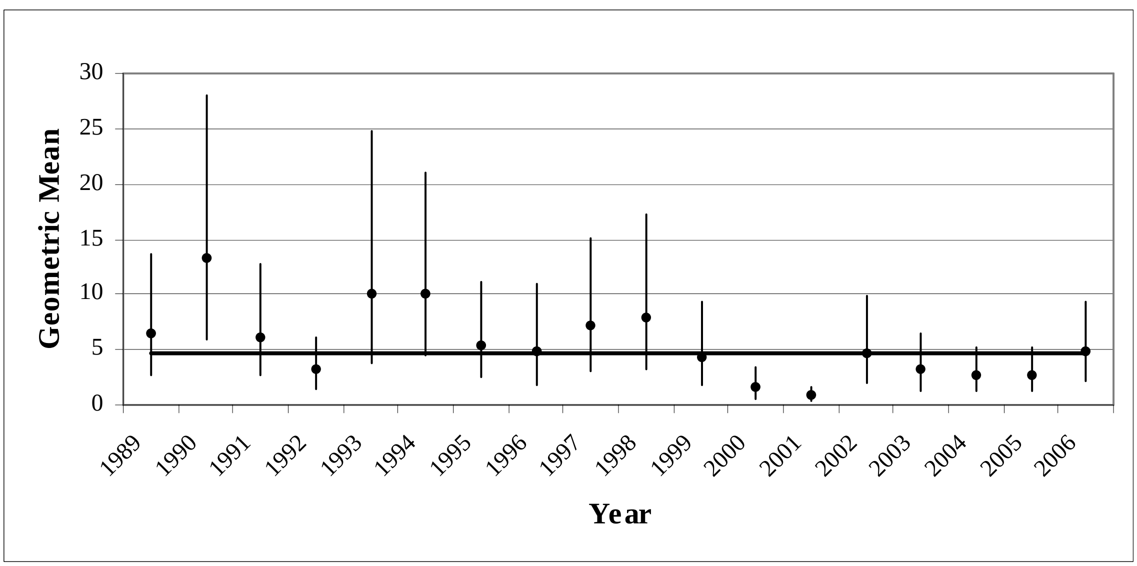


Figure 20. Bay anchovy beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

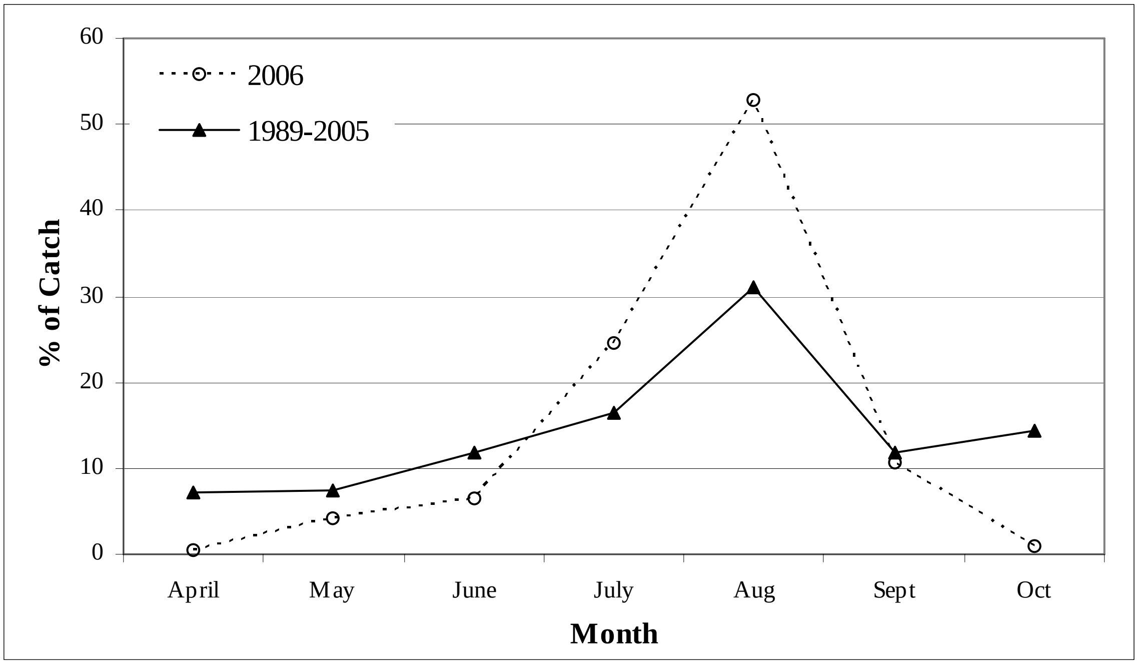


Figure 21. Comparison of the standardized (1989-2005) and 2006 seasonal bay anchovy trawl percent catch by month.

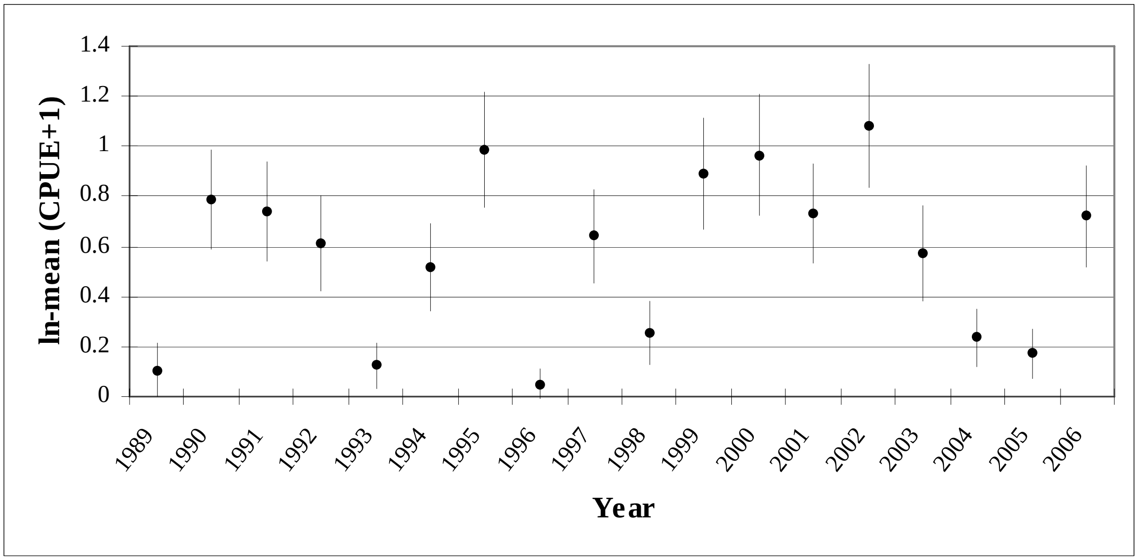


Figure 22. Black sea bass trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

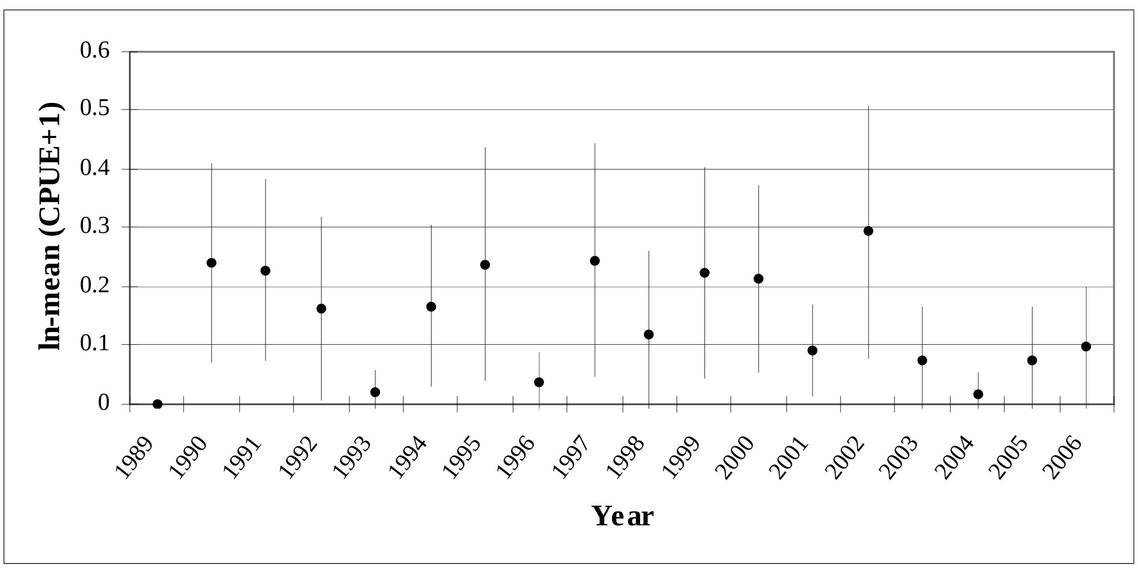


Figure 23. Black sea bass beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

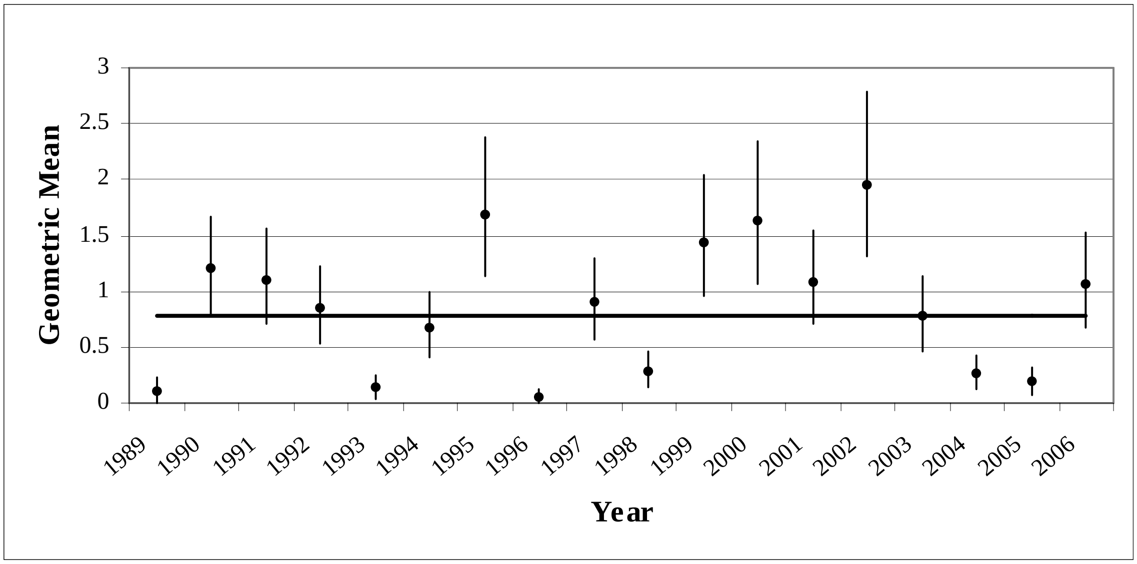


Figure 24. Black sea bass trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

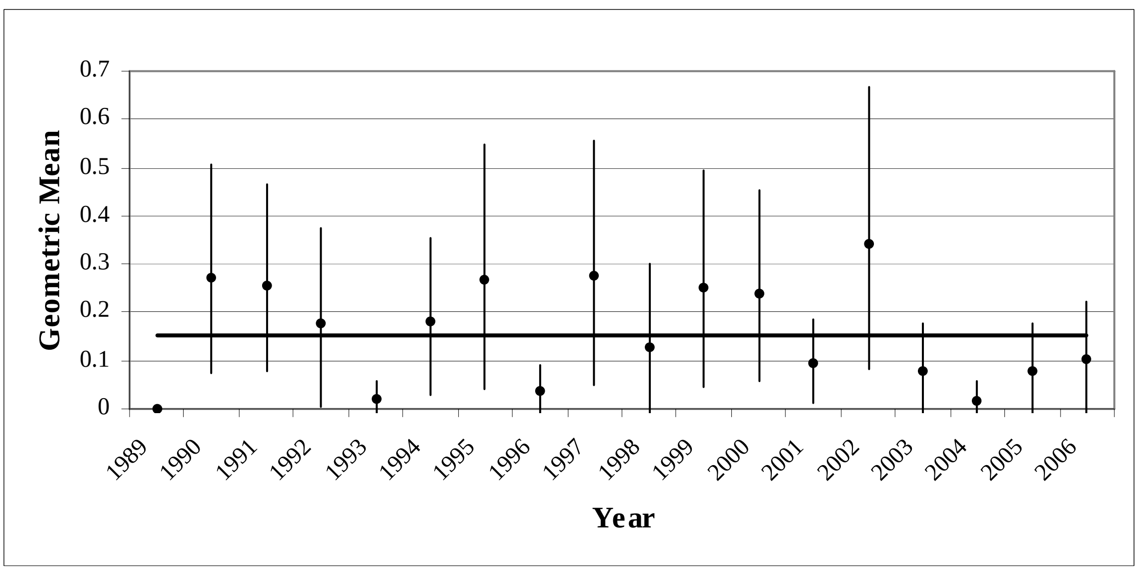


Figure 25. Black sea bass beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

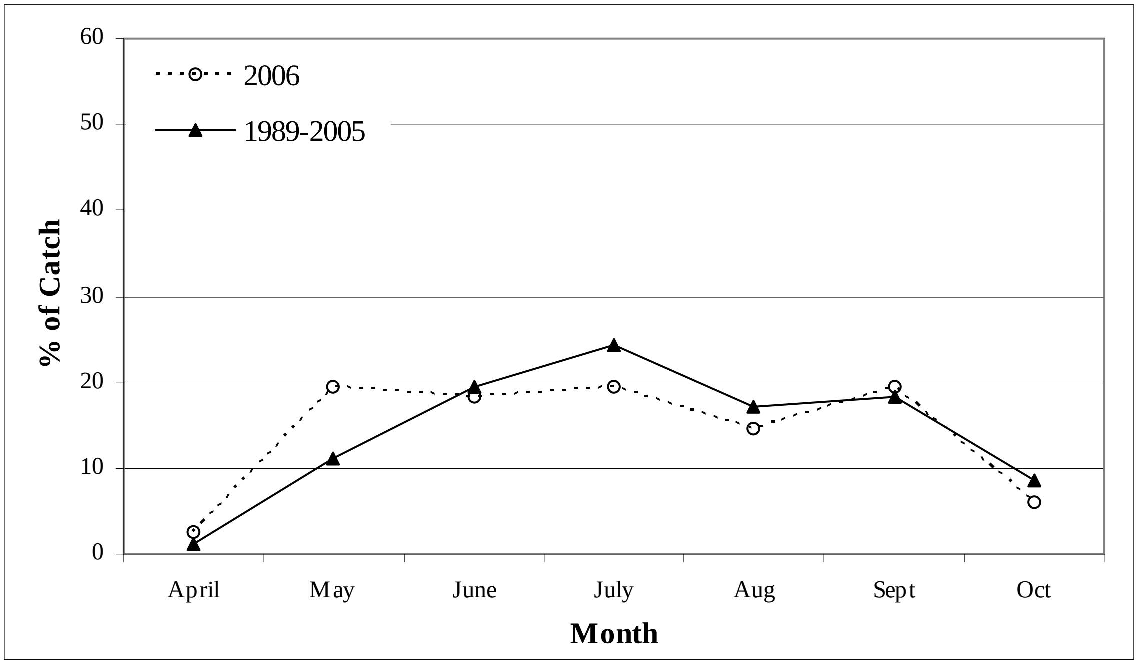


Figure 26. Comparison of the standardized (1989-2005) and 2006 seasonal black sea bass trawl percent catch by month.

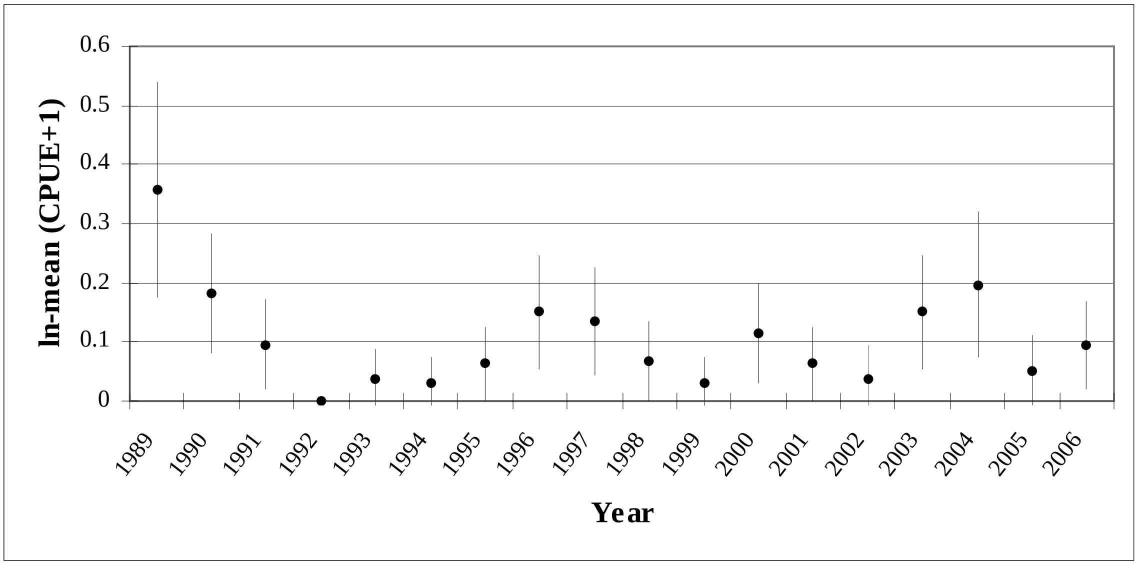


Figure 27. Bluefish trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

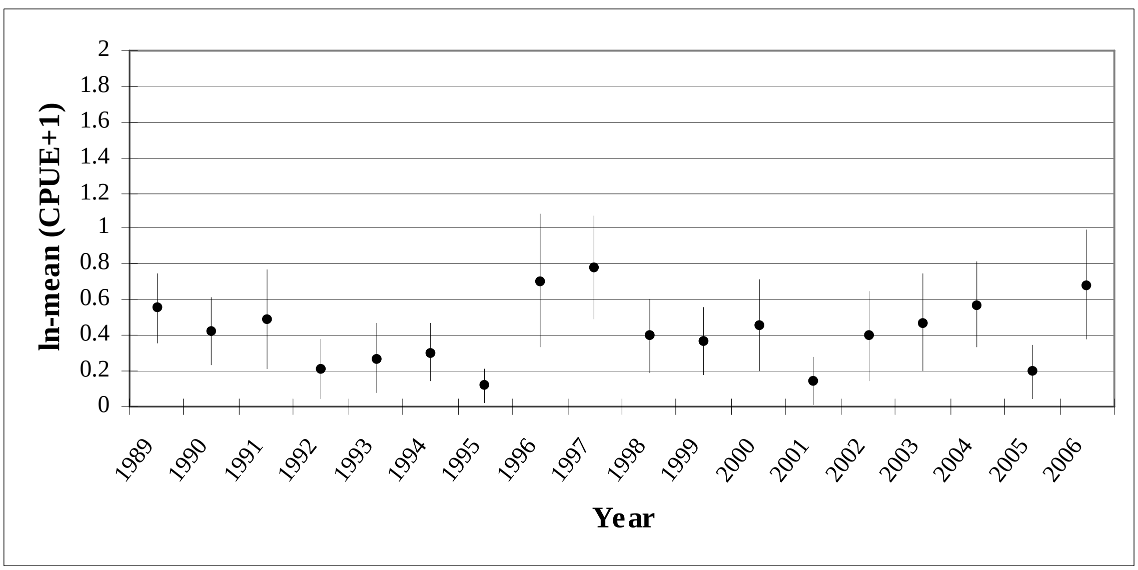


Figure 28. Bluefish beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

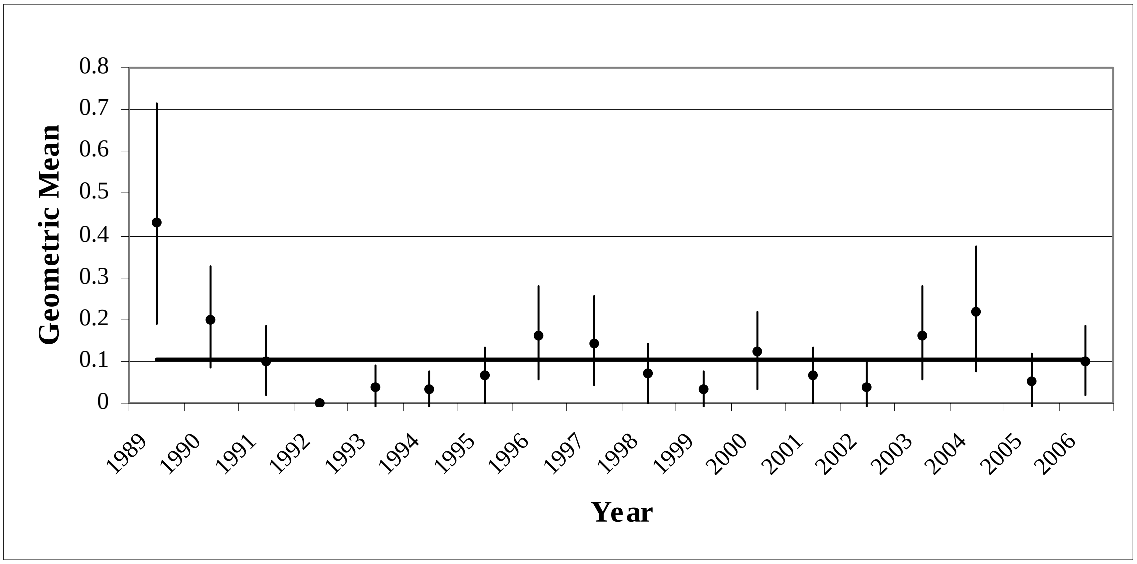


Figure 29. Bluefish trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

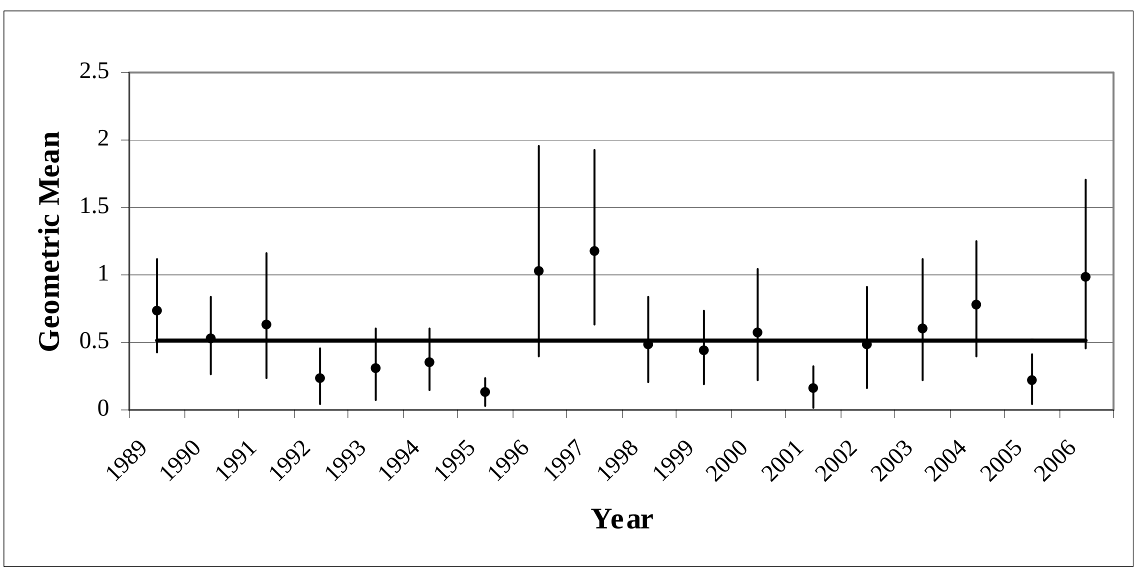


Figure 30. Bluefish beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

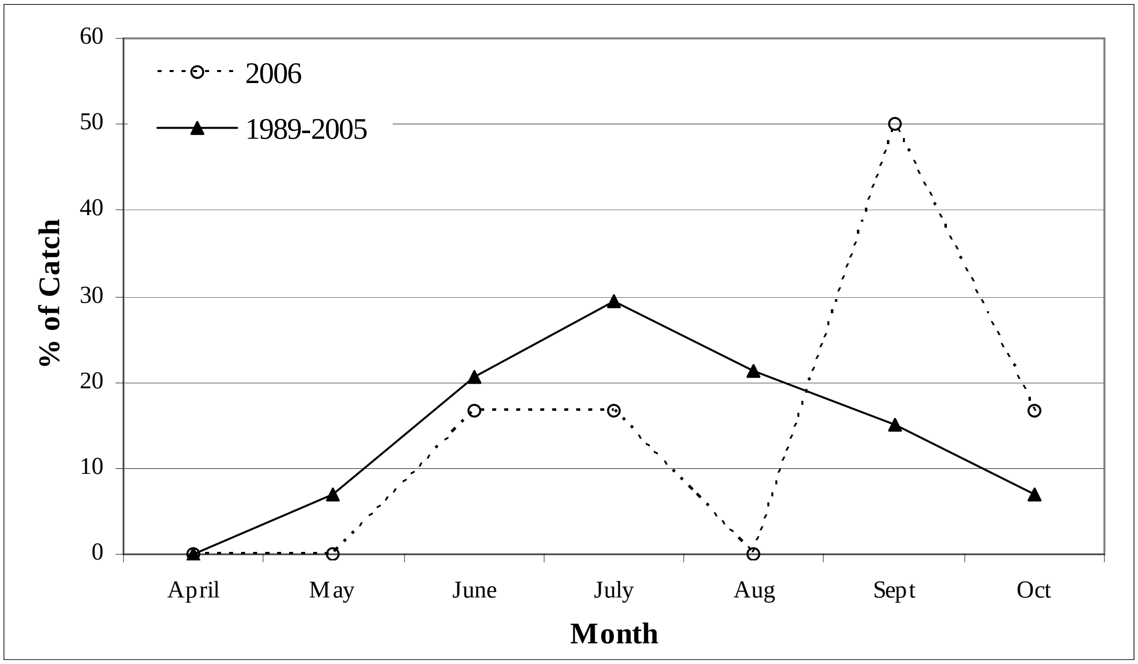


Figure 31. Comparison of the standardized (1989-2005) and 2006 seasonal bluefish trawl percent catch by month.

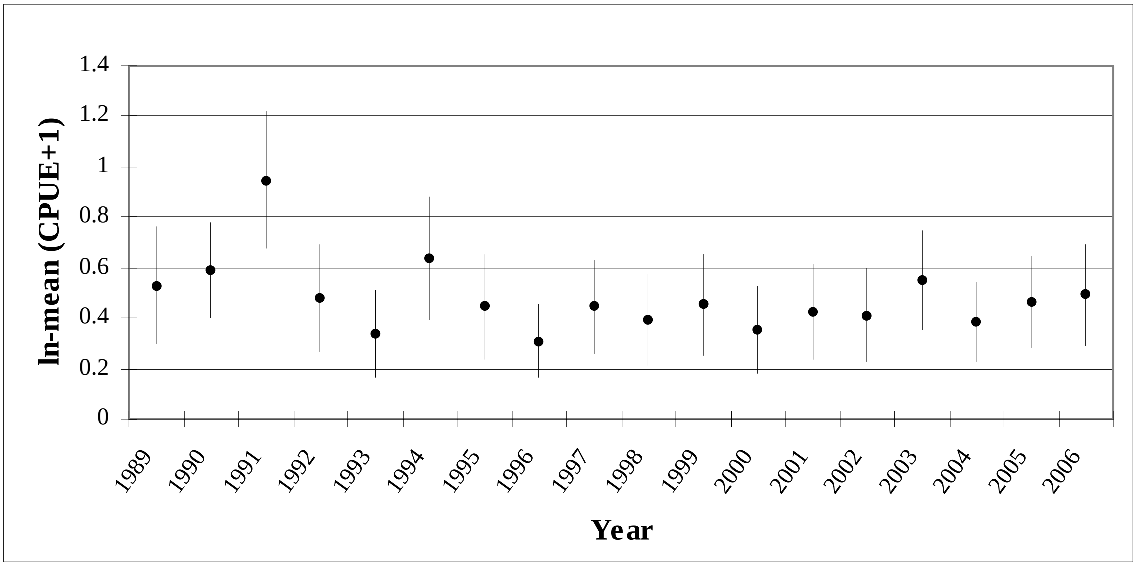


Figure 32. Hogchoker trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

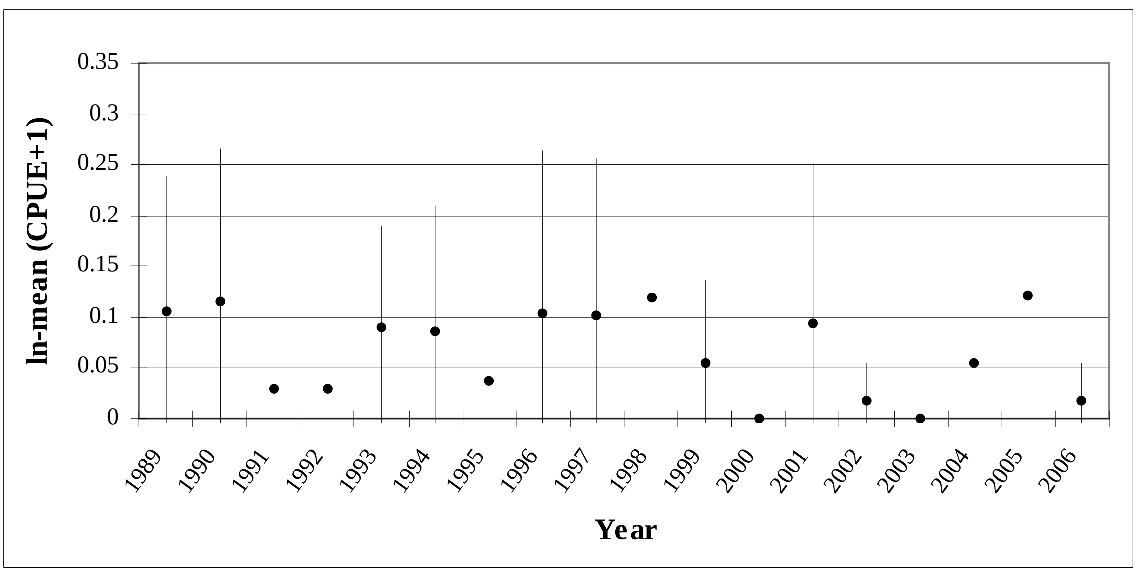


Figure 33. Hogchoker beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

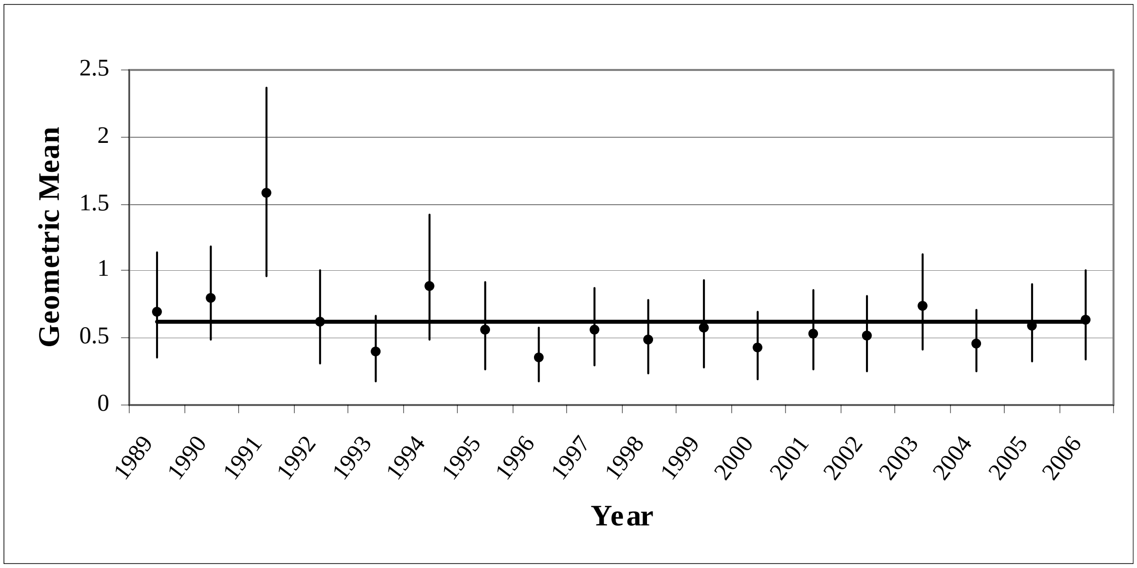


Figure 34. Hogchoker trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

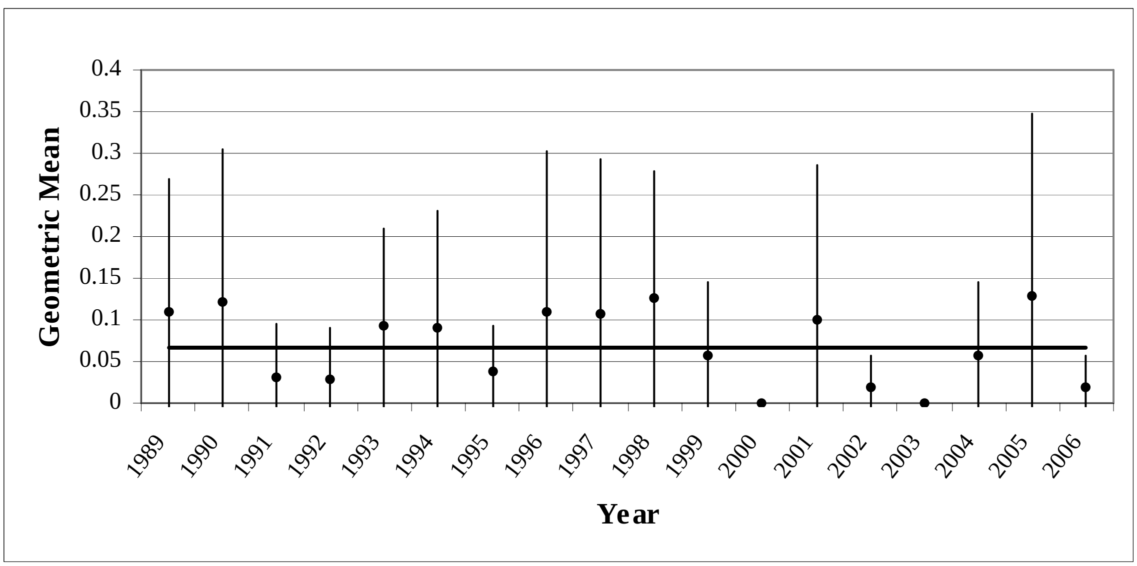


Figure 35. Hogchoker beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

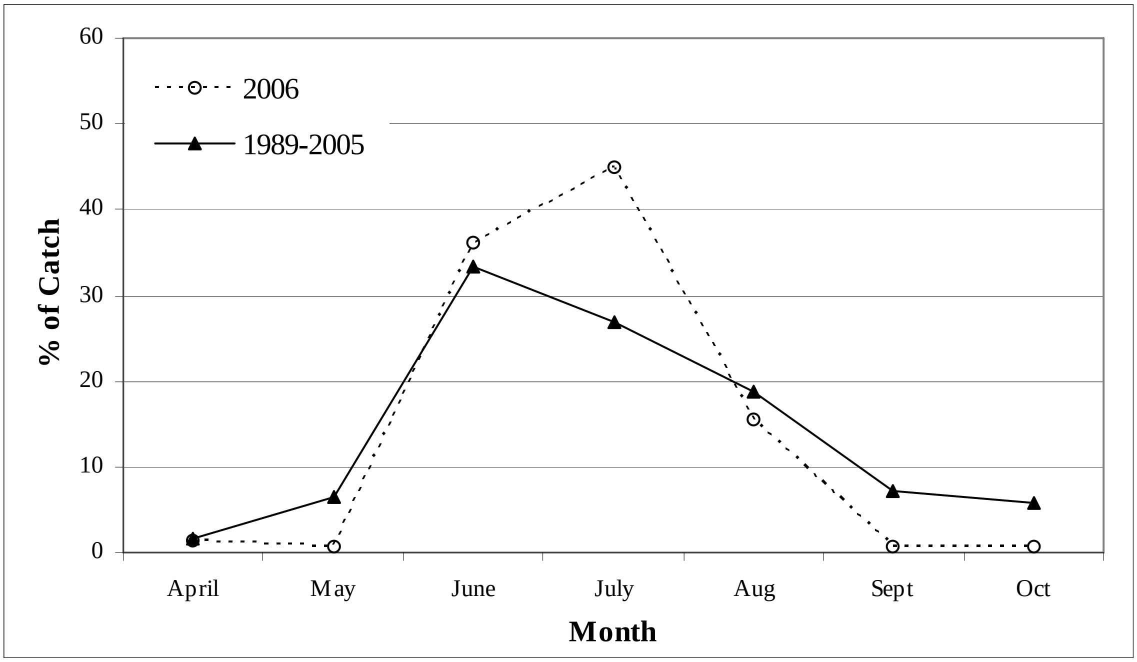


Figure 36. Comparison of the standardized (1989-2005) and 2006 seasonal hogchoker trawl percent catch by month.

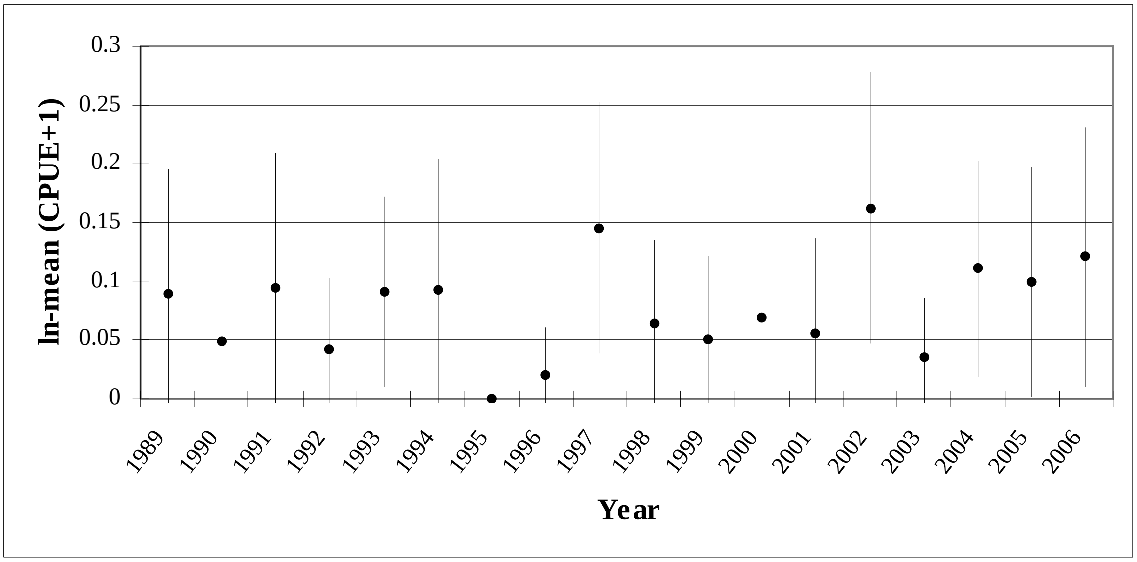


Figure 37. Mummichog trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

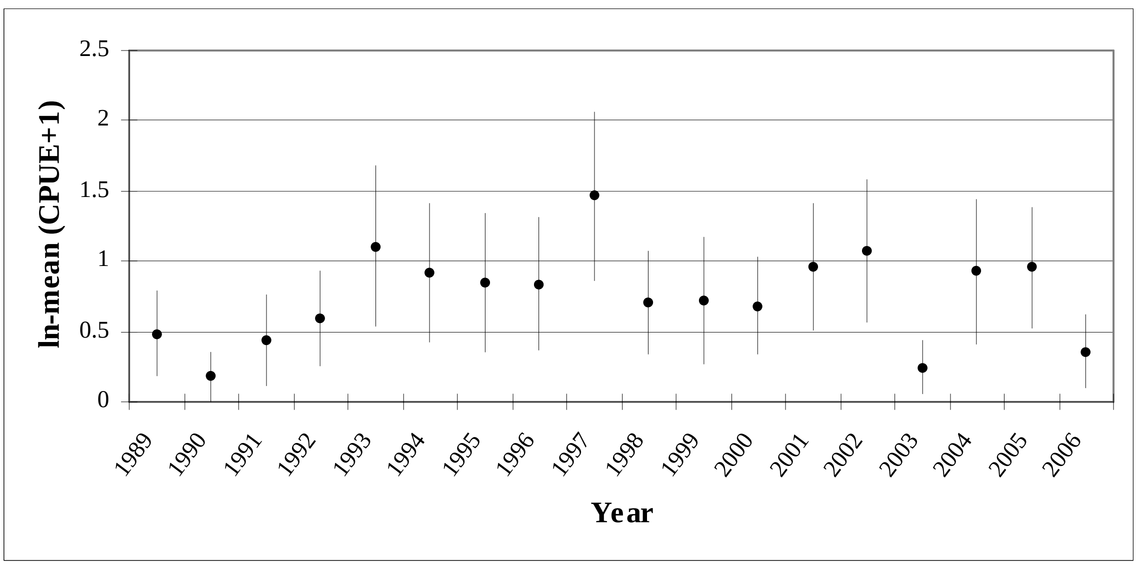


Figure 38. Mummichog beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

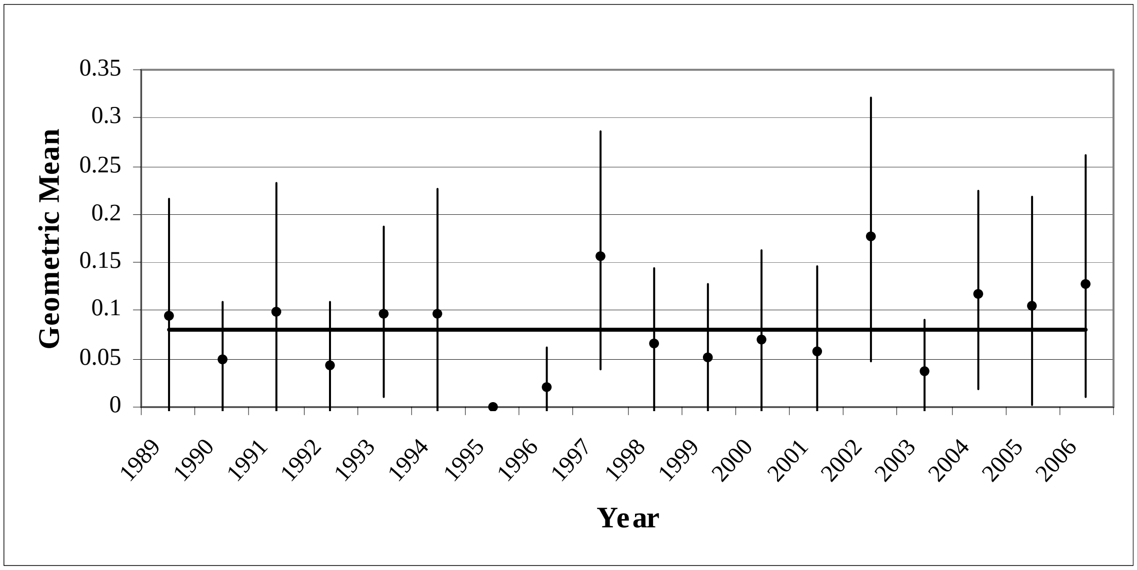


Figure 39. Mummichog trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

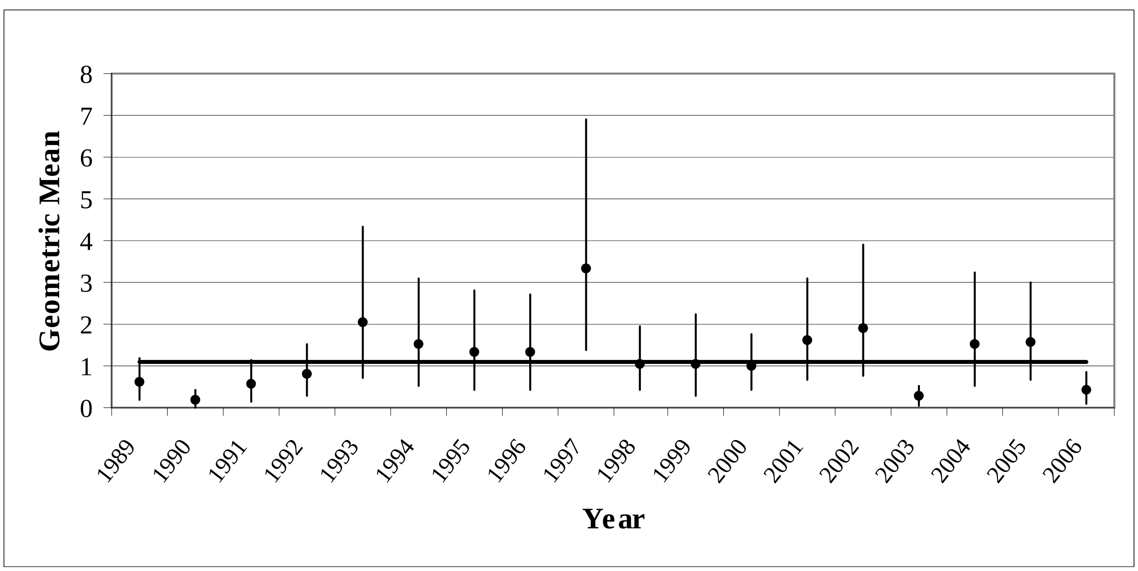


Figure 40. Mummichog beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

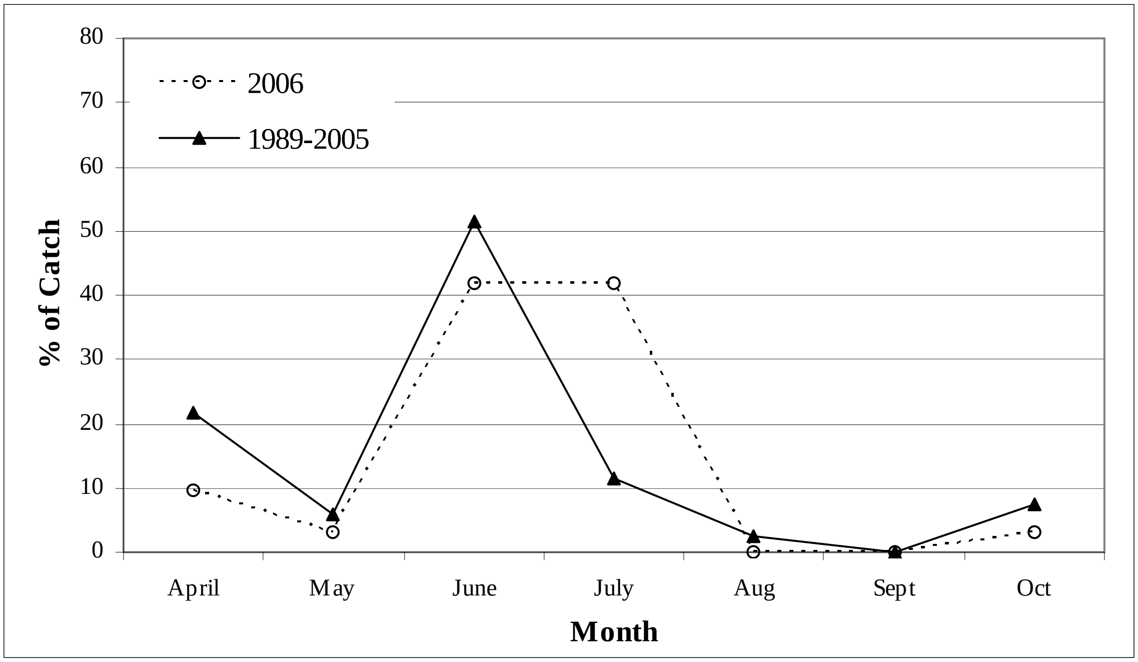


Figure 41. Comparison of the standardized (1989-2005) and 2006 seasonal mummichog trawl percent catch by month.

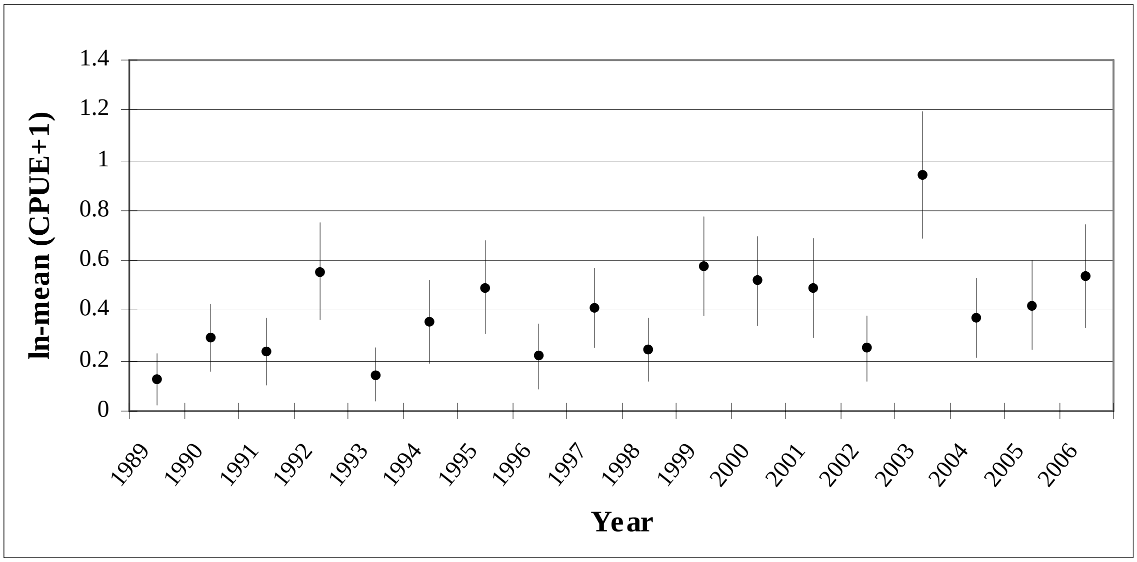


Figure 42. Northern sea robin trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

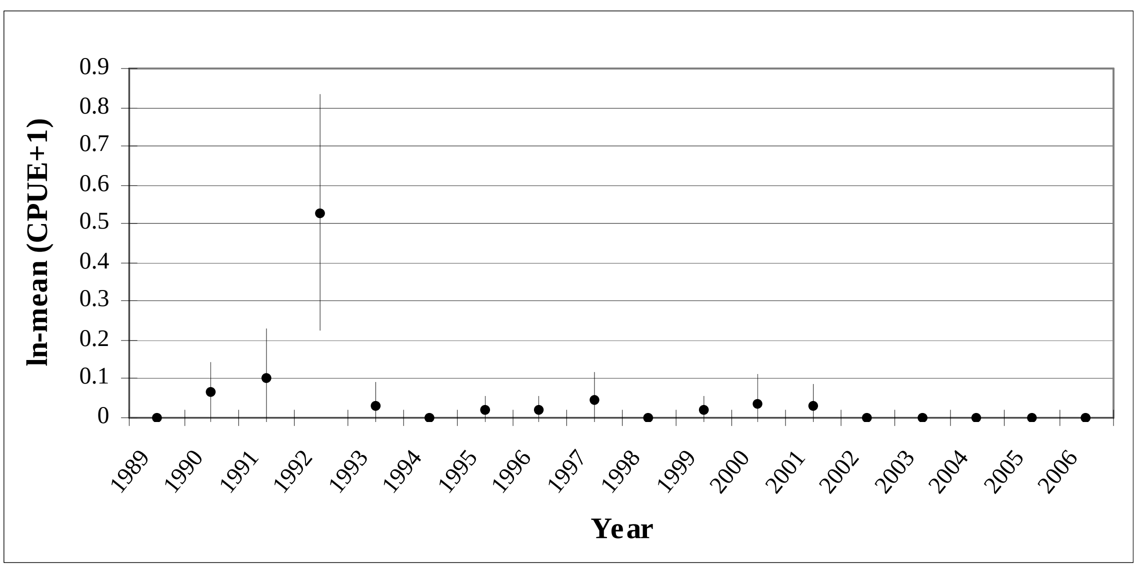


Figure 43. Northern sea robin beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

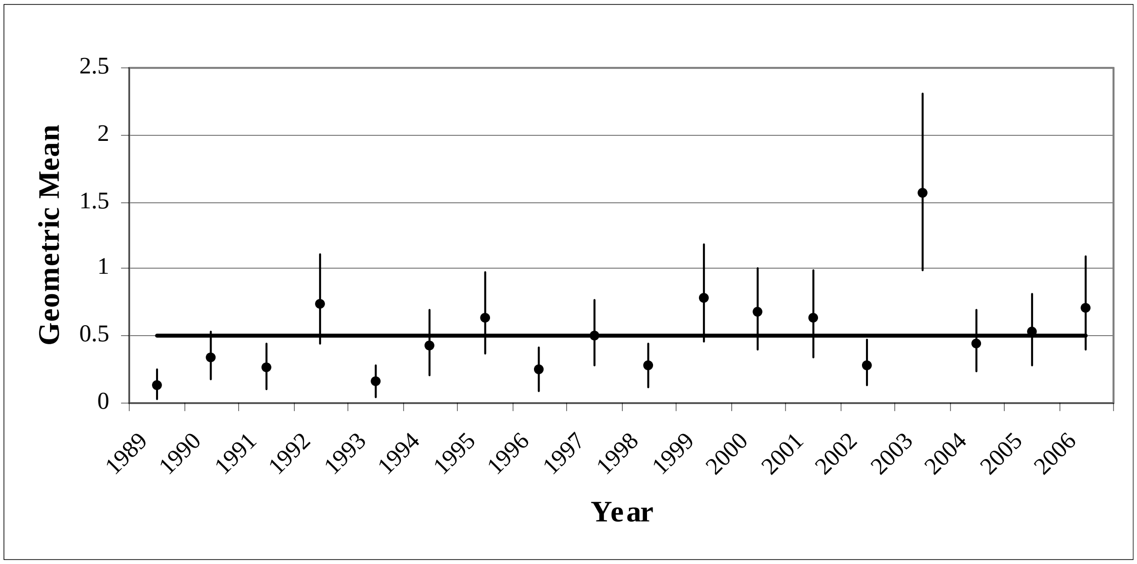


Figure 44. Northern sea robin trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

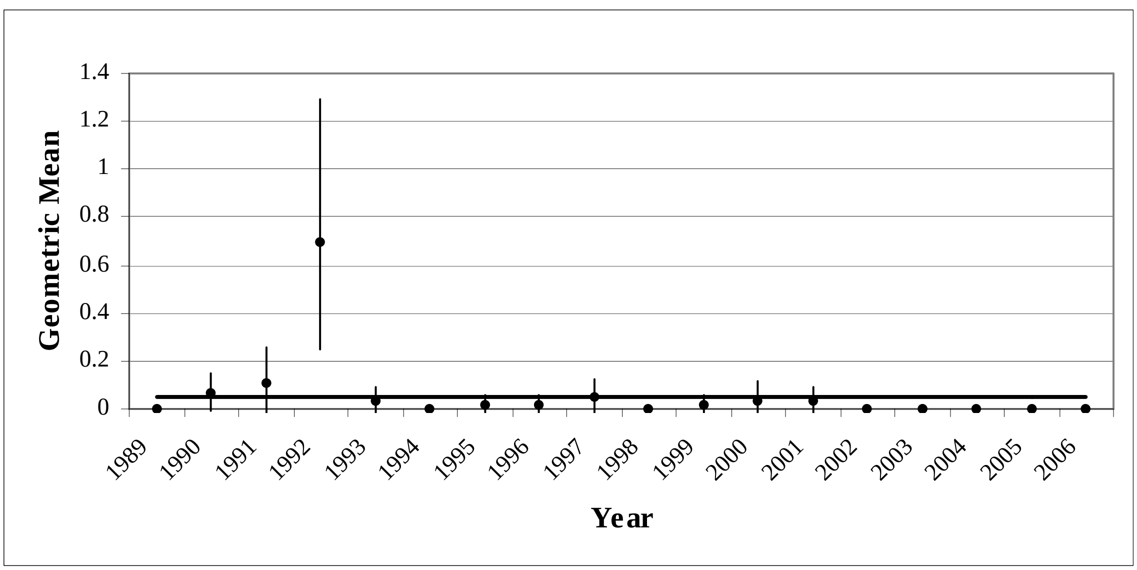


Figure 45. Northern sea robin beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

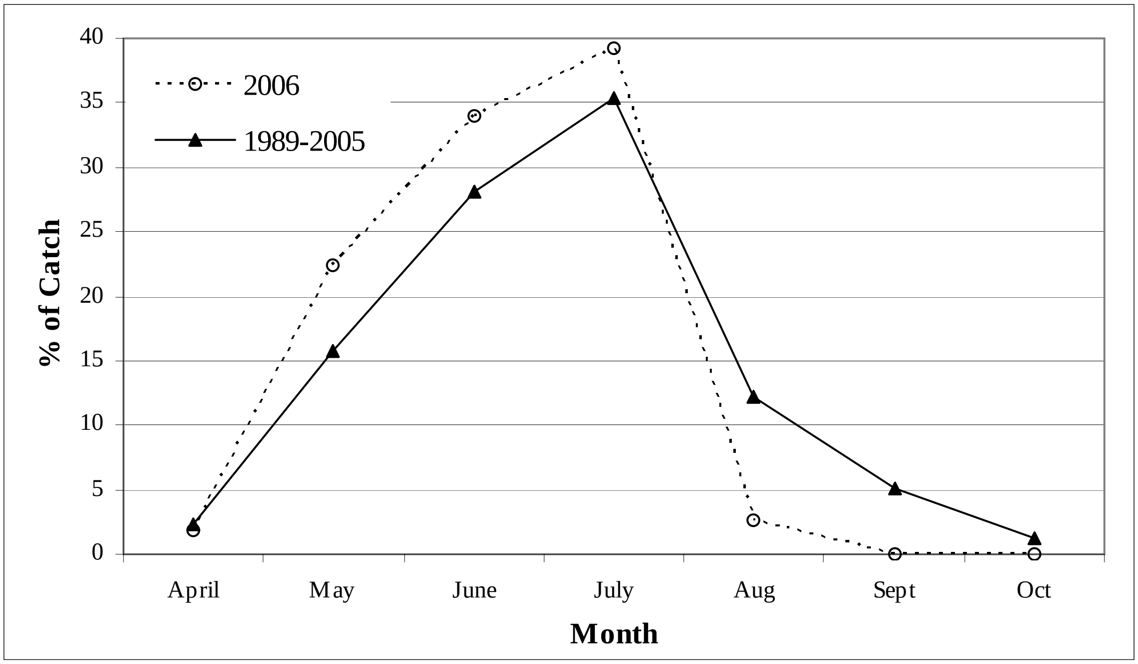


Figure 46. Comparison of the standardized (1989-2005) and 2006 seasonal northern sea robin trawl percent catch by month.

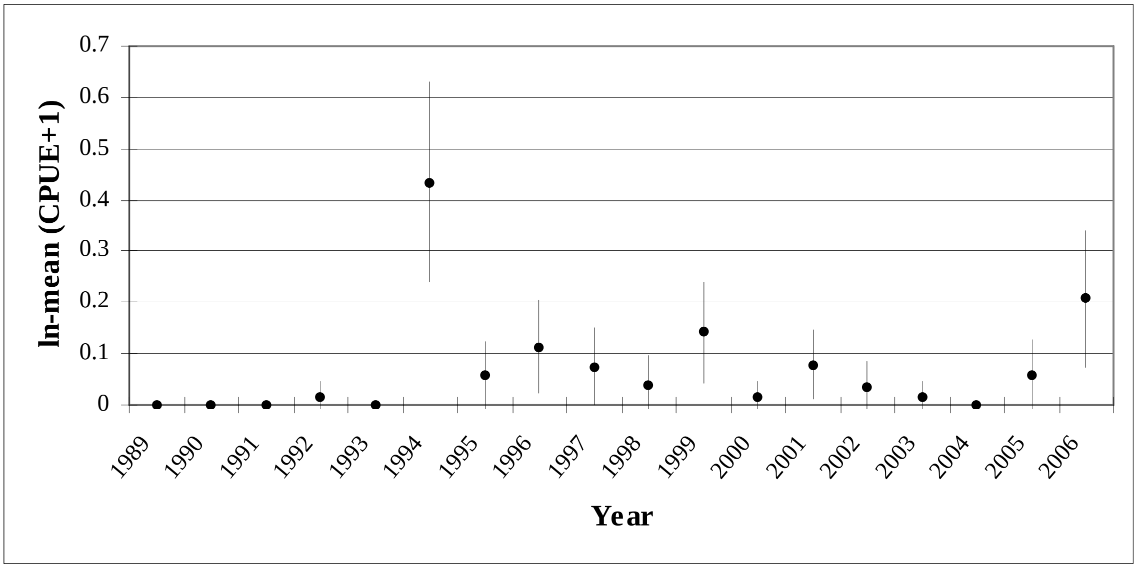


Figure 47. Pigfish trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

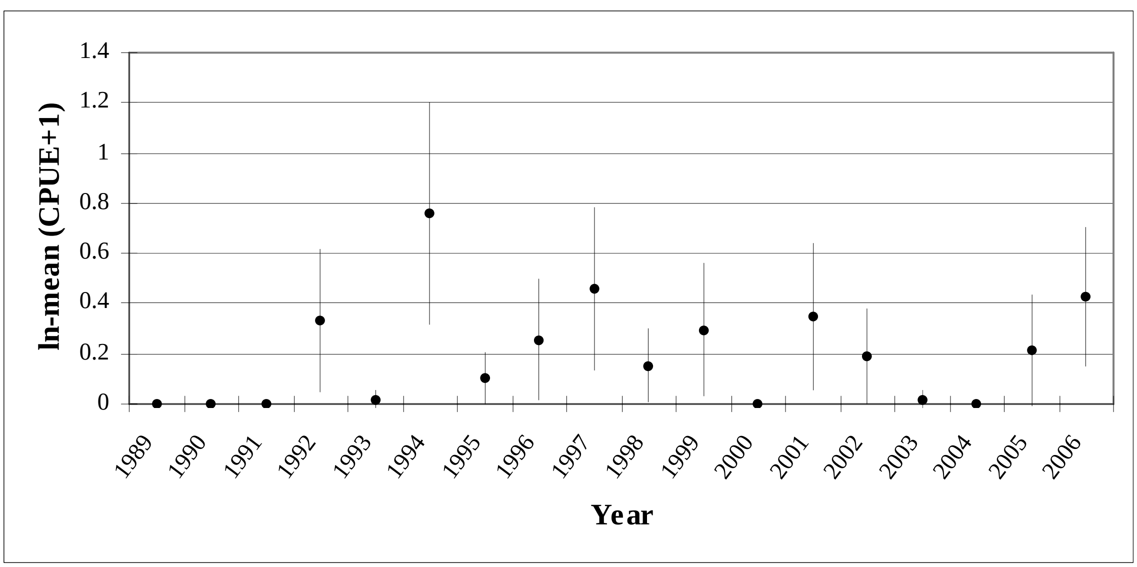


Figure 48. Pigfish beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

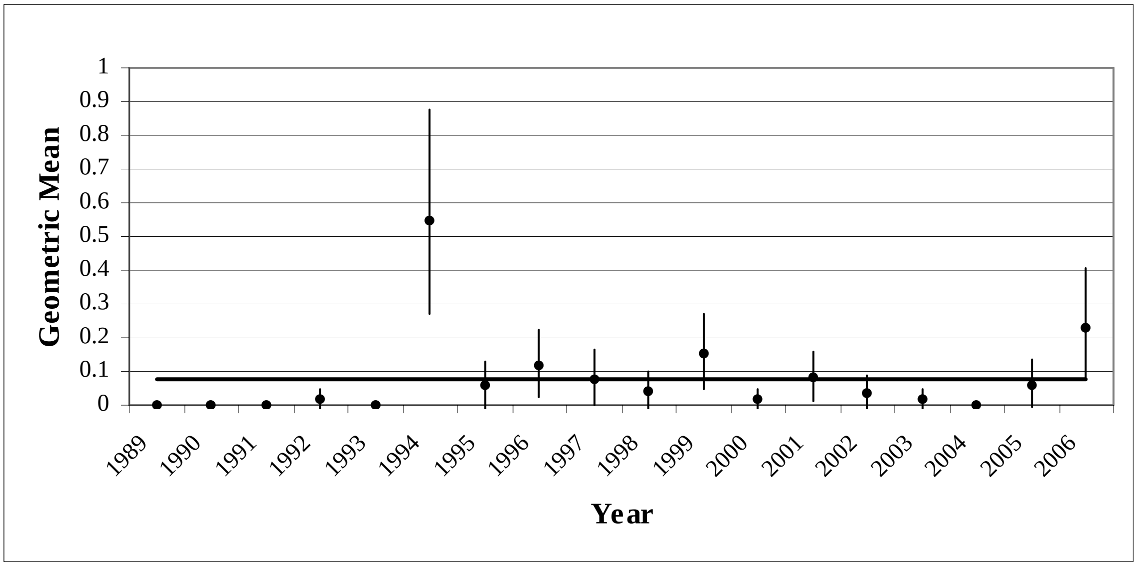


Figure 49. Pigfish trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

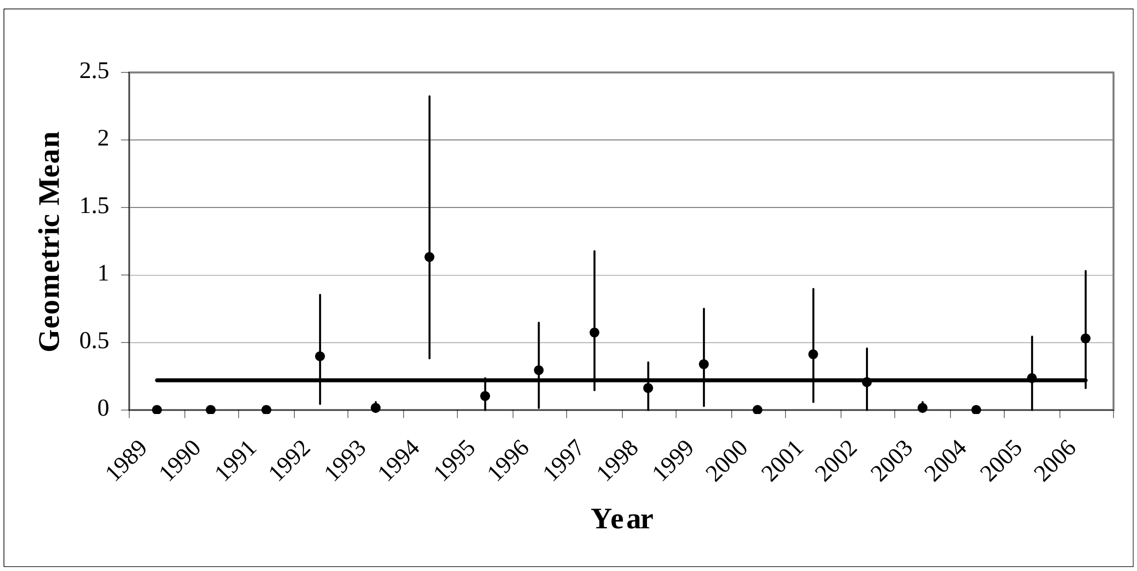


Figure 50. Pigfish beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

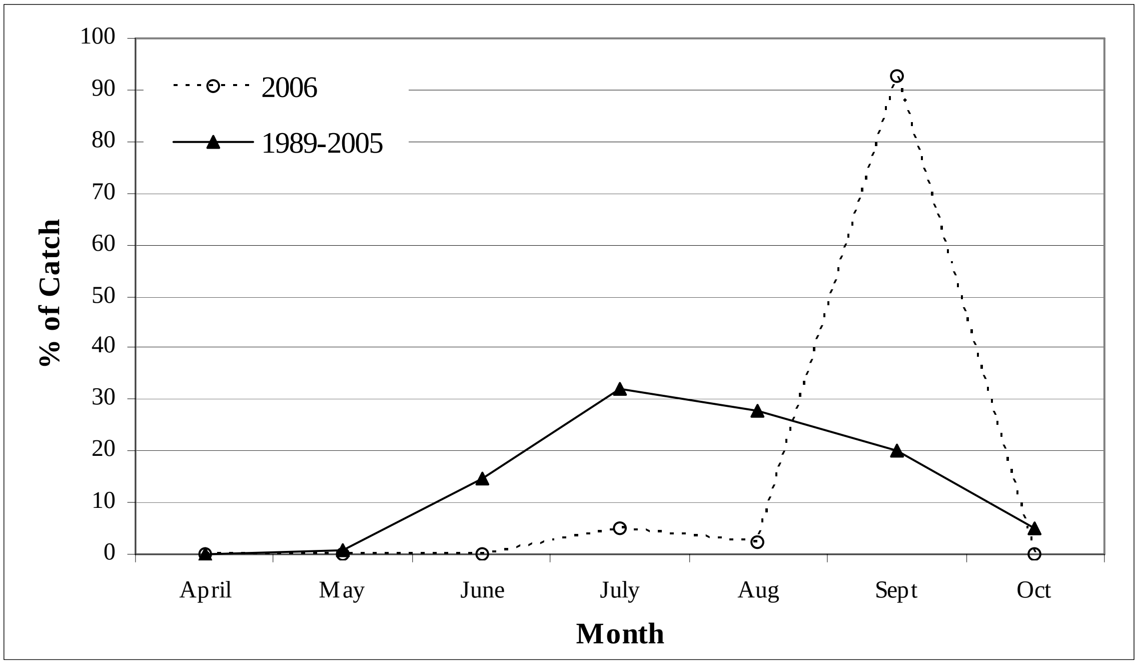


Figure 51. Comparison of the standardized (1989-2005) and 2006 seasonal pigfish trawl percent catch by month.

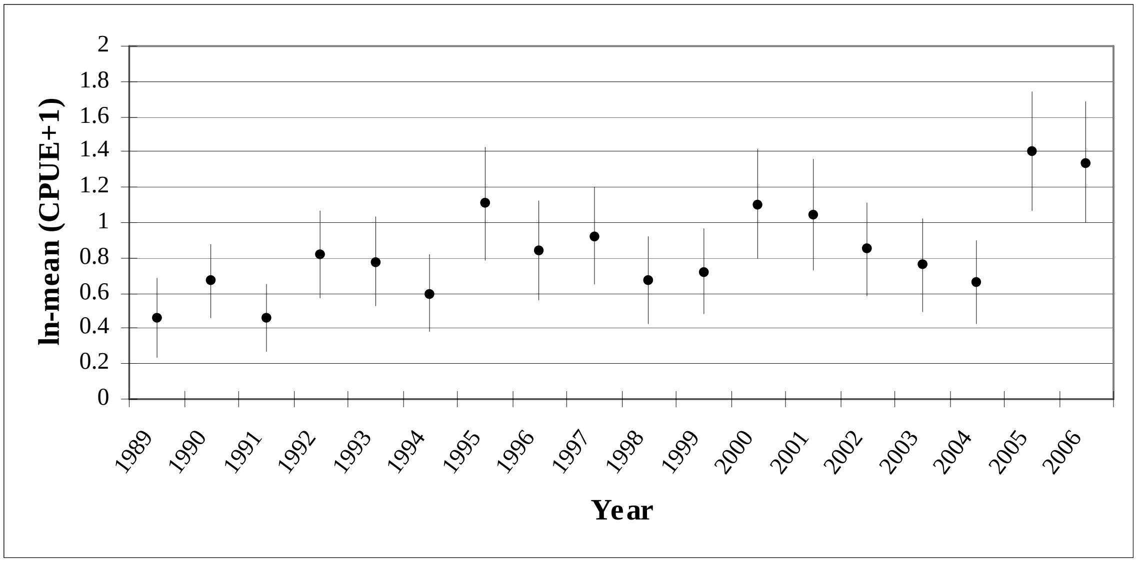


Figure 52. Silver perch trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

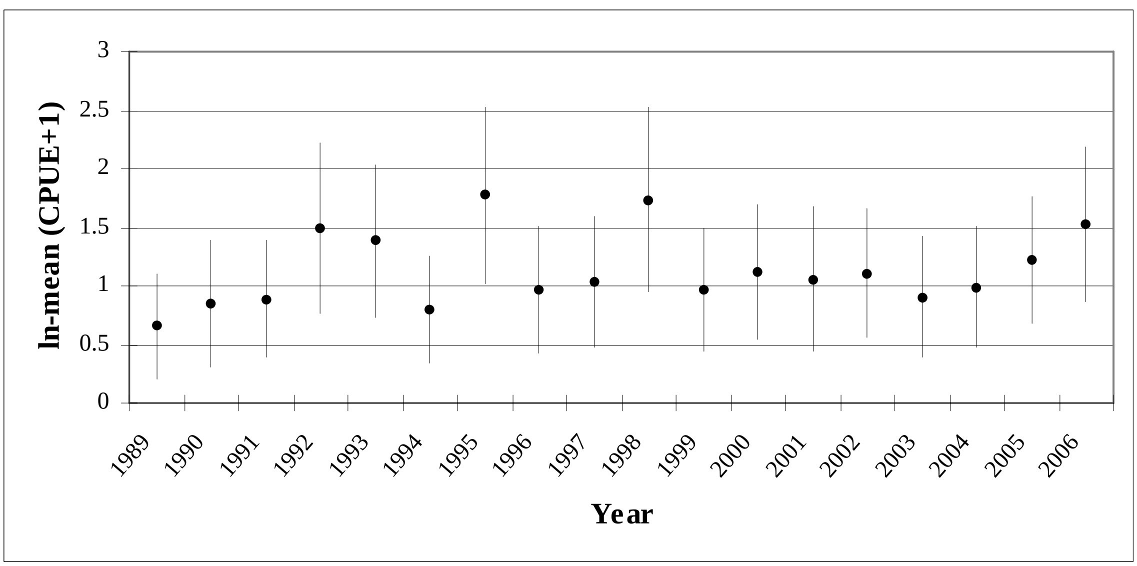


Figure 53. Silver perch beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

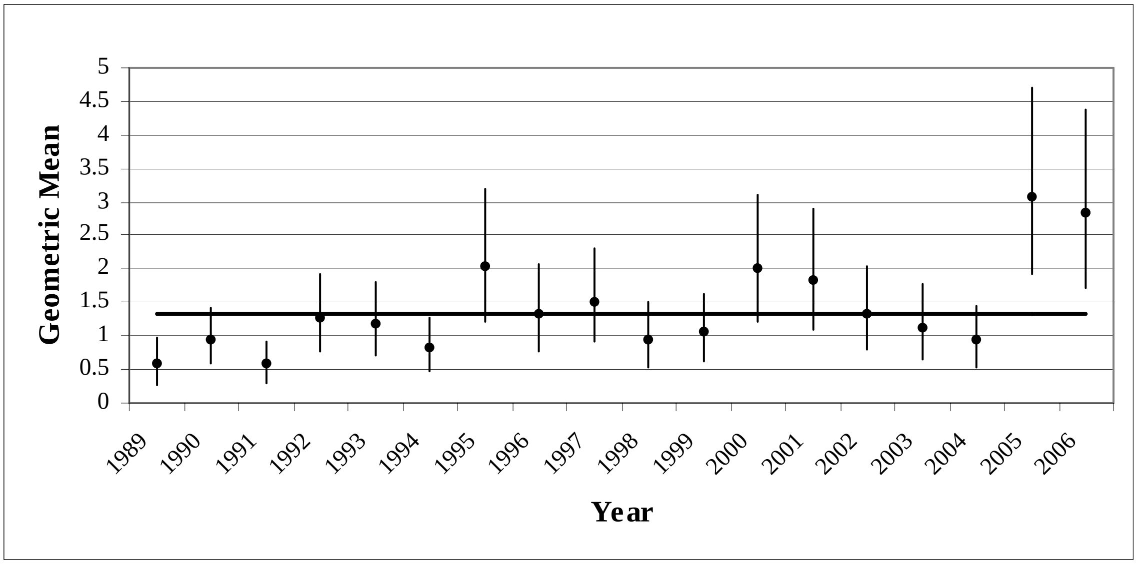


Figure 54. Silver perch trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

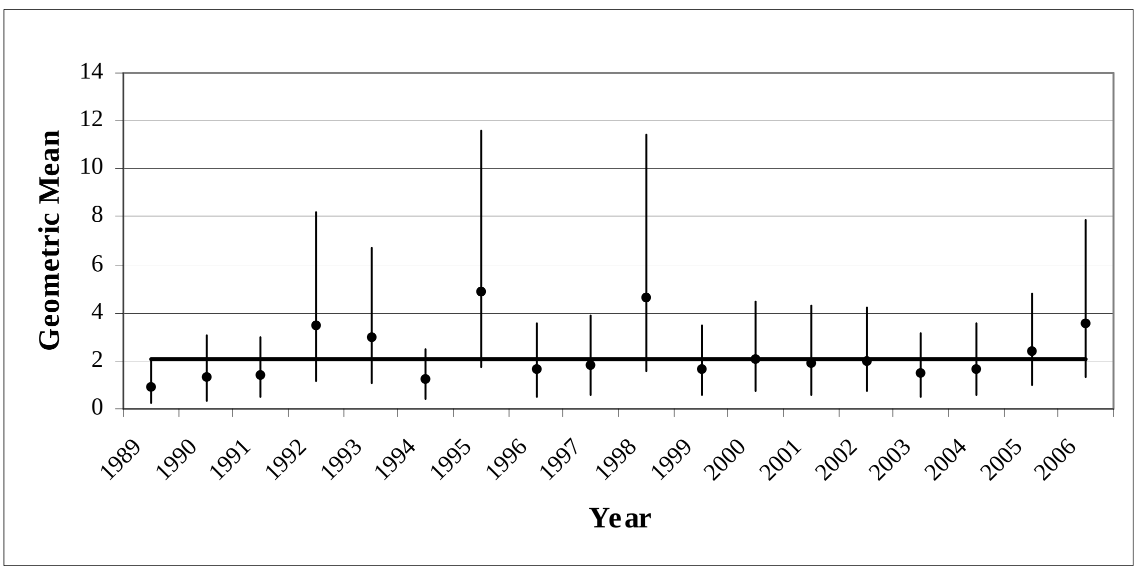


Figure 55. Silver perch beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

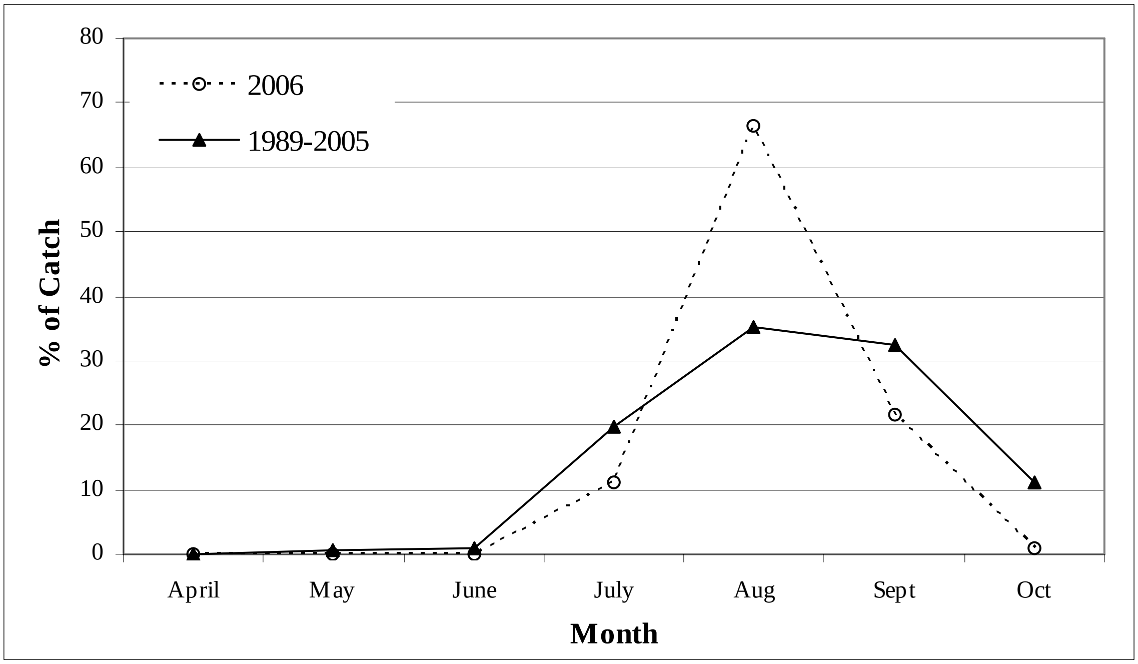


Figure 56. Comparison of the standardized (1989-2005) and 2006 seasonal silver perch trawl percent catch by month.

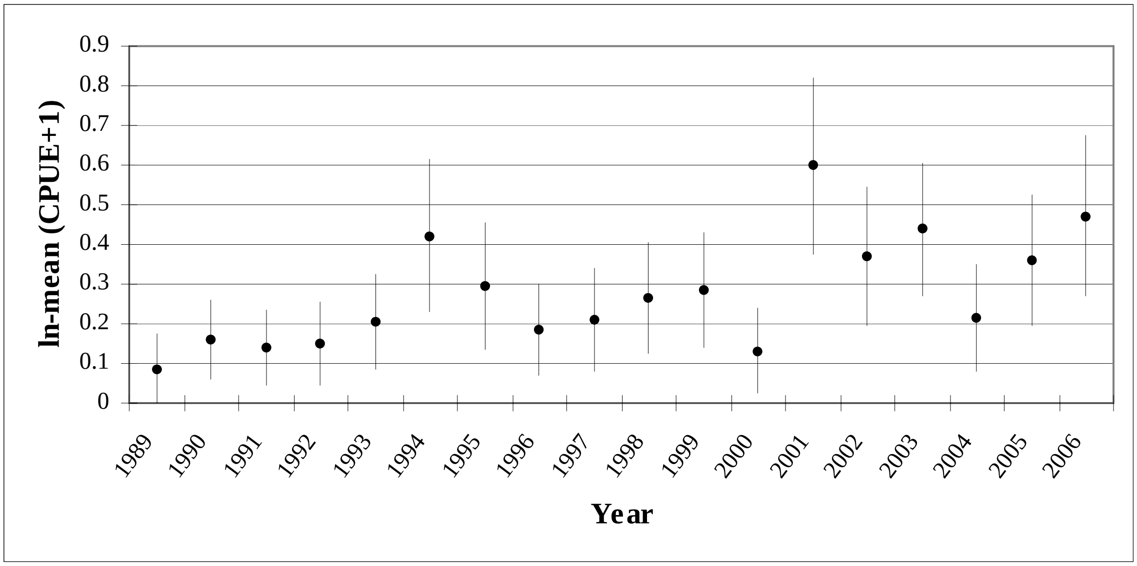


Figure 57. Smallmouth flounder trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

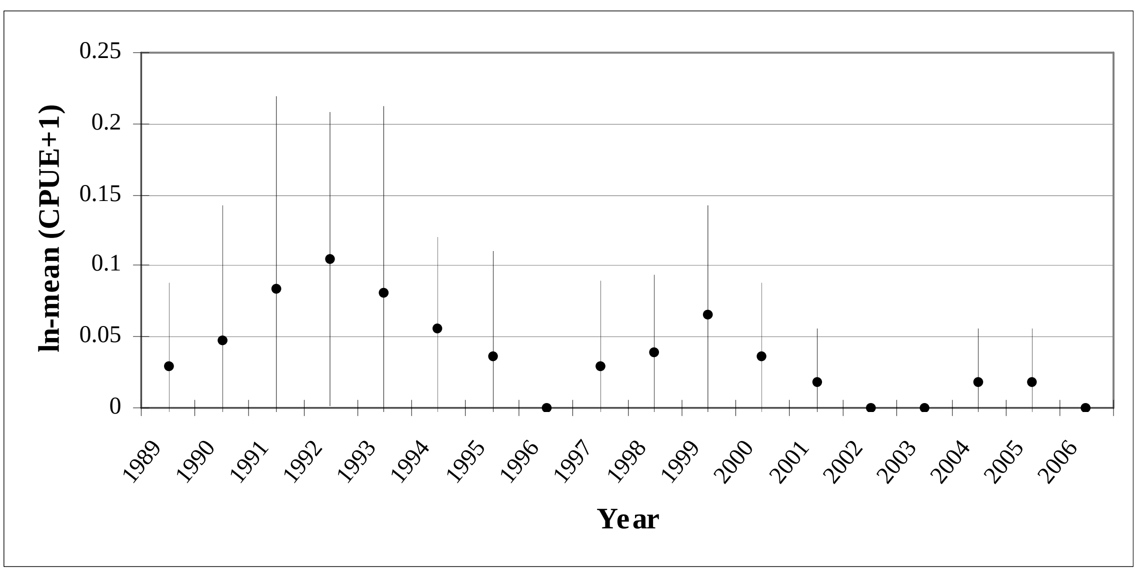


Figure 58. Smallmouth flounder beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

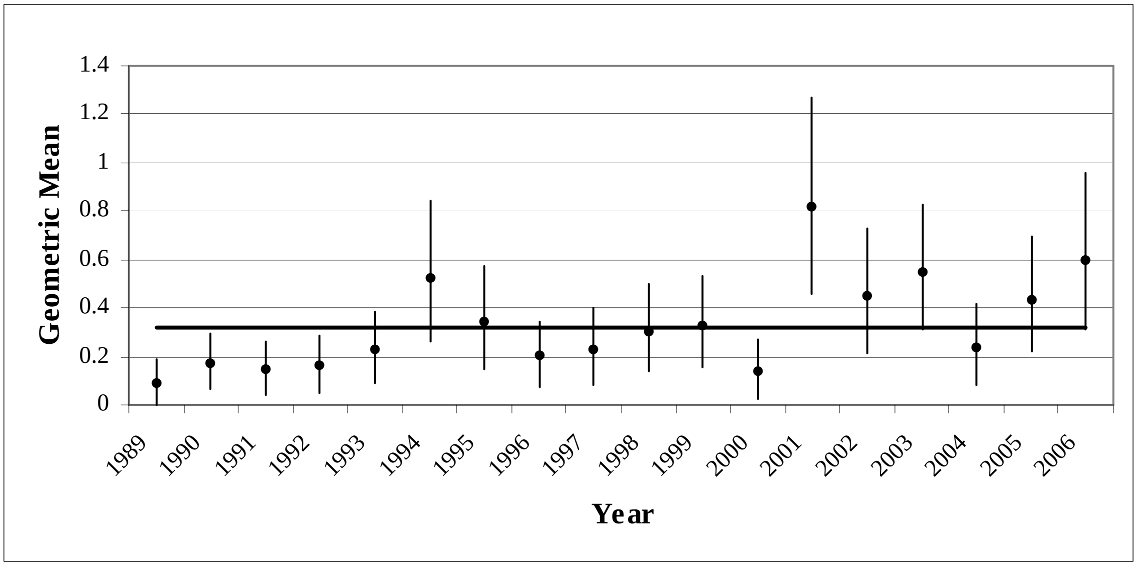


Figure 59. Smallmouth flounder trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

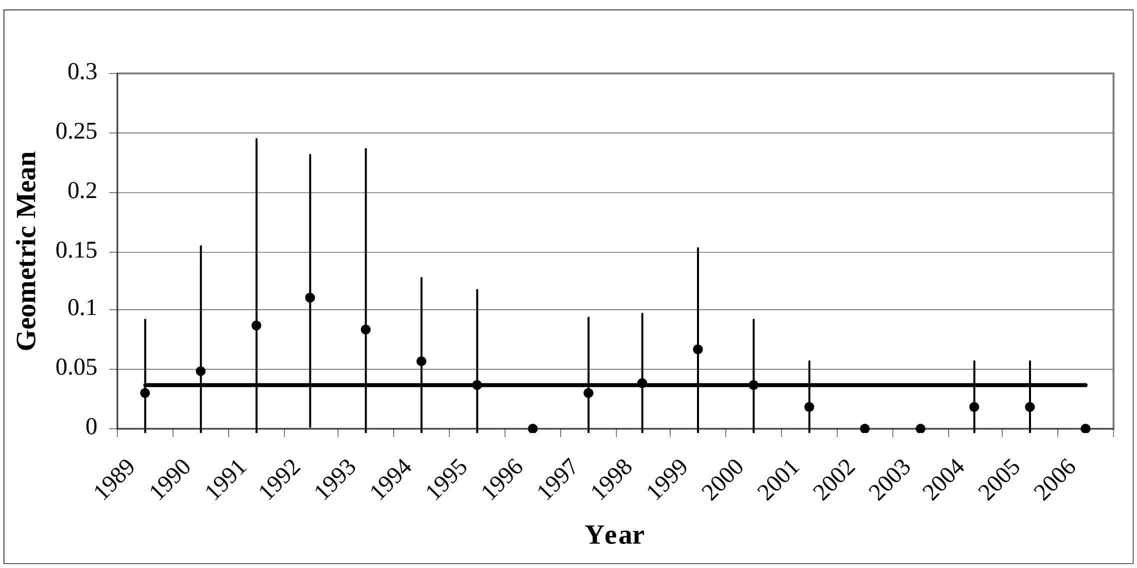


Figure 60. Smallmouth flounder beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

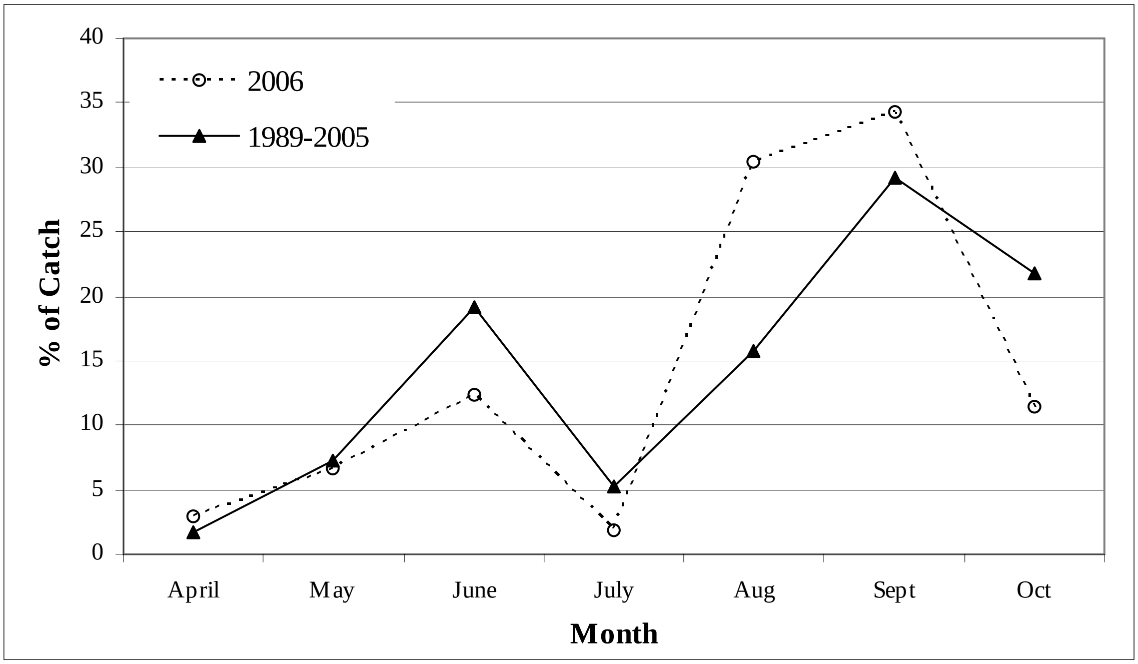


Figure 61. Comparison of the standardized (1989-2005) and 2006 seasonal smallmouth flounder trawl percent catch by month.

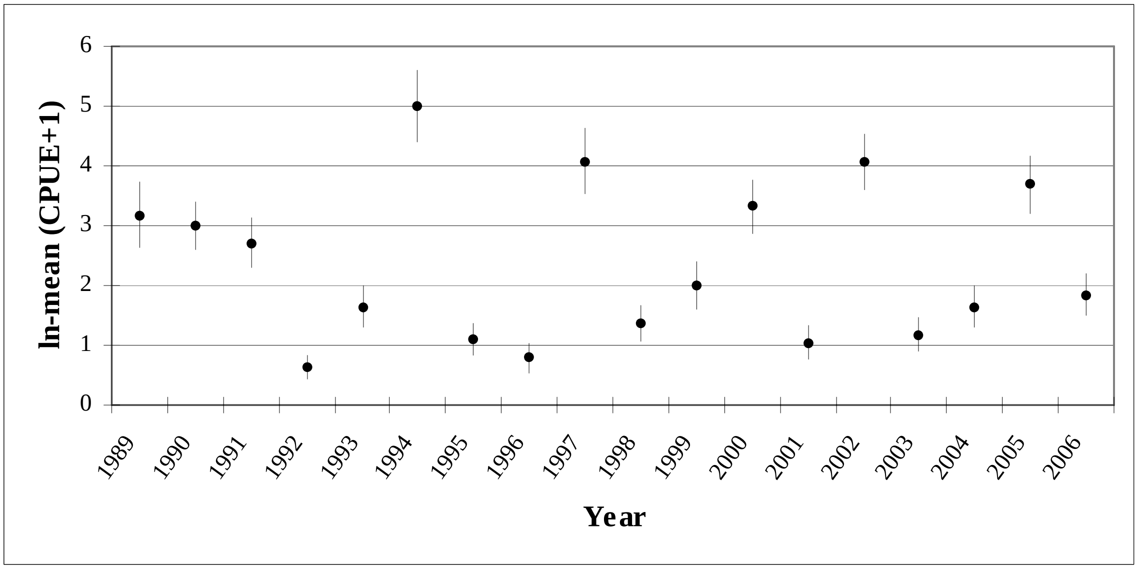


Figure 62. Spot trawl relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

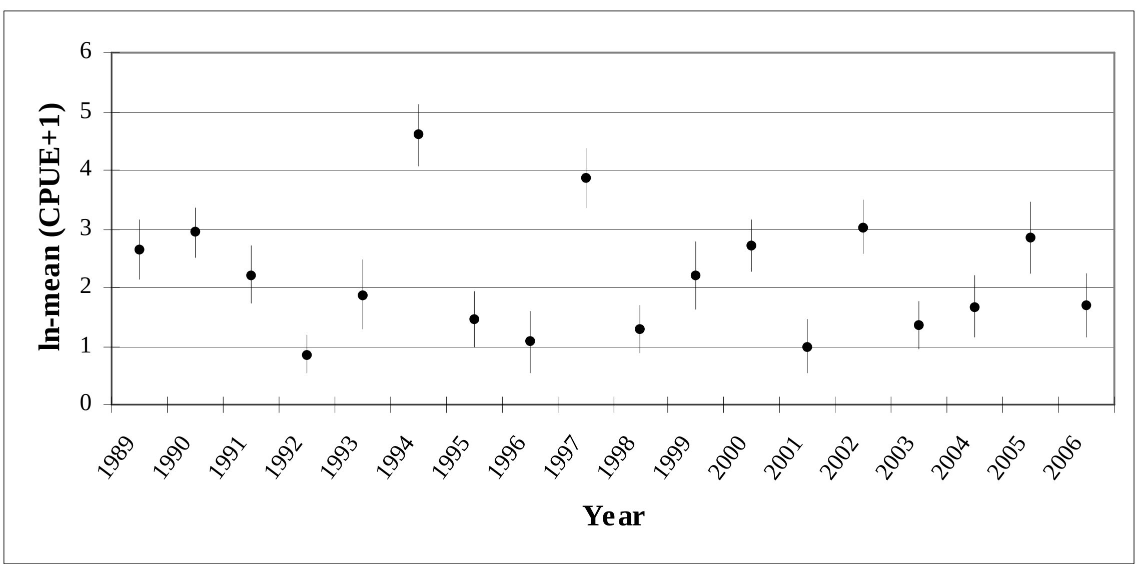


Figure 63. Spot beach seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

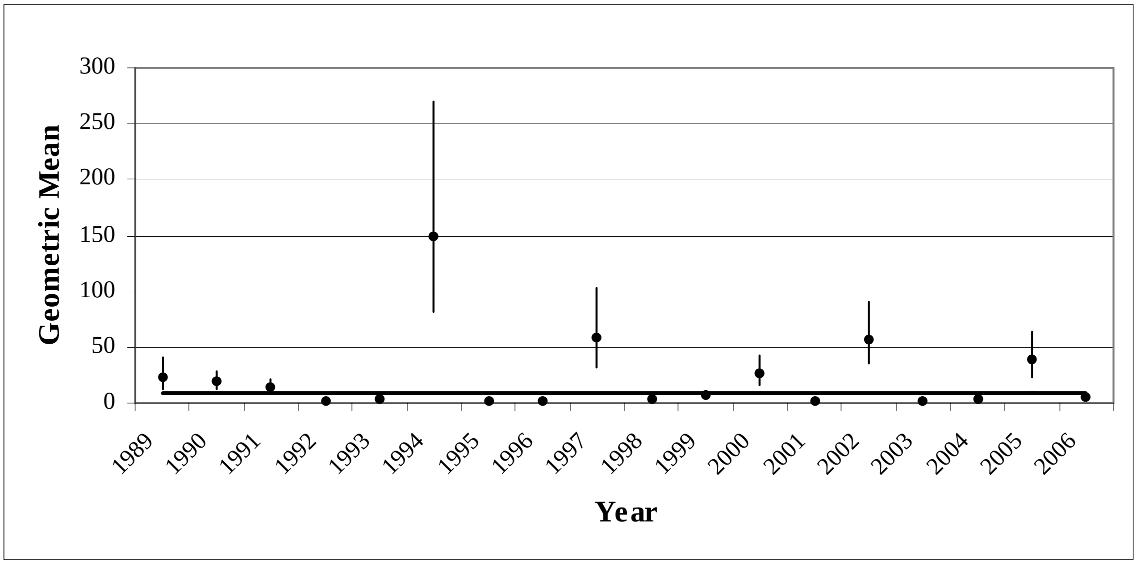


Figure 64. Spot trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

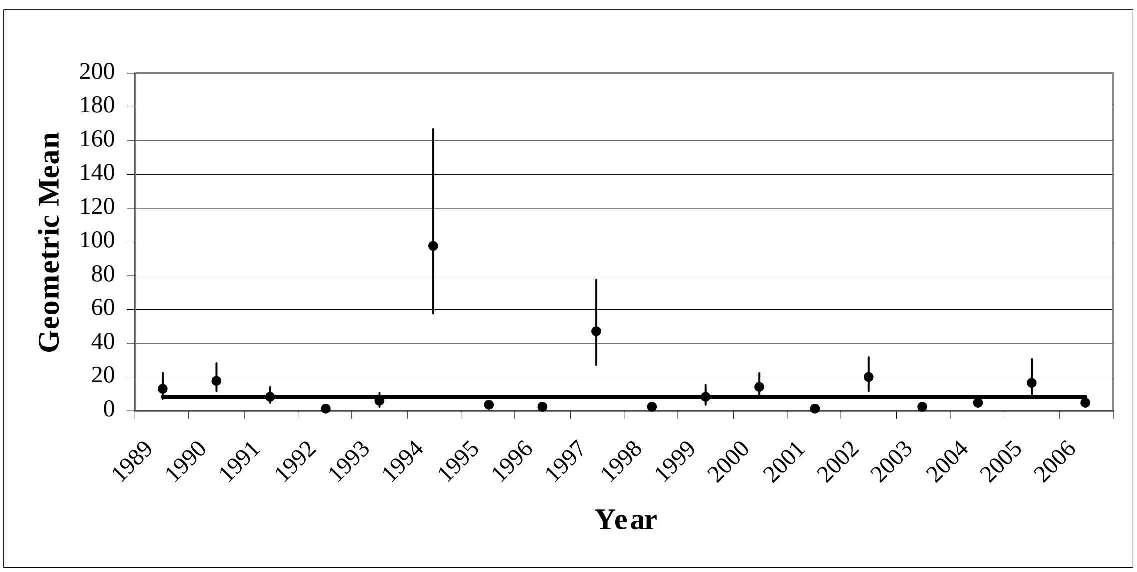


Figure 65. Spot beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

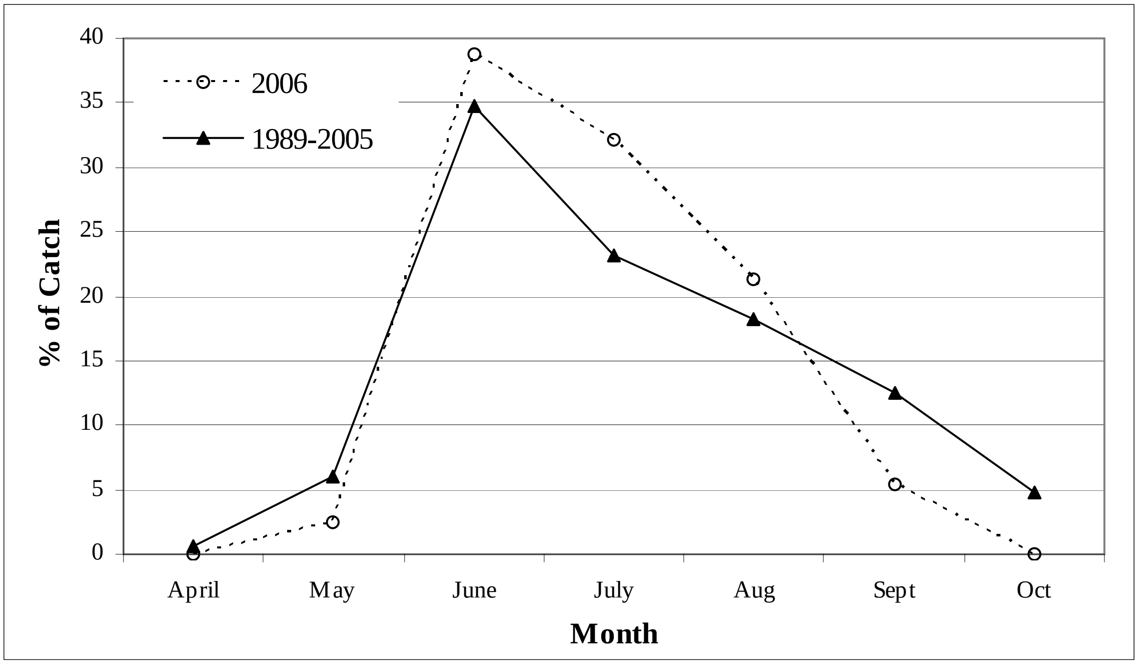


Figure 66. Comparison of the standardized (1989-2005) and 2006 seasonal spot trawl percent catch by month.

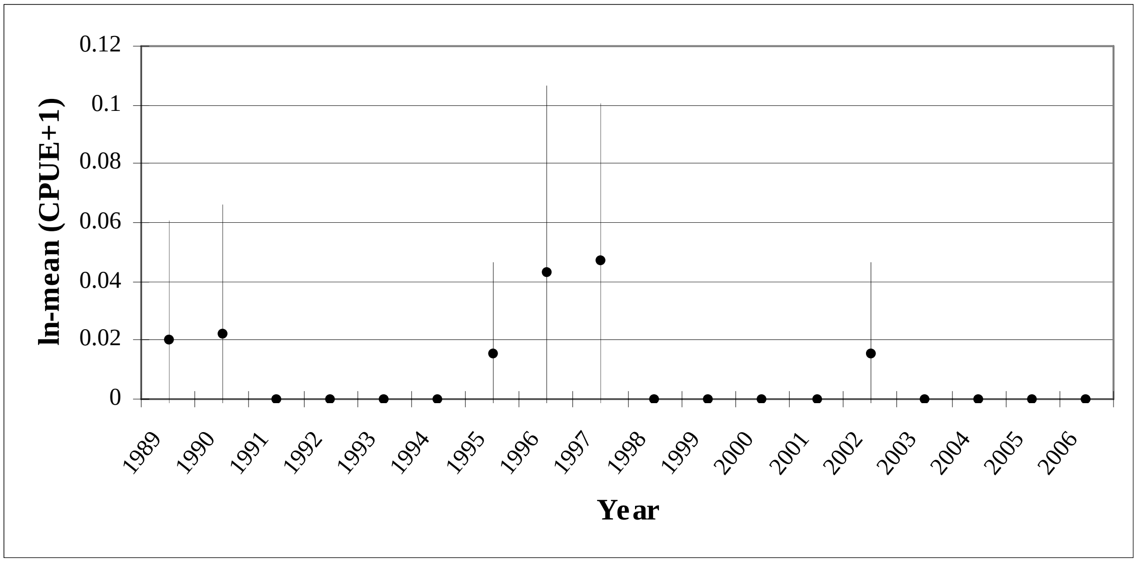


Figure 67. Striped killifish relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

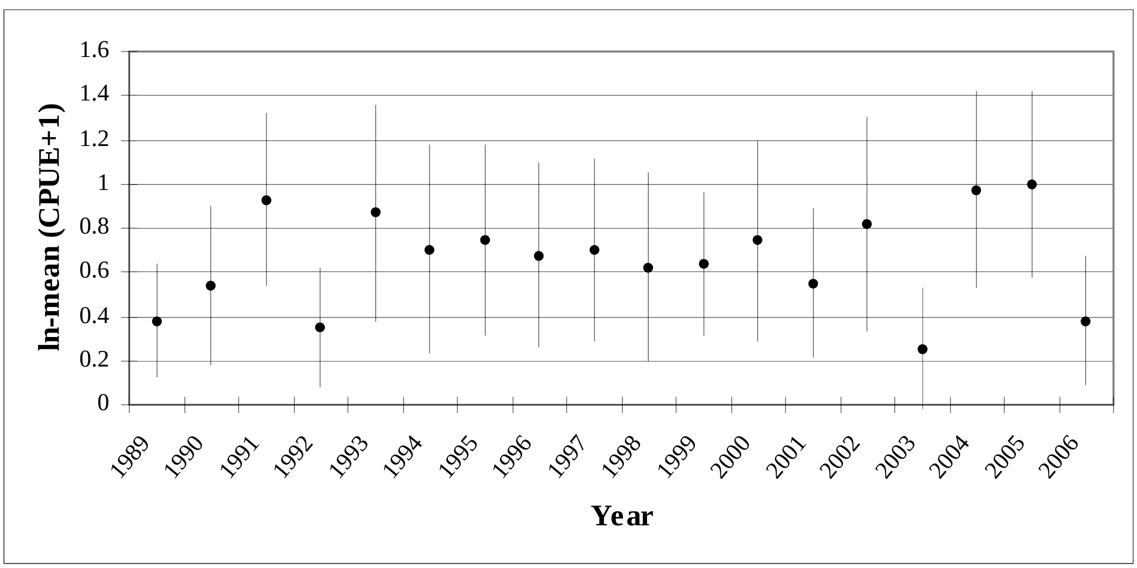


Figure 68. Striped killifish seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

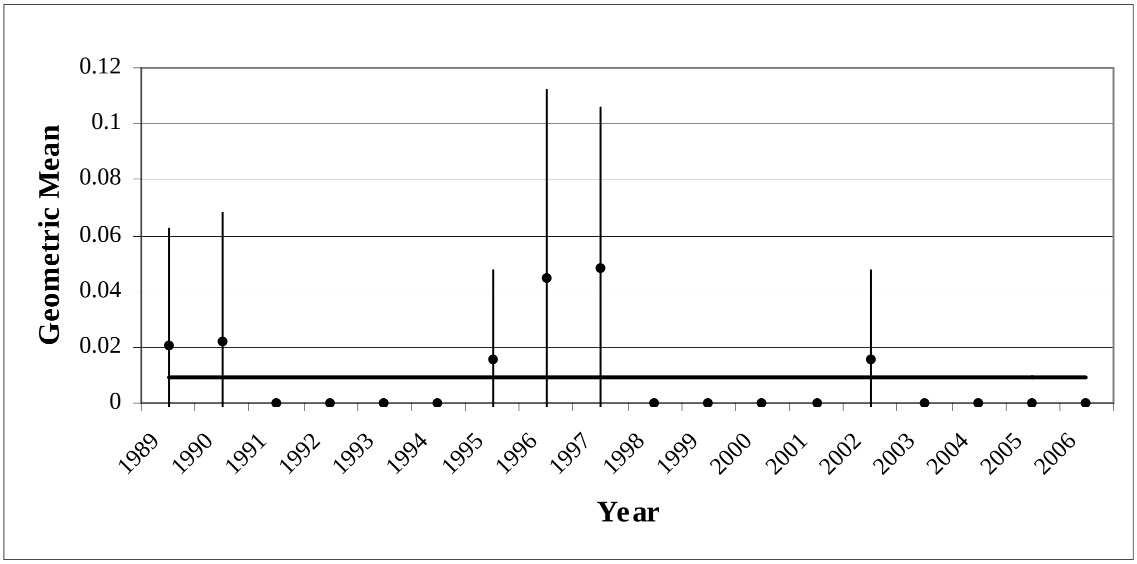


Figure 69. Striped killifish trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

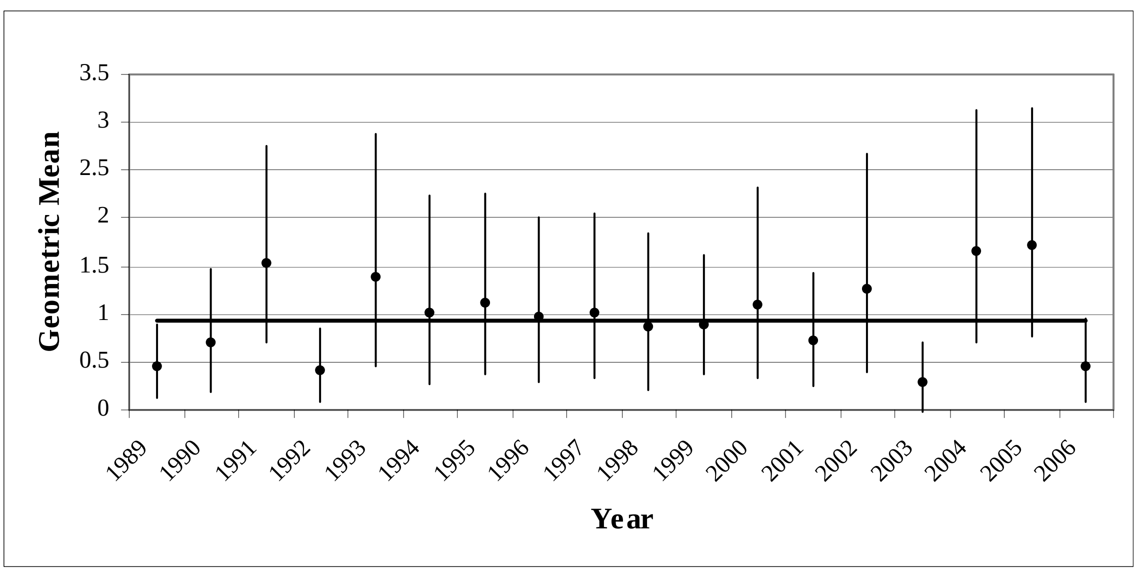


Figure 70. Striped killifish beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

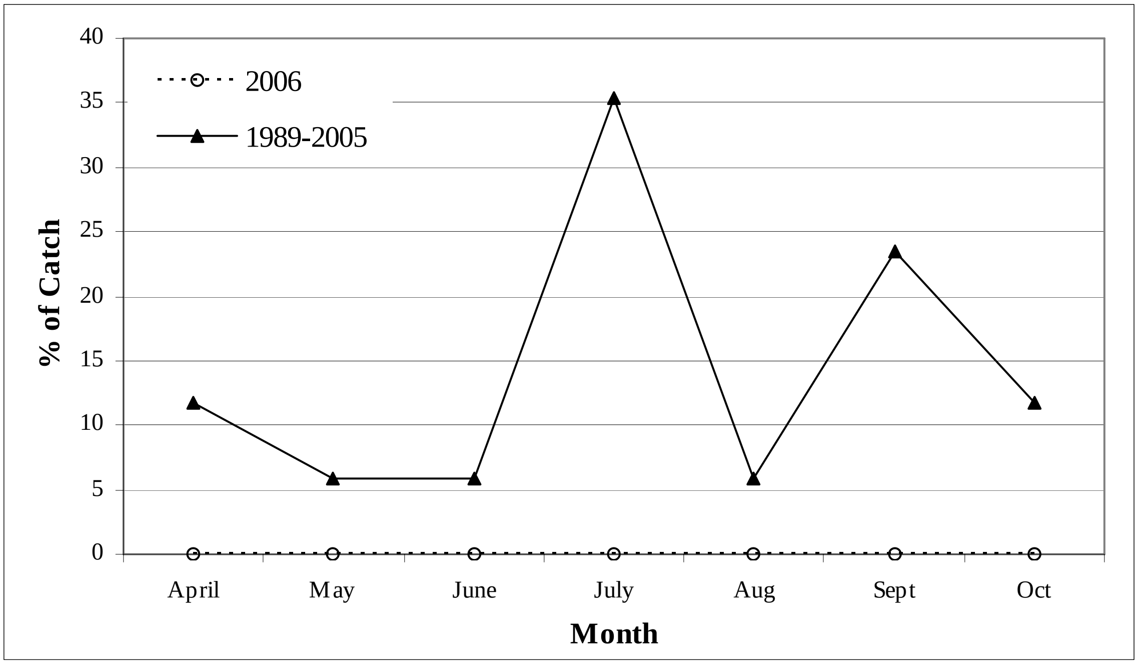


Figure 71. Comparison of the standardized (1989-2005) and 2006 seasonal striped killifish trawl percent catch by month. There were no striped killifish collected during the 2006 trawl sampling.

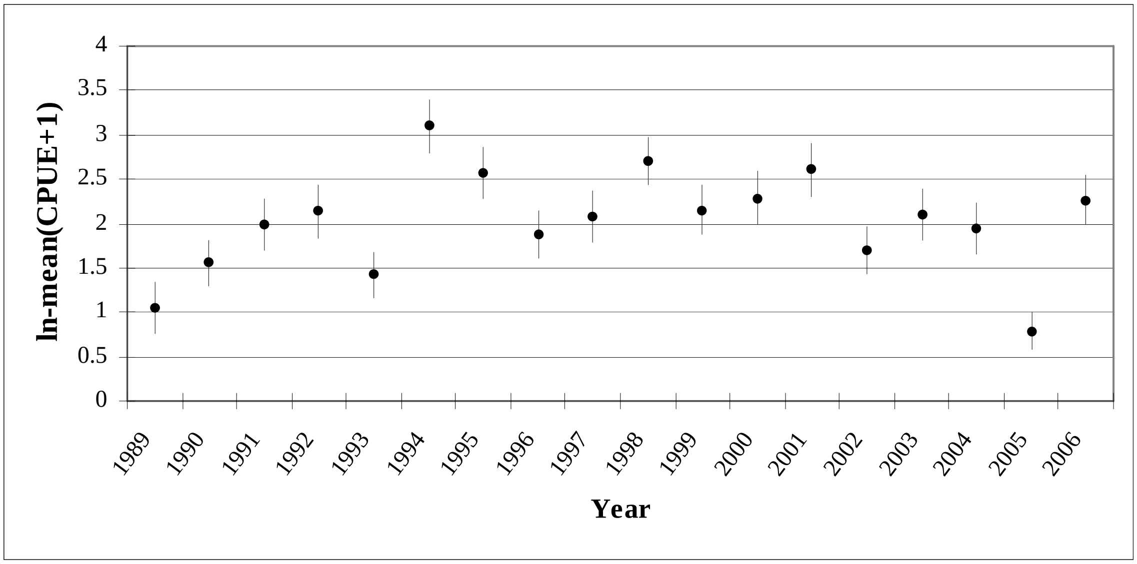


Figure 72. Summer flounder relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

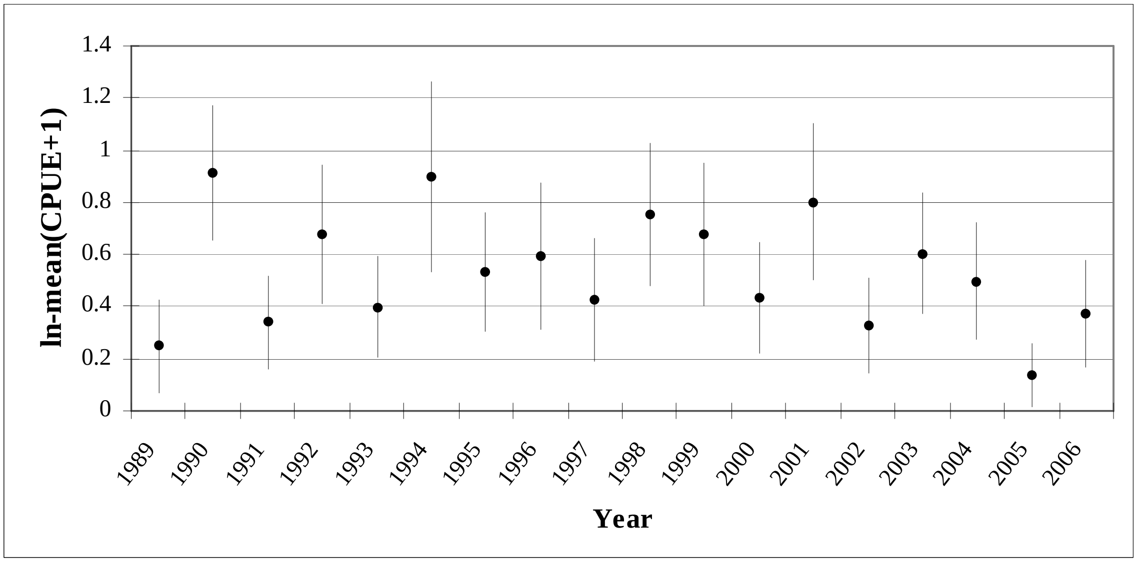


Figure 73. Summer flounder seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

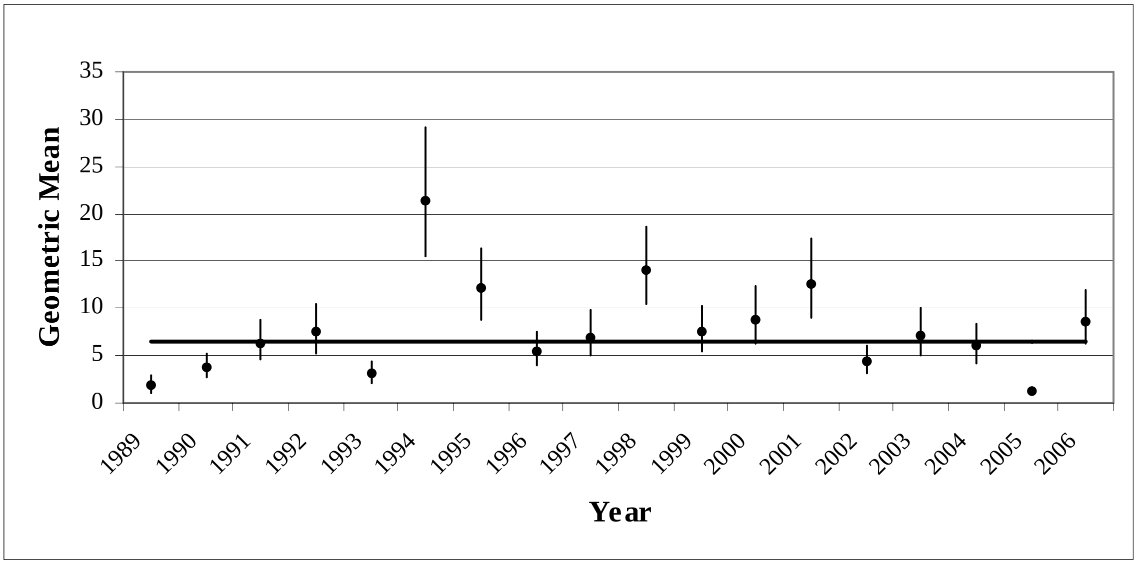


Figure 74. Summer flounder trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

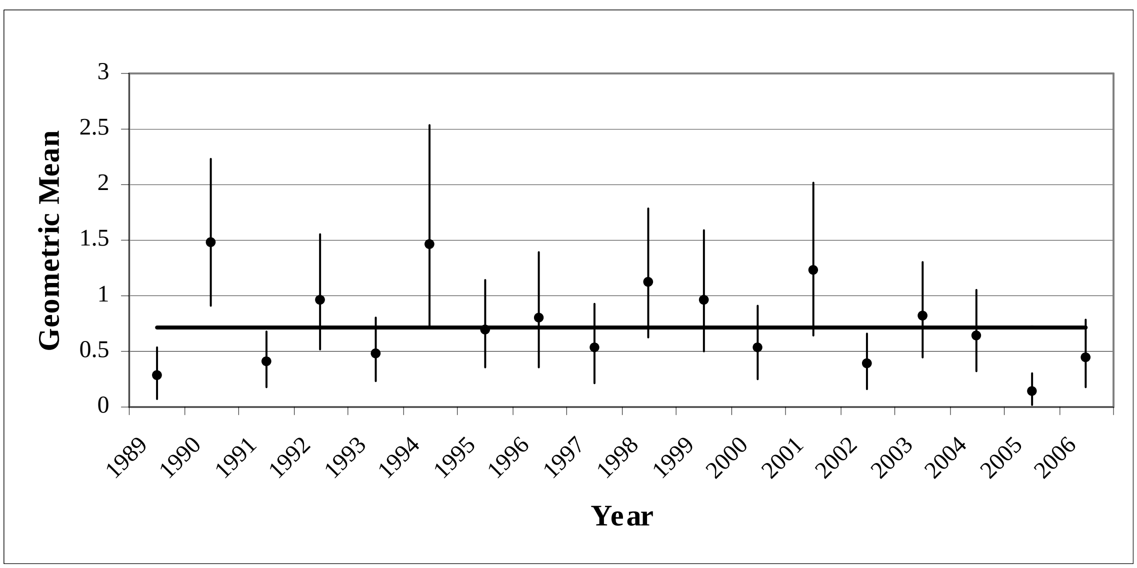


Figure 75. Summer flounder beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

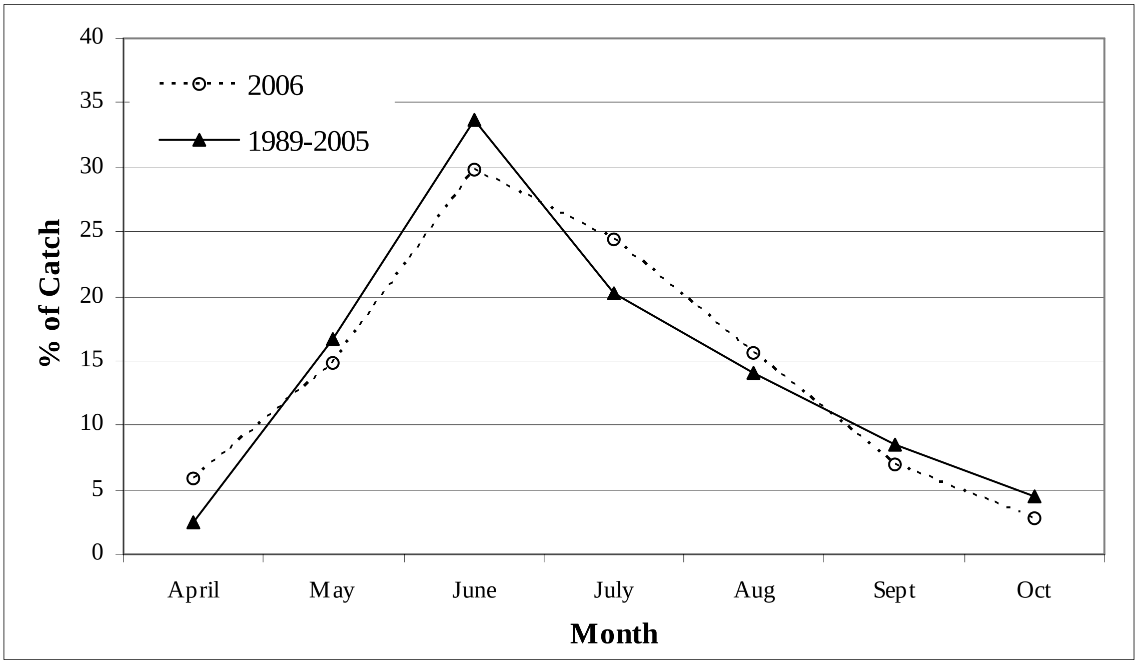


Figure 76. Comparison of the standardized (1989-2005) and 2006 seasonal summer flounder trawl percent catch by month.

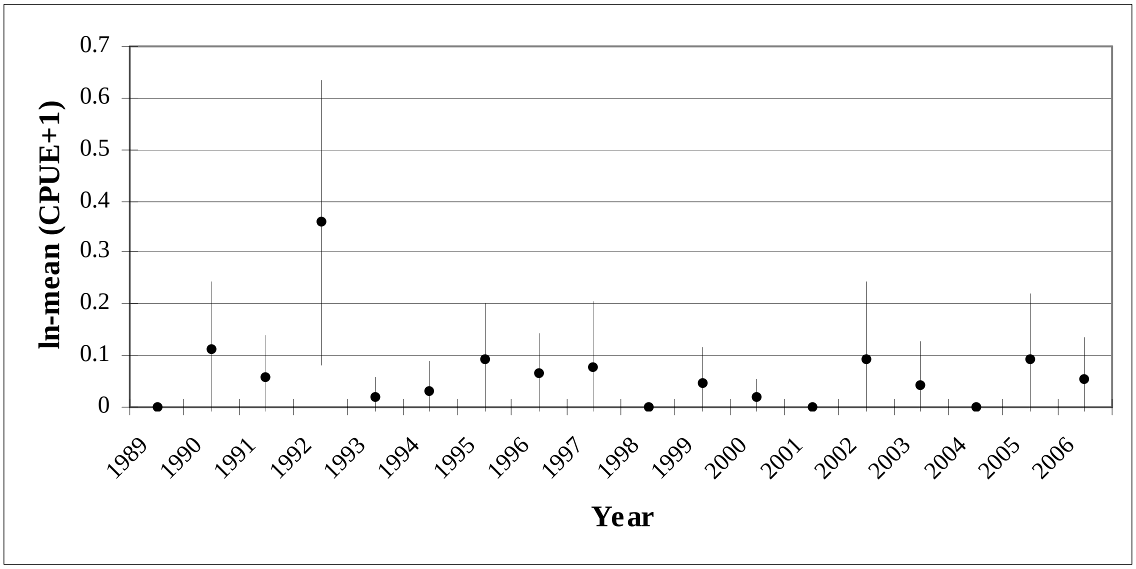


Figure 77. Weakfish relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

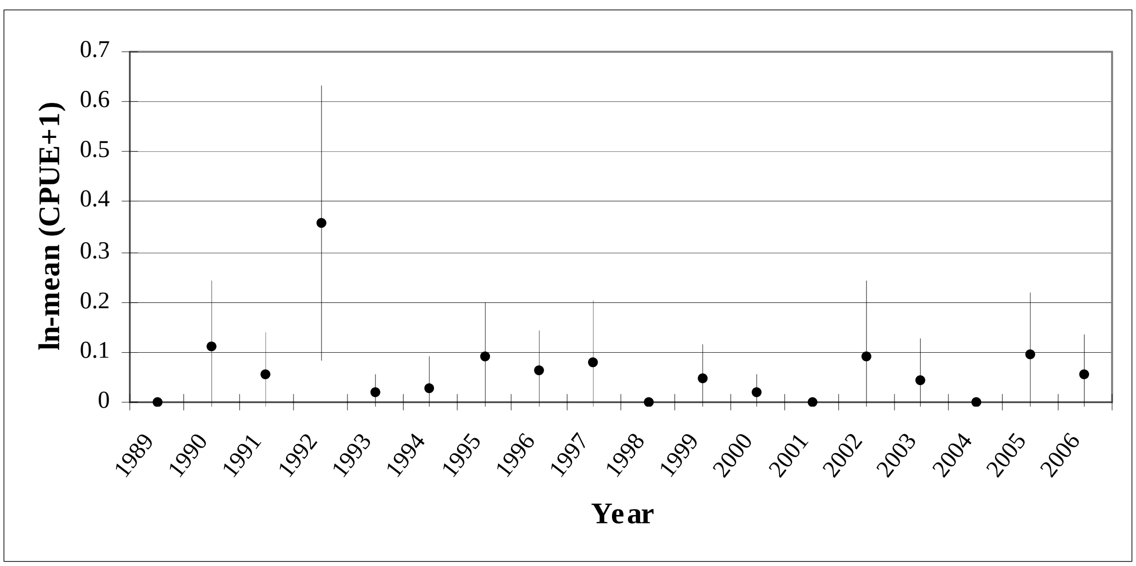


Figure 78. Weakfish seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

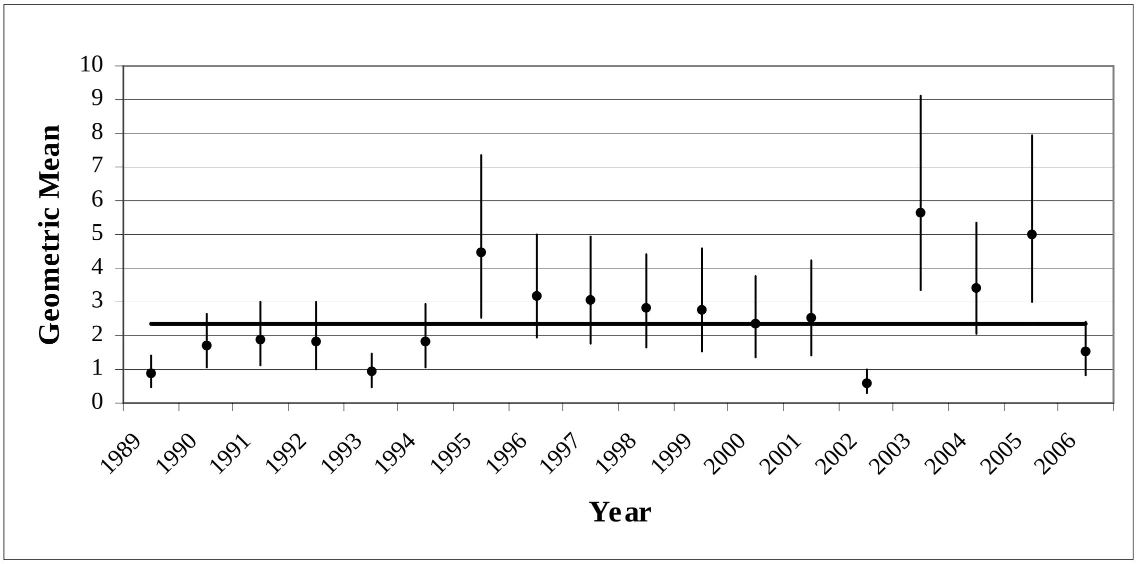


Figure 79. Weakfish trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

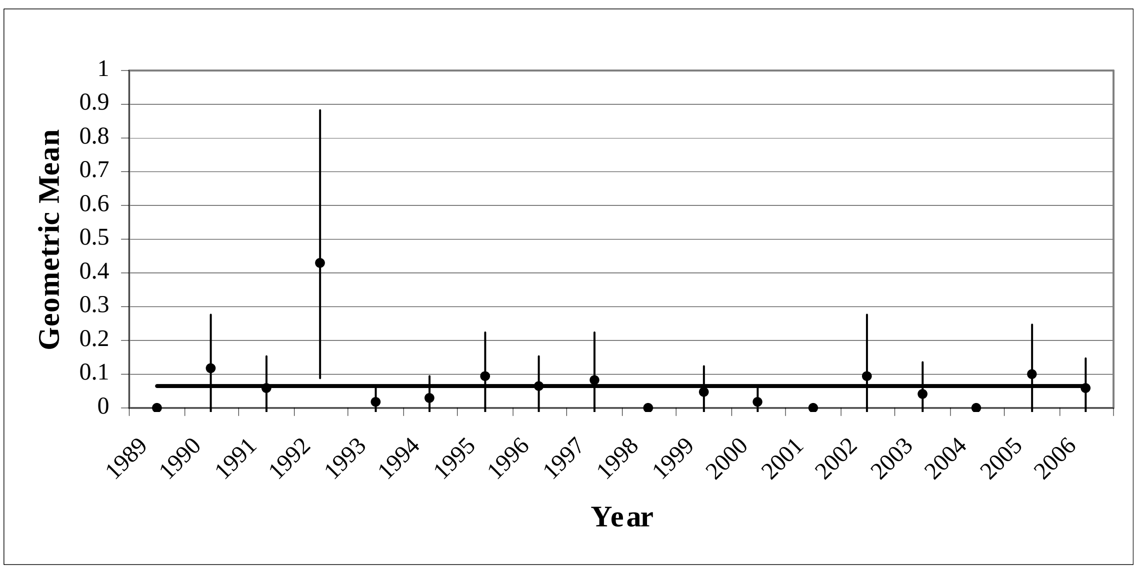


Figure 80. Weakfish beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

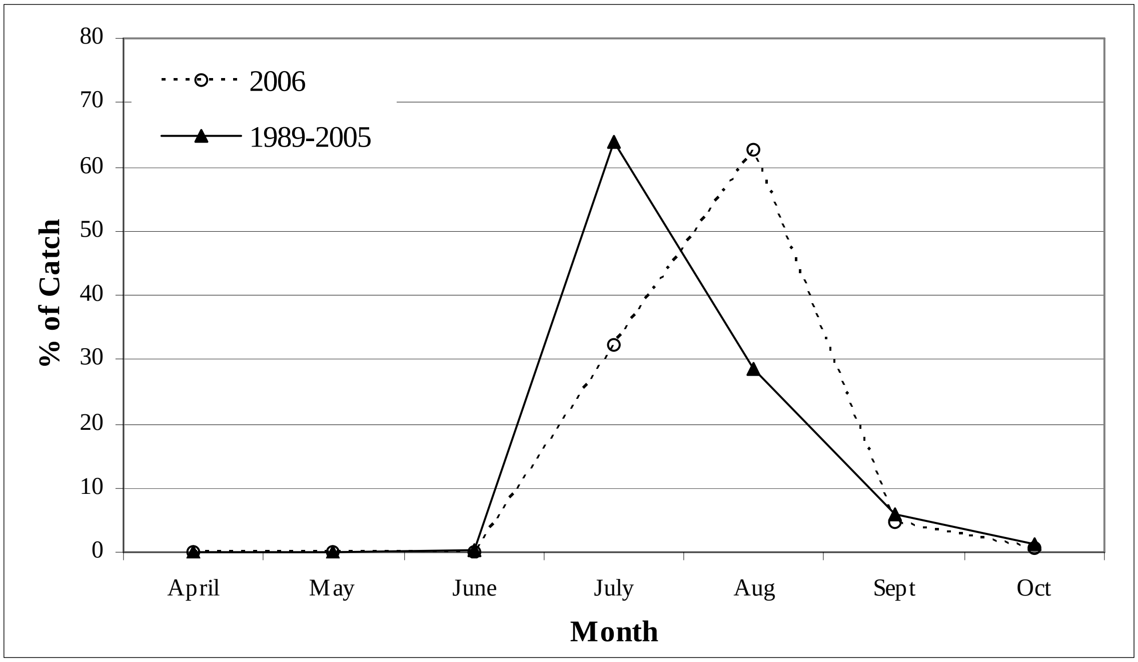


Figure 81. Comparison of the standardized (1989-2005) and 2006 seasonal weakfish trawl percent catch by month.

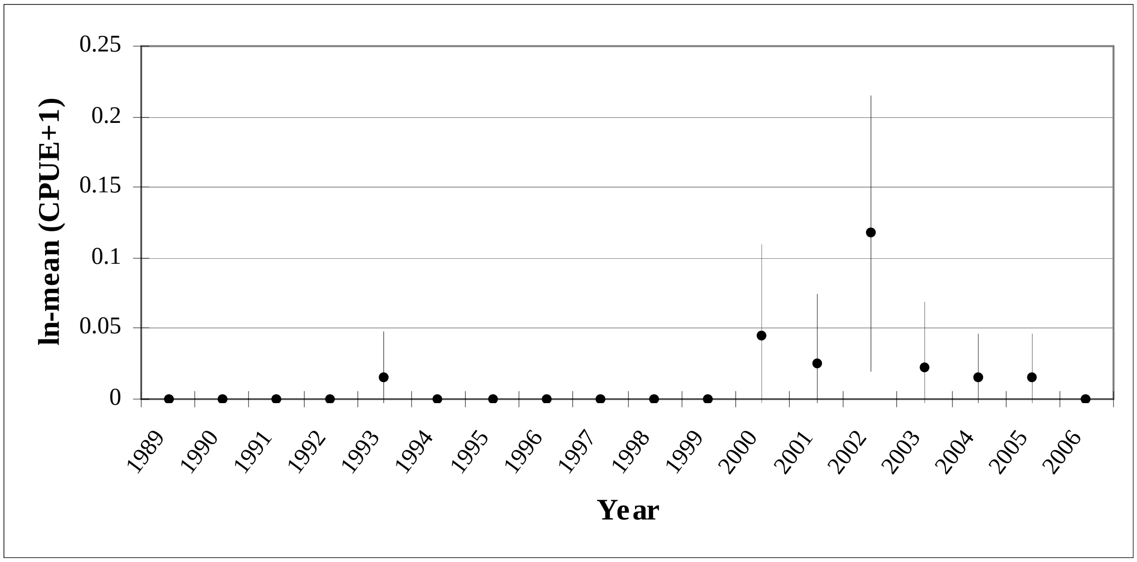


Figure 82. White mullet relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

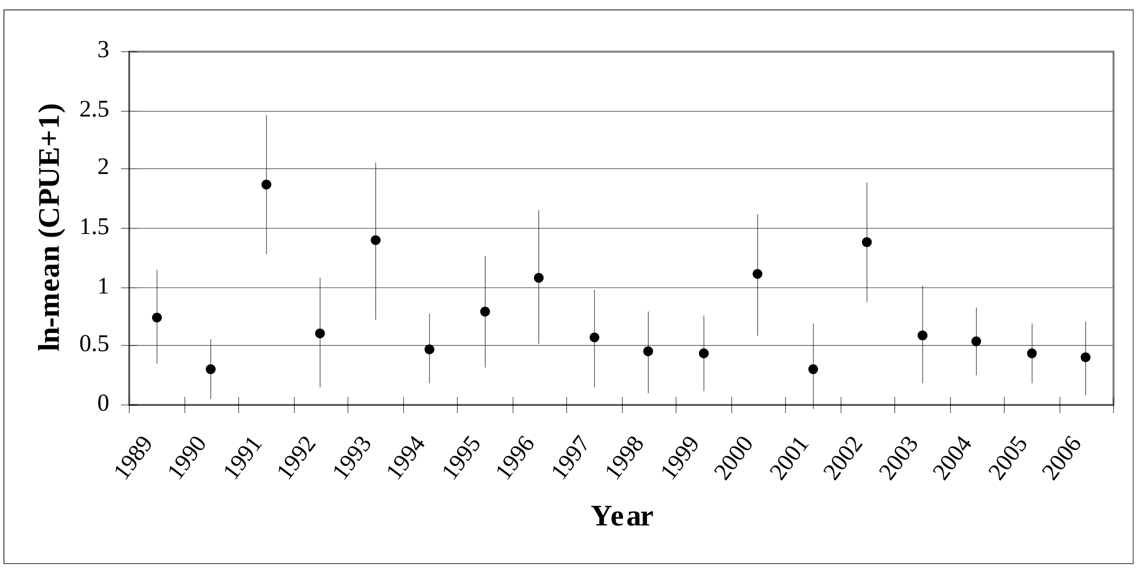


Figure 83. White mullet seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

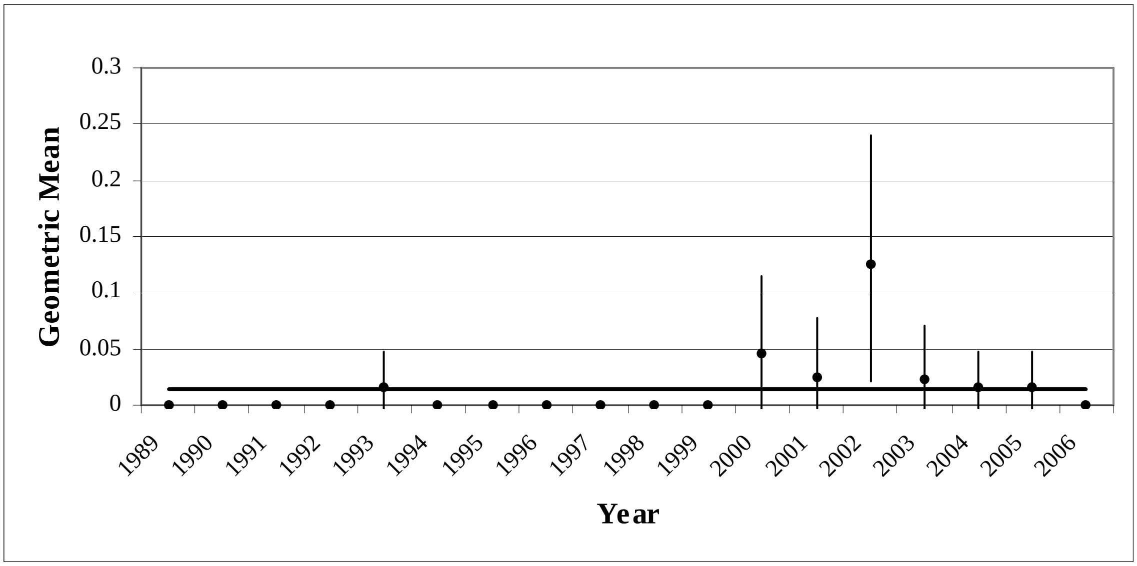


Figure 84. White mullet trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

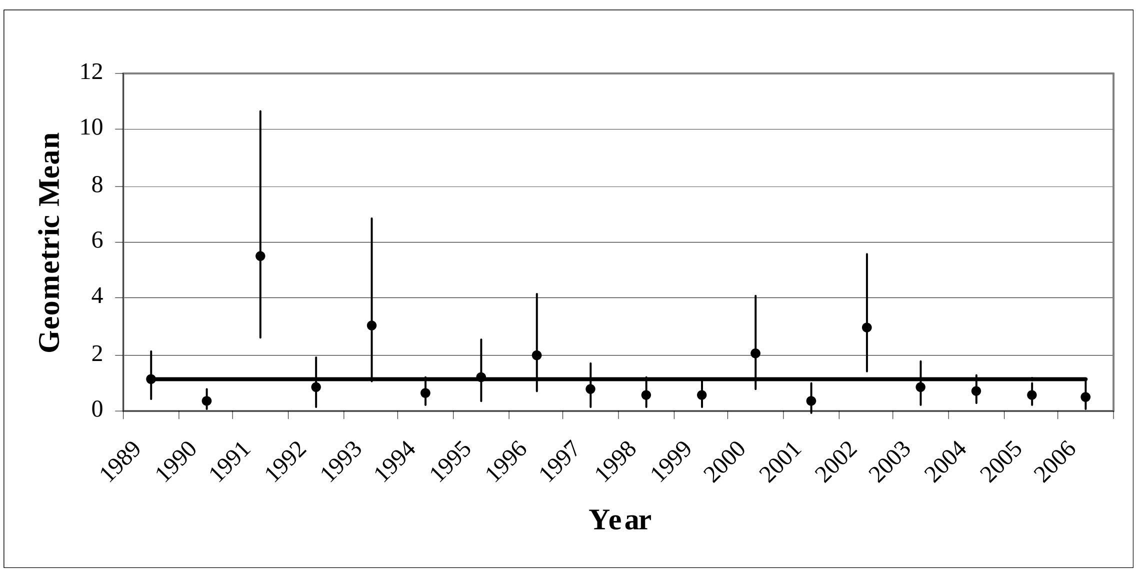


Figure 85. White mullet beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

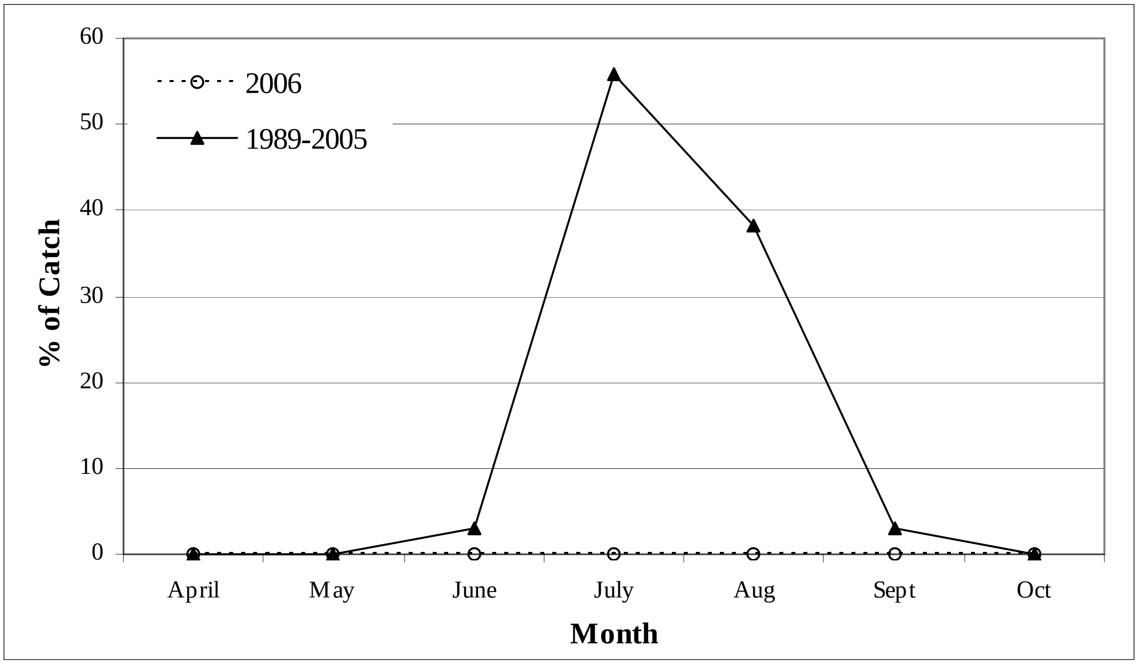


Figure 86. Comparison of the standardized (1989-2005) and 2006 seasonal white mullet trawl percent catch by month. There were no white mullet collected during the 2006 trawl sampling.

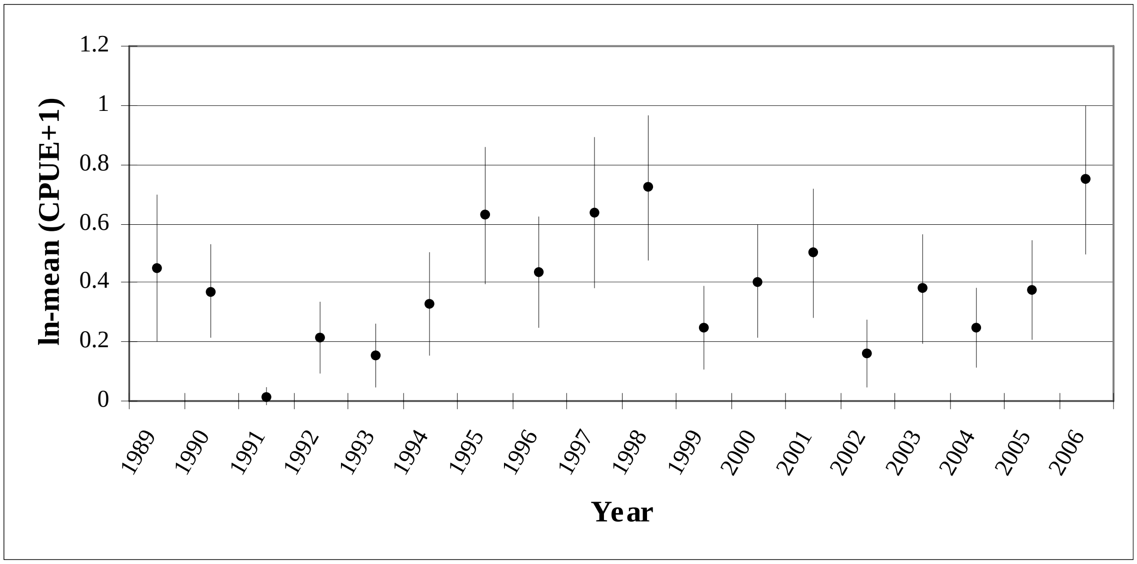


Figure 87. Winter flounder relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989–2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

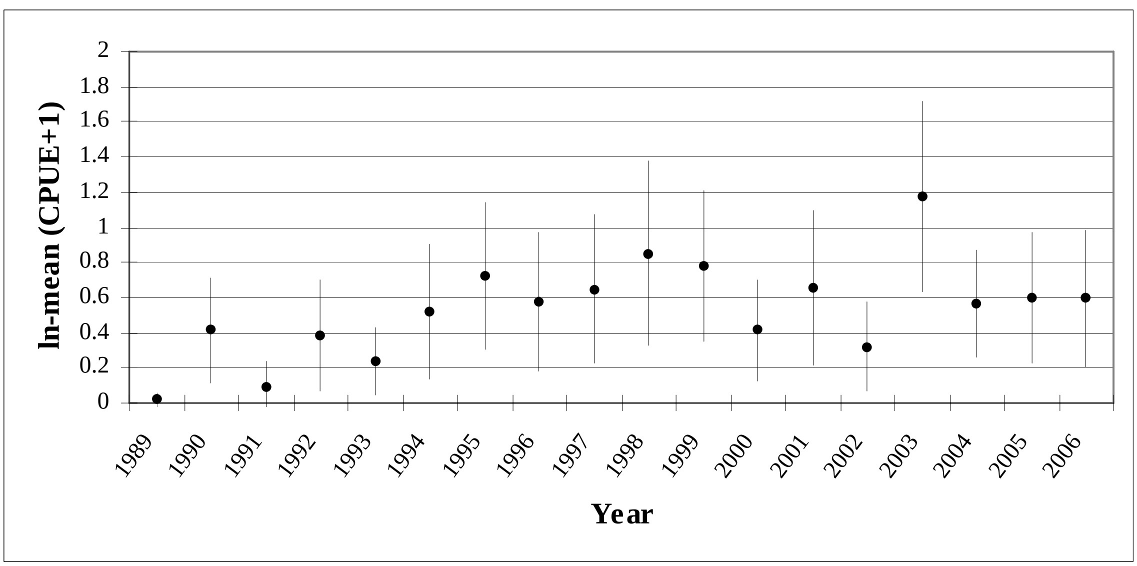


Figure 88. Winter flounder seine relative abundance (ln-mean CPUE+1) with 95% confidence intervals (1989-2006). Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

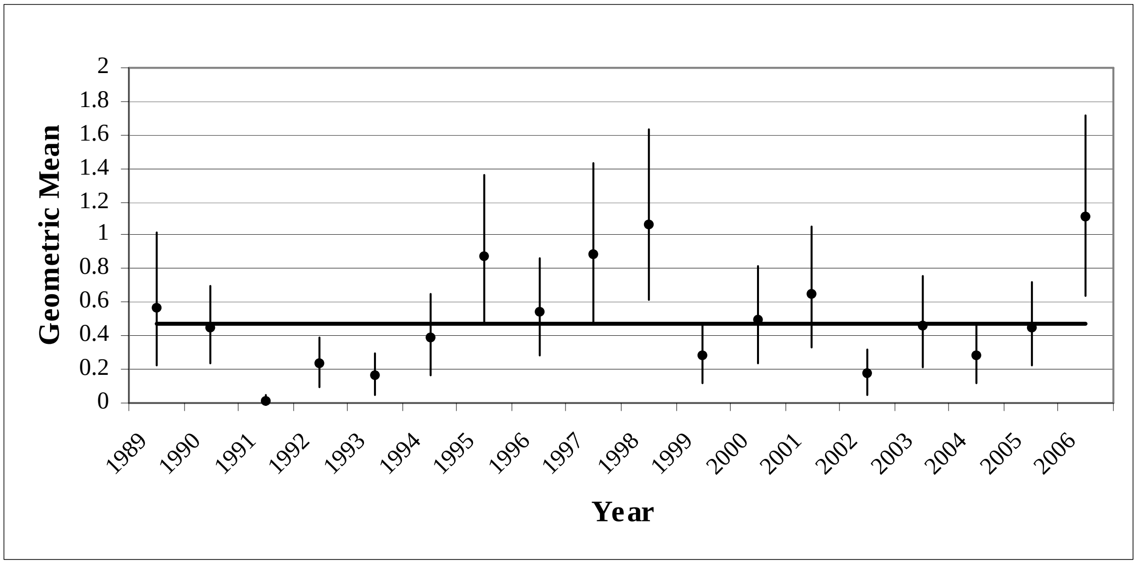


Figure 89. Winter flounder trawl index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=140/year).

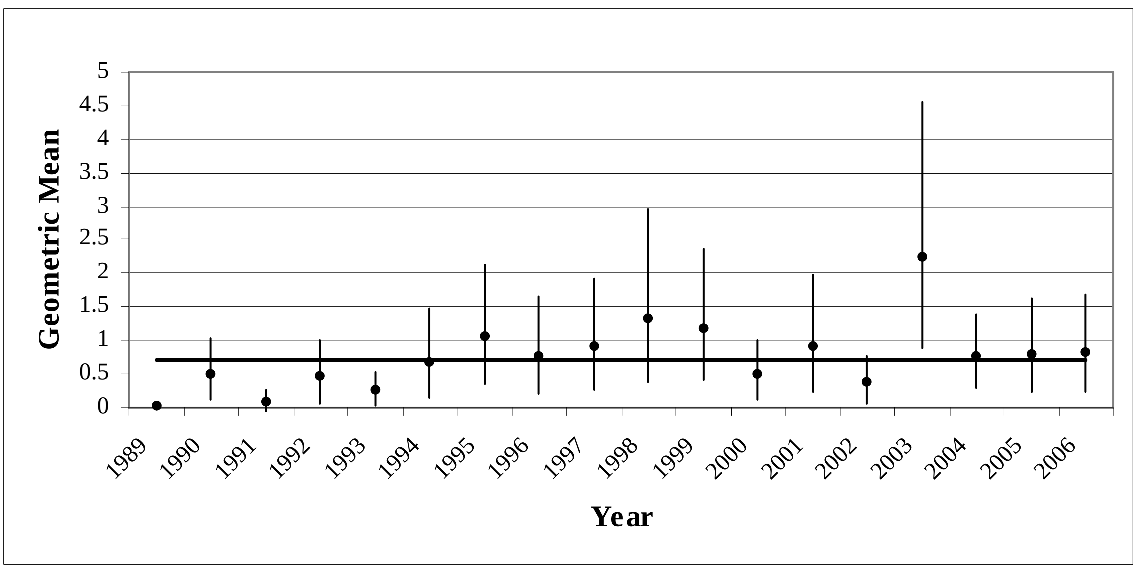


Figure 90. Winter flounder beach seine index of relative abundance (geometric mean) with 95% confidence intervals (1989-2006). Solid line represents the 1989-2006 time series grand mean. Protocols of the Coastal Bays Fishery Investigation Trawl and Beach Seine Survey were standardized in 1989 (n=38/year).

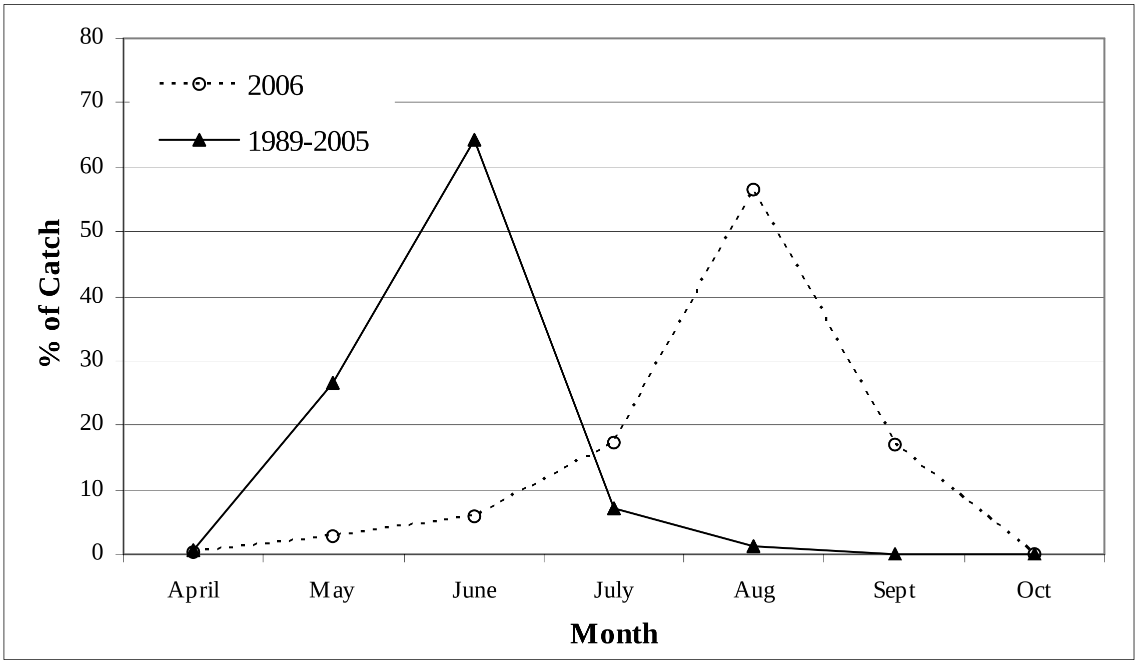


Figure 91. Comparison of the standardized (1989-2005) and 2006 seasonal winter flounder trawl percent catch by month.

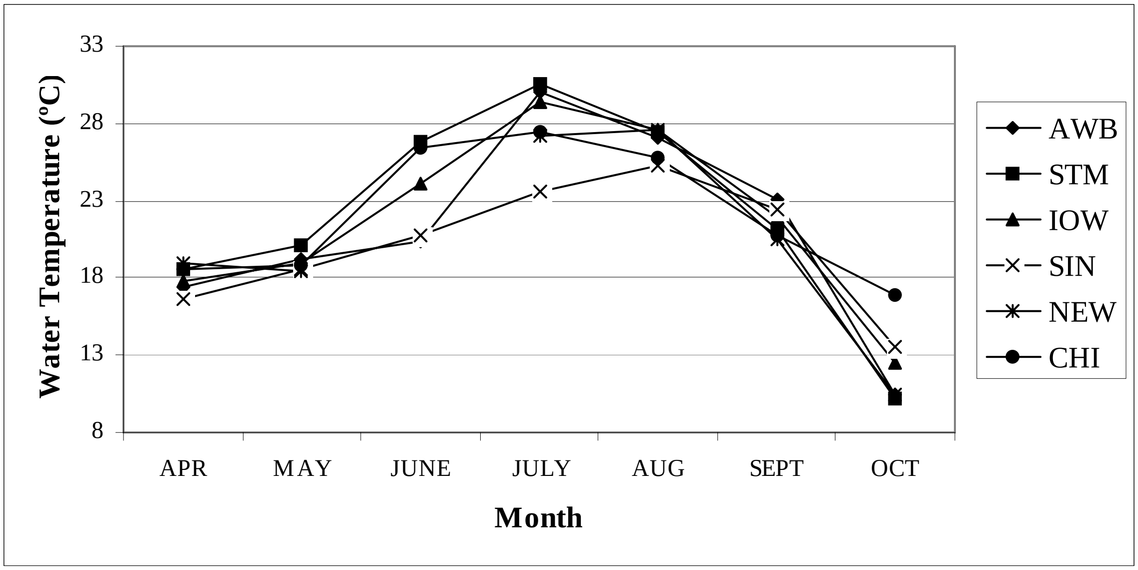


Figure 92. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (°C) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI). June data are not available for Newport Bay due to water quality instrument failure.

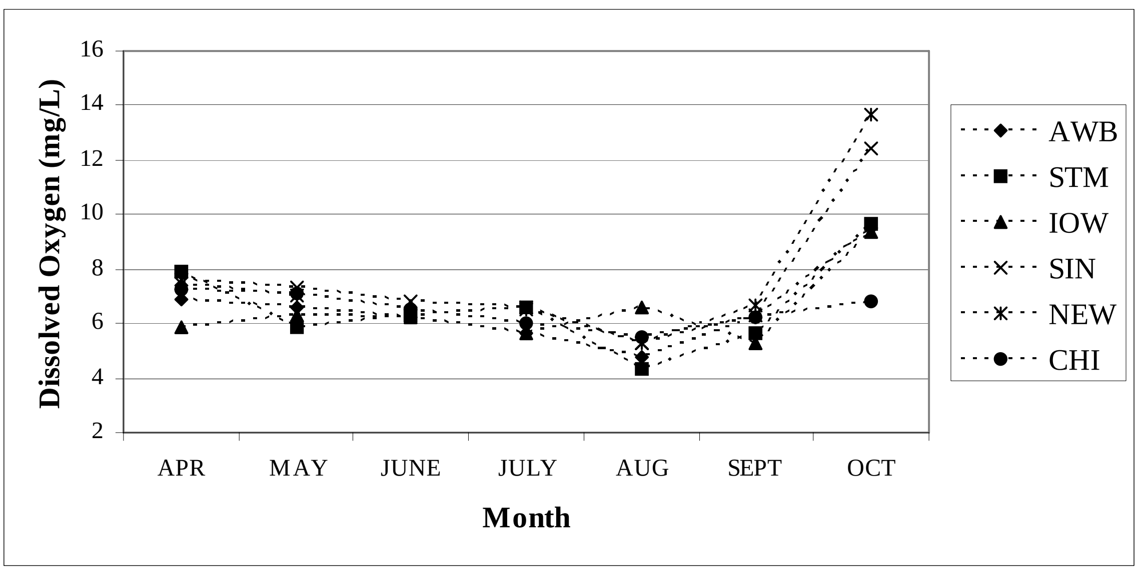


Figure 93. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean dissolved oxygen (mg/L) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI). June data are not available for Newport Bay due to water quality instrument failure.

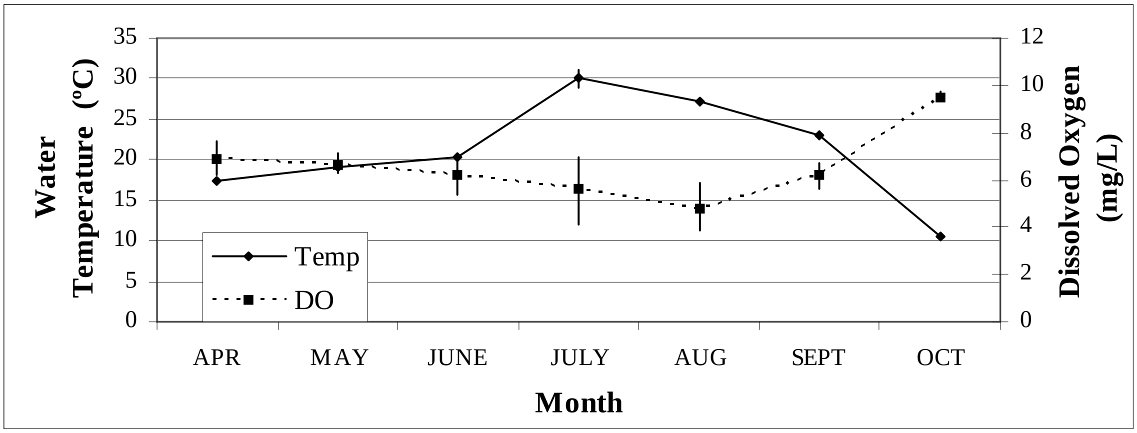


Figure 94. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (°C) and dissolved oxygen (mg/L) in Assawoman Bay. Error bars represent the range of values collected.

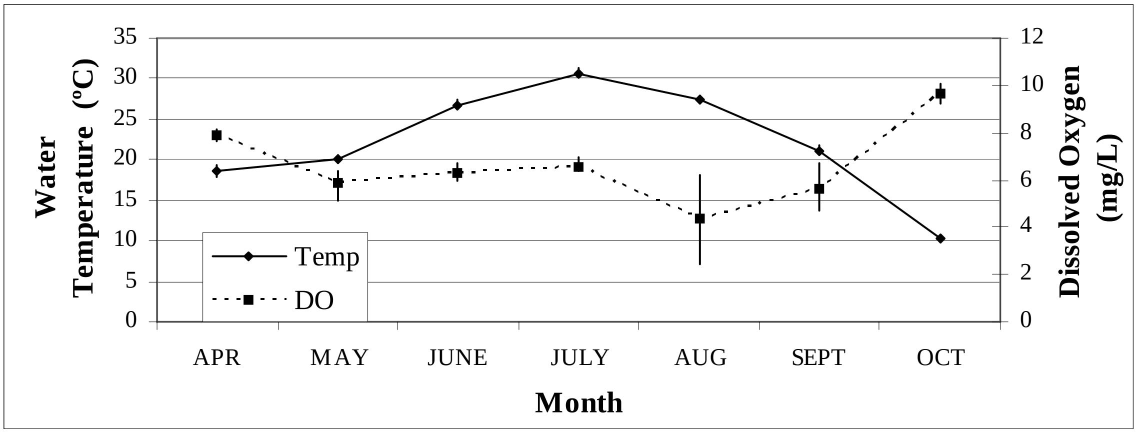


Figure 95. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (°C) and dissolved oxygen (mg/L) in St Martins River. Error bars represent the range of values collected.

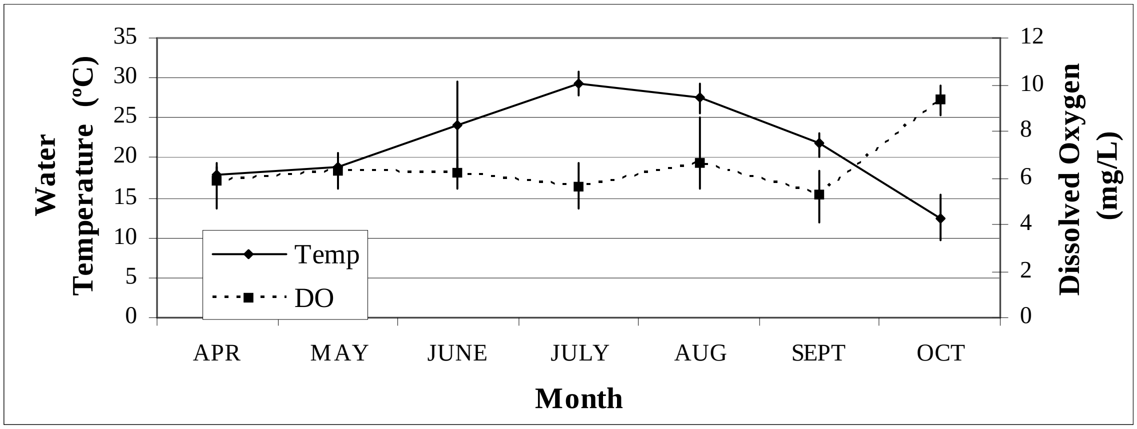


Figure 96. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (°C) and dissolved oxygen (mg/L) in Isle of Wight Bay. Error bars represent the range of values collected.

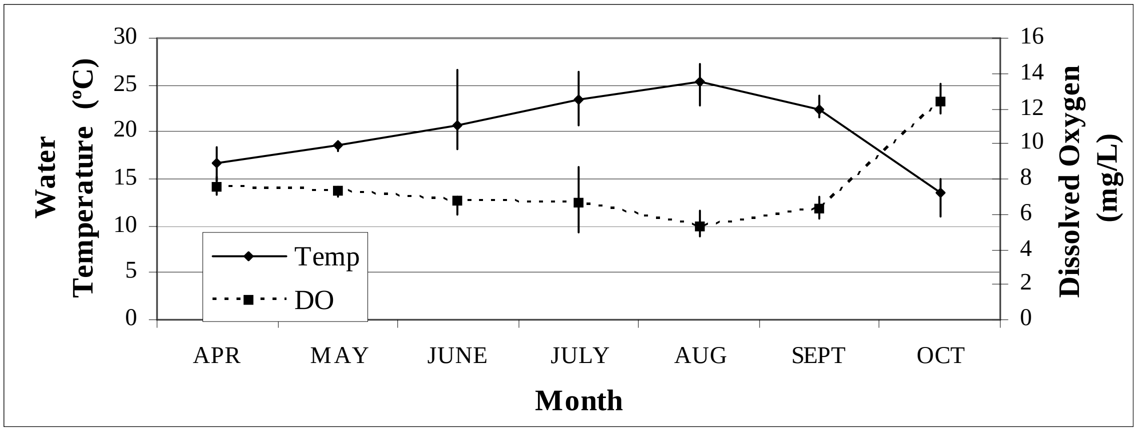


Figure 97. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (°C) and dissolved oxygen (mg/L) in Sinepuxent Bay. Error bars represent the range of values collected.

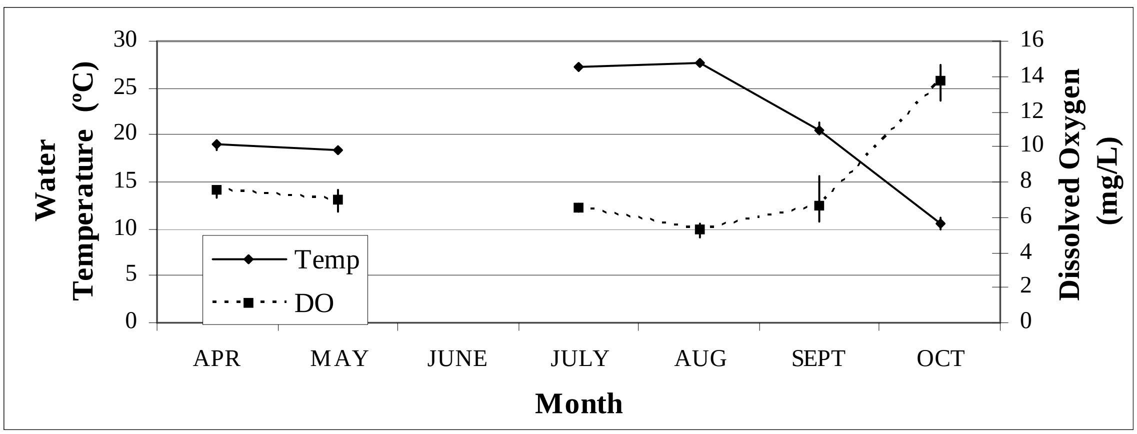


Figure 98. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (°C) and dissolved oxygen (mg/L) in Newport Bay. Error bars represent the range of values collected. June data are not available due to water quality instrument failure.

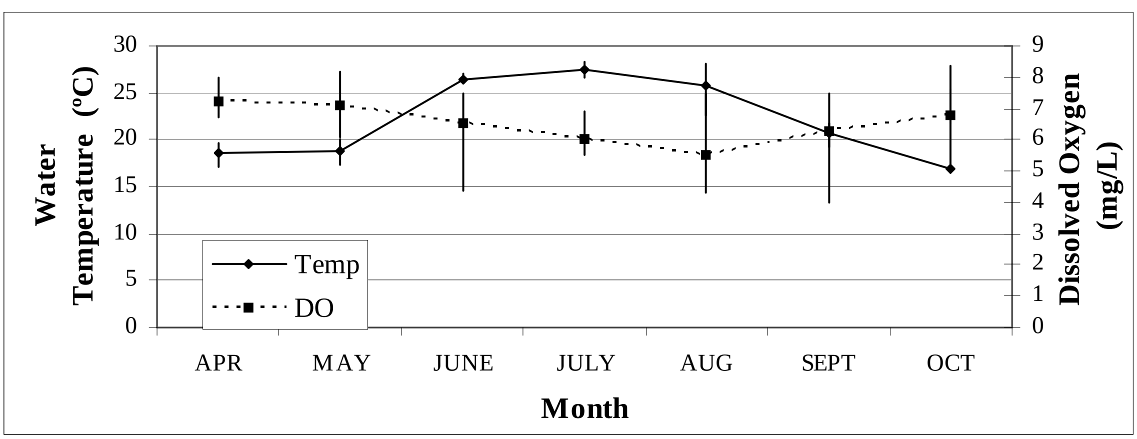


Figure 99. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean water temperature (°C) and dissolved oxygen (mg/L) in Chincoteague Bay. Error bars represent the range of values collected.

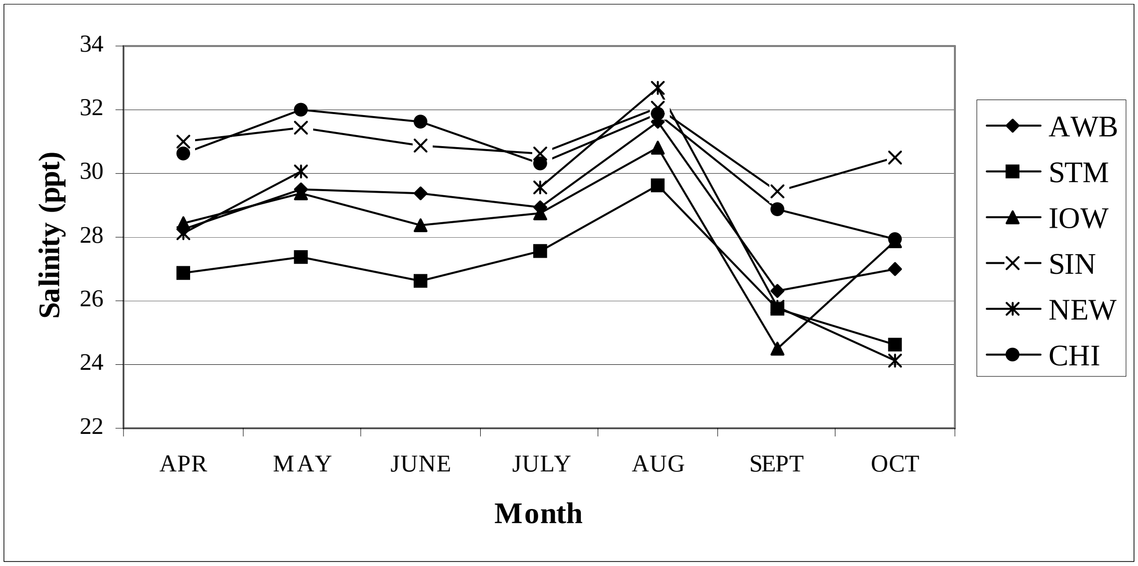


Figure 100. 2006 Coastal Bays Fisheries Investigations Trawl Survey mean salinity (ppt) by month for Assawoman Bay (AWB), St. Martins River (STM), Isle of Wight Bay (IOW), Sinepuxent Bay (SIN), Newport Bay (NEW), and Chincoteague Bay (CHI). June data are not available for Newport Bay due to water quality instrument failure.

Chapter 2

Offshore Trawl Survey

Introduction:

In an effort to obtain information on adult gamefishes in the near-shore Atlantic waters, catches onboard cooperating commercial trawlers operating out of Ocean City, Maryland were sampled. Resulting length and relative abundance data have been used to supplement the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey. In addition, those 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 crab (*Limulus polyphemus*).

In 2006, the Maryland Department of Natural Resources (MDNR) collaborated with the University of Maryland Eastern Shore (UMES) on an offshore trawl survey, focusing on the migration of summer flounder in the vicinity of Ocean City Inlet and coastal bays. Routine offshore sampling efforts were combined with the UMES tagging study.

Methods:

Time

An attempt was made, when weather cooperated, to sample monthly from April through December. Regularly scheduled offshore sampling efforts were combined with the tagging study for three dates in 2006 (5/16/2006, 6/1/06, and 7/14/2006). An additional trip occurred on 11/28/06 that was exclusive of the tagging study.

Gear and Location

Sampling was conducted on commercial trawlers targeting summer flounder and other mid-Atlantic species such as weakfish, croaker, and striped bass. For the first three trips, the net was a standard summer flounder trawl net with a 13.97 cm (5.5 inches) cod end. The net for the November trip was a high rise mid water trawl. Latitude (Long Range Navigation (LORAN)), longitude (LORAN) and start and stop depth (m) of each trawl sample were recorded.

Sampling location was chosen by the captain to maximize the capture of summer flounder. Trawls were completed in the area between one and three miles off the coast, within one mile north and south of the Ocean City Inlet (Figure 1). The depth range was between 9.1 meters (m, 30 feet) and 18.3 m (60 feet). Tow duration was one hour or less for all trawls.

Sample Processing

A sample of each haul was collected by randomly scooping the catch into a 1000 Liter (L) tub, and then estimating the volume of the sample to the whole catch. All fishes were measured for Total Length (TL) in millimeters (mm, Table 1). Wing span was measured for skates and rays. Horseshoe crabs were measured for prosomal width. Crabs were measured for carapace width. Whelks were measured for length. Data were recorded on a standardized data sheet.

Data analysis

Staff biologists entered the data into a Microsoft Excel spreadsheet. Data on length and abundance were analyzed using Excel. Total catch was estimated by multiplying the number of fish in the sample by the inverse of the percentage of catch the sample represented. When sufficient in quantity, length frequency graphs were produced for individual species.

Results:

The predominant species encountered in these trawls were clearnose skate (*Raja eglanteria*), scup (*Stenotomus chrysops*), weakfish (*Cynoscion regalis*), Atlantic croaker (*Micropogonias undulatus*), southern stingray (*Dasyatis americana*), little skate (*Leucoraja erinacea*) and horseshoe crabs (*Limulus polyphemus*; Table 1). A complete list of encountered species can be found in Table 1.

A total of 316 weakfish were collected and measured. Lengths ranged in size from 191 to 559 mm. The mode was 279 mm and the average was 295 mm (Figure 2).

A total of 145 Atlantic croaker were collected and measured. Lengths ranged in size from 152 to 406 mm. The mode was 203 mm and the average was 200 mm (Figure 3).

A total of 49 summer flounder were collected and measured. Lengths ranged in size from 90 mm to 780 mm. The mode was 410 mm and the mean was 432 mm (Figure 4).

Discussion:

Collecting length data on adult fishes from commercial vessels supplements those collected from the Coastal Bays Fisheries Investigation Trawl and Beach Seine Survey. These collections could be improved by increasing sampling frequency and diversifying by gear type. Additional samples would provide a better description of the populations of fishes.

References:

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

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. 386pp.

List of Tables

List of Figures

Table 1. List of species collected in Maryland's Offshore Trawl Surveys from April through October, 2006. Species are grouped (Finfish, Crustaceans, Mollusks, Other) and listed by order of total abundance.

Common Name	Scientific Name	Total Number
Finfish Species		
Clearnose Skate	*Raja eglanteria*	15850
Scup	*Stenotomus chrysops*	2965
Weakfish	*Cynoscion regalis*	2705
Atlantic Croaker	*Micropogonias undulatus*	1200
Southern Stingray	*Dasyatis americana*	804
Little Skate	*Leucoraja erinacea*	734
Spotted Hake	*Urophycis regia*	625
Summer Flounder	*Paralichthys dentatus*	615
Atlantic Angel Shark	*Squatina dumeril*	315
Butterfish	*Peprilus triacanthus*	309
Striped Bass	*Morone saxatilis*	309
Windowpane Flounder	*Scophthalmus aquosus*	215
Cownose Ray	*Rhinoptera bonasus*	185
Atlantic Menhaden	*Brevoortia tyrannus*	184
Spiny Dogfish	*Squalus acanthias*	118
Smallmouth Flounder	*Etropus microstomus*	75
Smooth Dogfish	*Mustelus canis*	60
Atlantic Sturgeon	*Acipenser oxyrinchus*	55
Northern Kingfish	*Menticirrhus saxatilis*	50
Smooth Butterfly Ray	*Gymnura micrura*	45
Black Sea Bass	*Centropristis striata*	45
Spot	*Leiostomus xanthurus*	40
Silver Hake	*Merluccius bilinearis*	25
Northern Searobin	*Prionotus carolinus*	20
Striped Searobin	*Prionotus evolans*	20
Bluefish	*Pomatomus saltatrix*	20
Northern Puffer	*Sphoeroides maculatus*	15
Red Hake	*Urophycis chuss*	15
Sheepshead	*Archosargus probatocephalus*	5
Sand Tiger	*Carcharias taurus*	1
Monkfish	*Lophius americanus*	1
Black Drum	*Pogonias cromis*	1
	Total Finfish	**27,626**

Table 1. Con't.

Common Name	Scientific Name	Total Number
Crustacean Species		
Blue Crabs	*Callinectes sapidus*	133
Nine-Spined Spider Crab	*Libinia emarginata*	125
Six-Spined Spider Crab	*Libinia dubia*	109
Atlantic Rock Crab	*Cancer irroratus*	91
Flat-Claw Hermit Crab	*Pagurus pollicaris*	64
Long-Clawed Hermit Crab	*Pagurus longicarpus*	12
	Total Crustaceans	**534**
Mollusk Species		
Channeled Whelk	*Busycotypus canaliculatus*	617
Knobby Whelk	*Busycon carica*	598
Longfin Squid	*Loligo pealeii*	145
Sea Scallop	*Placopecten magellanicus*	55
Boreal Squid	*Illex illecebrosus*	20
Dwarf Surf Clam	*Mulinia lateralis*	20
Atlantic Brief Squid	*Lolliguncula brevis*	8
Lobed Moon Snail	*Polinices duplicatus*	4
	Total Mollusks	**1,467**
Other Species		
Horseshoe Crab	*Limulus polyphemus*	950
Sea Star	*Asterias forbesi*	90
Common Sea Cucumber	*Sclerodactyla briareus*	32
Sand Dollars	*Echinarachnius parma*	1
	Total Other	**1,073**

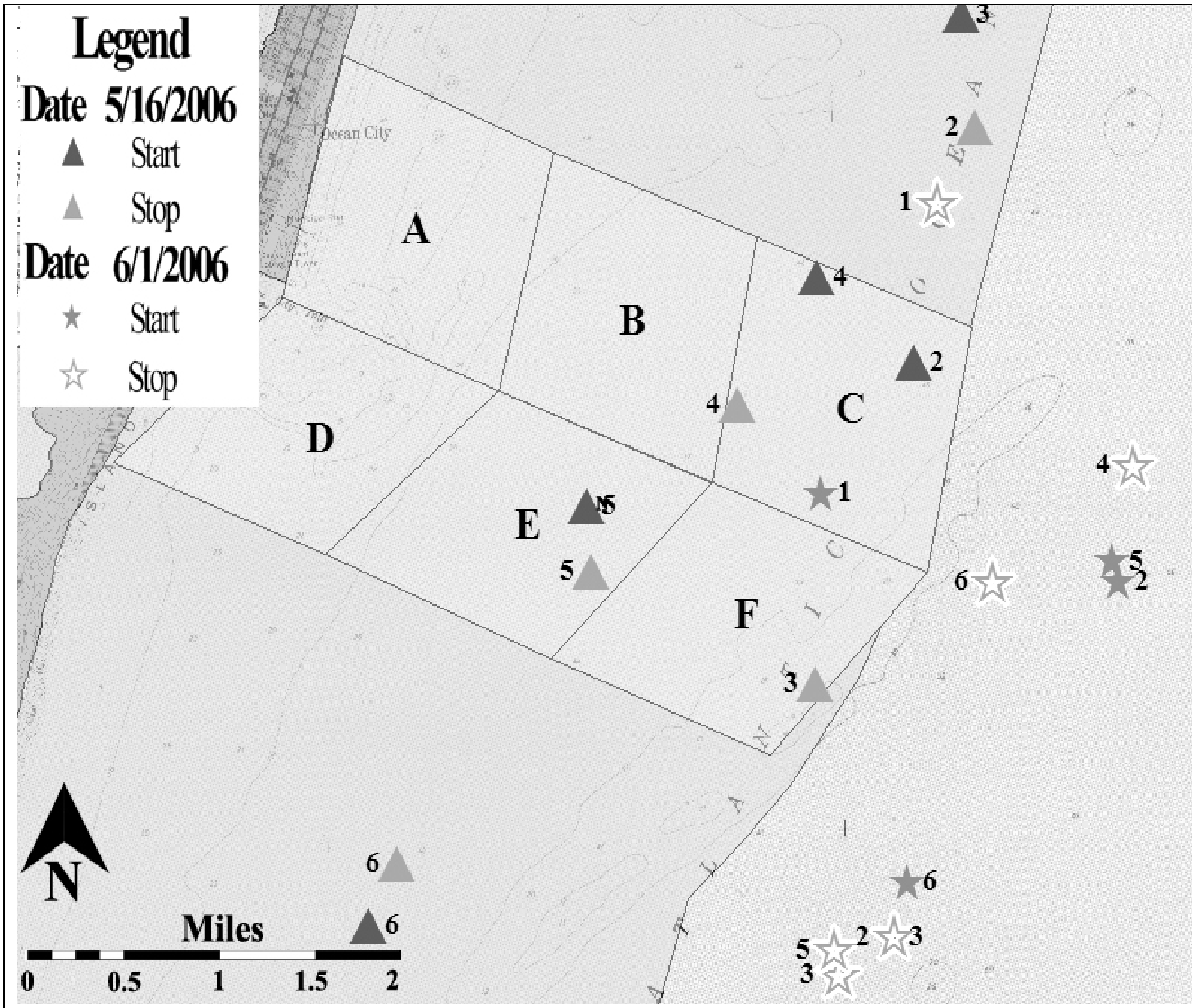


Figure 1. Site locations for the 2006 offshore trawl sampling area. The grid is set up in 1 square mile sections. Set 1 taken on May 16, 2006 is in Loran; and the start of set 4 taken on June 1, 2006 was located further south than the grid shows and therefore is not shown on the map.

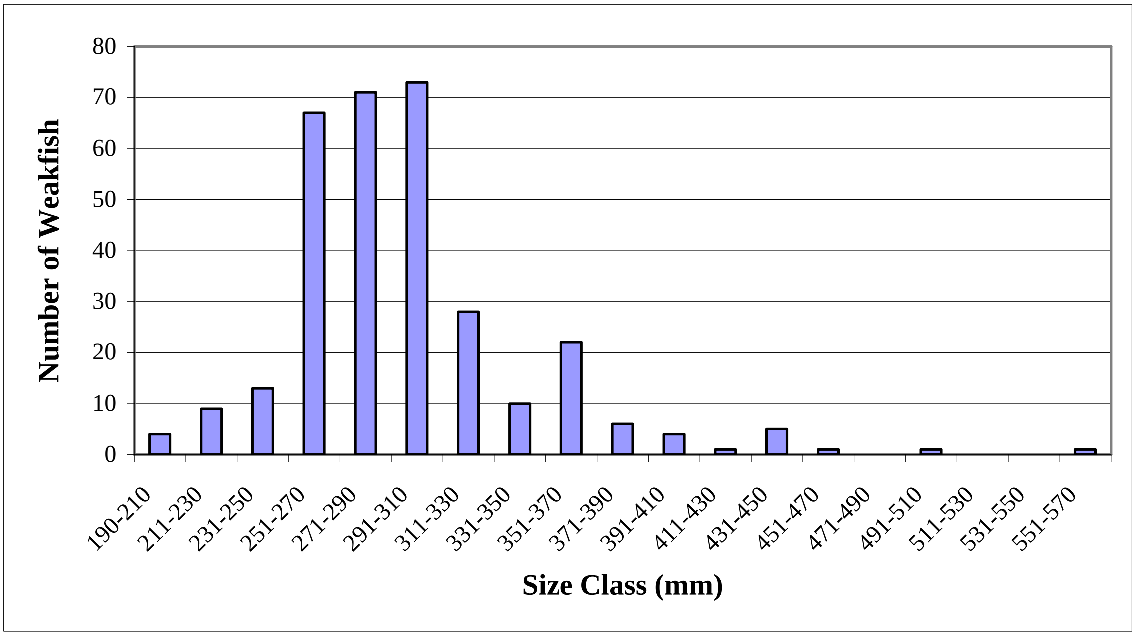


Figure 2. 2006 Weakfish Length Frequency from Offshore Trawls, n=316.

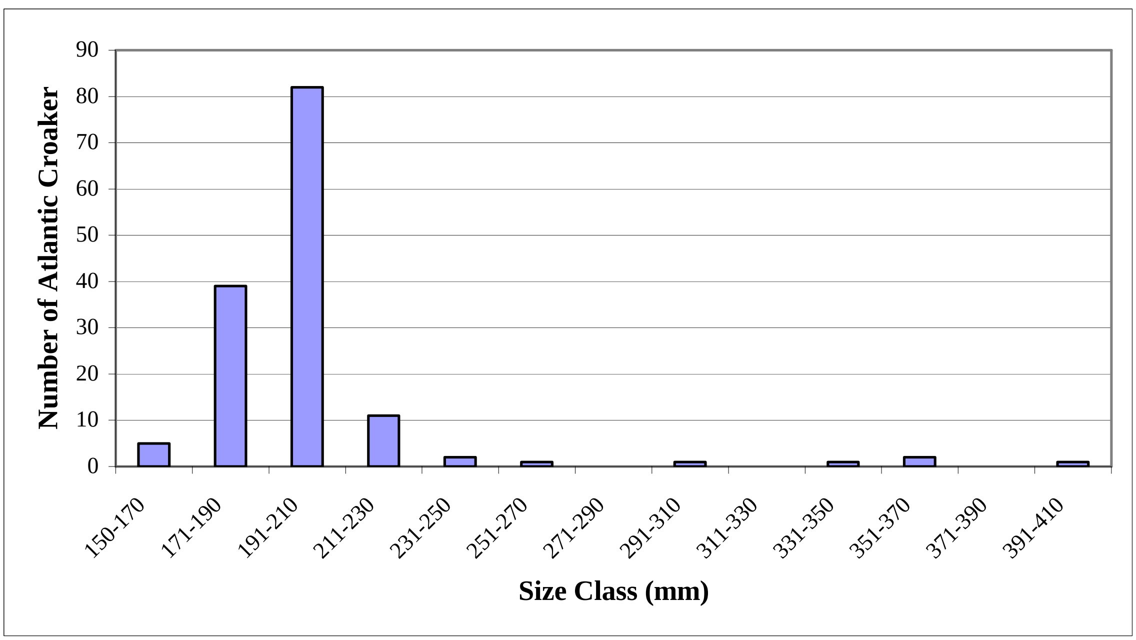


Figure 3. 2006 Atlantic Croaker Length Frequency from Offshore Trawls, n=145.

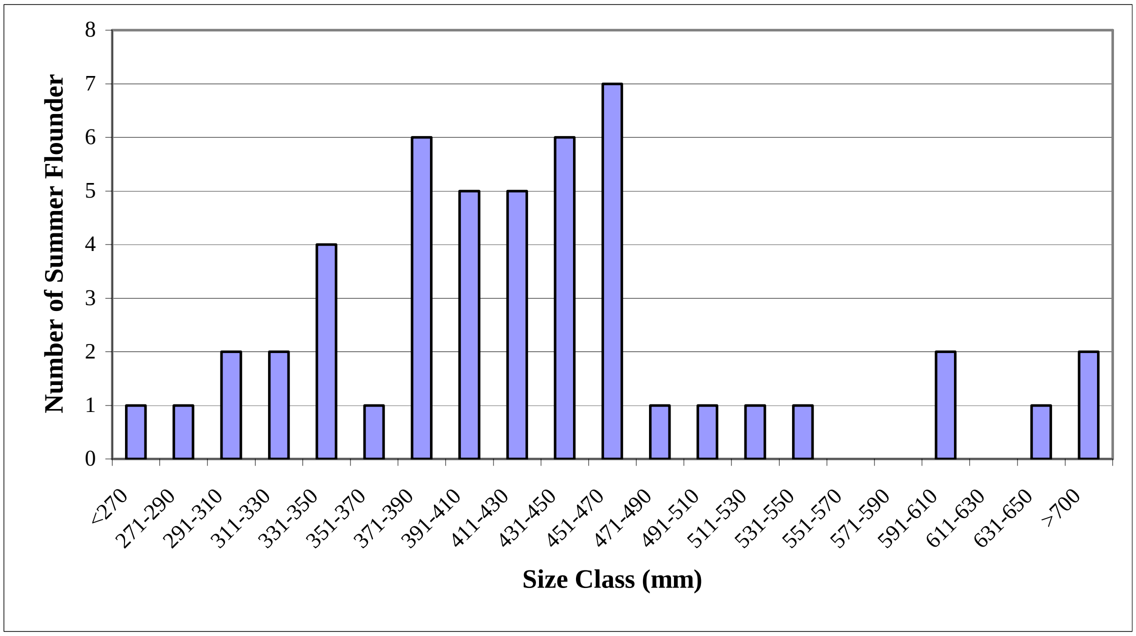


Figure 4. 2006 Summer Flounder Length Frequency from Offshore Trawls, n=49.

Chapter 3

2006 Seafood Dealer Catch Monitoring

Introduction:

Data have been collected for several years to be used in the coastal stock assessment for weakfish (*Cynoscion regalis*). The weakfish stock assessment committee needed information on age and size of commercially harvested fish along the Atlantic Coast. Samples from commercially harvested fish satisfy that need as well as fulfill data collection compliance requirements of the Atlantic States Marine Fisheries Commission (ASMFC).

Methods:

In 2006 weakfish were obtained from a local fish dealer and sampled for length, weight, and age. Between October 20th and December 13th, 129 weakfish were purchased for samples from a commercial seafood marketer. Eighty of the fish were caught by trawl, and thirty-nine were caught by gill net. These fish were measured for Total Length (TL) in millimeters (mm), weighed to the nearest gram (g), and sexed. Otoliths were extracted and sent to Charlie Wenner at the South Carolina Department of Natural Resources.

Results and Discussion:

The fish ranged in age from one to four years (yrs) with a mean age of 1.6 yrs. Average age for males was 1.9 yrs and average age for females was 1.5 yrs. Weakfish mean length and weight was 353 mm (range 300-557 mm) and 465 g (range 280-1800 g), respectively. The minimum length for commercially caught weakfish in Maryland was 304.8 mm.

The following is a table of mean lengths and weights by gear and sex (Table 1 and Table 2). A wider range of fish sizes were caught in the gill net when compared to trawl catches. In the gill net samples, the females average weight and length was greater than that of the males. In the trawl samples, the difference in size by sex was not evident.

List of Tables

Table 1. Ocean City, Maryland Bottom 2006 Bottom Trawl Caught Commercial Samples Average Weight and Lengths (with Range) for Weakfish (n=115).

Gender (n)	**Weight (g)**	**Length (mm)**
Male (20)	410 (290-680)	336 (300-392)
Female (60)	394 (280-670)	335 (300-431)

Table 2. Ocean City, Maryland 2006 Commercial Gill Net Average Weight and Lengths (with range) for Weakfish (n=64).

Gender (n)	**Weight (g)**	**Length (mm)**
Male (11)	543 (370-670)	378 (325-425)
Female (28)	627 (280-1800)	391 (325-557)

Chapter 4

Maryland Volunteer Angler Summer Flounder Survey (MVASFS)

Introduction:

The MVASFS began in 2002 after anglers expressed dissatisfaction with the Marine Recreational Fisheries Statistical Survey (MRFSS) harvest numbers which resulted in an increase in the minimum size and a creel reduction. Survey design was based off the successful Maryland Striped Bass Cooperative Angler Survey. Data collected from this survey have been used by the Maryland Department of Natural Resources (MD DNR) Fisheries Service for the following:

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

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

Methods:

Data Collection

The survey was promoted by outdoor columnists (Candus Thomson, Gene Mueller, Bill Burton) writing for large local newspapers (Baltimore Sun, Washington Times, Annapolis Capital) as well as several smaller newspapers catering to the maritime industry. Local sport fishing organizations (Coastal Conservation Association (CCA), Maryland Saltwater Sportfishermen's Association (MSSA), Pasadena Sportfishing Group (PSG), tackle shops, and marinas also promoted voluntary participation via newsletters (Figure 1), announcements at meetings, and Internet content. A brief description of the survey with contact information was included with fishing license sales in 2006 (Figure 2). Additional promotional techniques included: presentations to fishing clubs, 2005 summary content in the MD DNR winter 2005/2006 Fishing Report (Figure 3), advertisements off the MD DNR website home page (Figure 4), content on the CCA website, and distribution of survey materials (instruction sheets (Figure 5), paper forms (Figures 6-8), postage paid return envelopes, survey business cards (Figure 9), summary of previous years results) at two winter fishing shows (Timonium Bass Expo, PSG Flea Market).

The survey operated from April through the end of October. Recreational anglers and charter boat captains, including partyboats/headboats, were asked to count the total number of fish caught, measure only the first 20 summer flounder to the nearest ¼ of an inch, and indicate fate of fish (kept or released). In order to calculate Catch Per Unit Effort (CPUE), anglers provided total number of anglers and time spent fishing. Anglers were informed to complete a survey for trips targeting SF where zero fish were caught. All survey information was required to be submitted online or mailed by November 1st of the current year (Figure 5). Anglers were reminded not to submit the same information twice or using both methods. Survey forms received in the mail were entered into the online survey so that all data were stored in one place.

Statistical Analyses

After November 15, 2006 the data were downloaded, cleaned and descriptive statistics were calculated using Microsoft Excel. Descriptive statistics included: total number of trips, total number of trips where no fish were caught, total number of anglers, total number of individuals that submitted a survey(s), total number of fish caught, total number of fish measured, total number of fish kept, total number of fish released, percent of legal sized fish in the survey, and mean length. A length frequency histogram was created from the measured lengths. All lengths were truncated and placed into one inch intervals.

CPUE was calculated several different ways because of the options available for separating the data. To calculate the general Atlantic CPUE, the following calculations were performed in this order using data from Atlantic trips:

Angler Hours per Trip = Number of anglers * Number of Hours Fished
Total Angler Hours = ∑ Angler Hours per Trip
CPUE = ∑SF/Total Angler Hours

Since all legal fish may not have been kept, CPUE was calculated for all catches that measured 15.5 inches or greater.

CPUE measured kept = Total number of measured kept SF/ Total Angler Hours
CPUE measured legal = Total number of measured legal SF/ Total Angler Hours

The partyboat/headboat, *Bay Bee*, submitted length and effort data from its twice daily flounder fishing trips from April through May. The MVASFS 2002-2006 Atlantic data were reviewed to determine if *Bay Bee* data created bias in the survey results (Appendix 4). For each year, a Kolmogorov-Smirnov (KS) chi-square test was performed to determine if there was a significant difference in the length frequency developed from *Bay Bee* data and measurements from all other recreational anglers' data. Atlantic CPUE was calculated with and without *Bay Bee* data.

Total length data were used in a study to determine if cuts in the 2007 Total Allowable Landings (TAL) would require Maryland to change minimum size and creel limits. In order to predict the 2007 harvest, a three year adjusted (for minimum size and a 3 fish creel) harvest was calculated from the length data. To meet the requirements of the Atlantic States Marine Fisheries Commission Summer Flounder Technical Committee, the actual 2006 Marine Recreational Fisheries Statistics Survey (MRFSS) landings were also used to make the same prediction. No averaging or adjustments were performed in the latter scenario since only one year of harvest was being used. Methods used to develop 2007 SF size limit options were described by Barker et al. in (2004) MD DNR Fisheries Service Technical Memo 45 (Appendix 5).

Results and Discussion:

Fewer individuals (46 people) participated in the seaside survey, but they submitted data from more trips than in 2005 (496 trips, Table 1). Status quo of creel and minimum size requirements may have influenced angler perception (i.e participation was not as important). An increase in trips may be attributed to better fishing, meaning more fish were available or the fish were more susceptible to being caught. More SF were caught (7,385 SF) in 2006 than in 2005 (7,204 SF) which may explain the increase in the number of measured fish (Table 1). There were 58 instances of no catch trips (zero SF caught), which was slightly more than 2005 (42 trips). The increase in reporting no catch trips may be related to public presentations reminding anglers of the importance of those data.

The average length of measured SF was 13.8 inches. Historical results indicate only slight fluctuations in the mean length over the years.(Table 1, Figures 10-11). This trend may be reflective of the relatively similar year class strengths (SAW, 2006). Anglers kept approximately 40% more fish in 2006 (1026 SF) than 2005 (619 SF). This was the greatest number of measured fish kept since the survey began in 2002 (663 kept SF). The number of measured releases was only slightly more than 2005 with a difference of 24 SF. Overall, 22% of the measured catch was equal to or greater than the 15.5 inch minimum size.

A KS test was performed to determine if there was a significant difference in the length frequency developed from *Bay Bee* data versus those from recreational anglers (Appendix 4). Results from that test indicated no differences (P = 0.674). Therefore, including *Bay Bee* measurements with those submitted from recreational anglers should result in an overall length frequency without bias.

The CPUE for all fish caught in the survey was less than one fish per angler hour (Table 1). Although that CPUE declined from 2005, the CPUE for measured, kept fish slightly increased and was constant for legal fish (regardless of fate). These results were expected since the minimum size and creel was status quo with 2005 (Table 1). Results from testing *Bay Bee* data against that submitted by recreational anglers showed that no bias existed for effort (Table 1, Appendix 4).

The 2007 predicted recreational harvest (69,958 SF) based off the MRFSS 2006 harvest figure showed that Maryland would continue to under harvest its quota in 2007, even with the lower Total Allowable Landings (TAL) of 71,527 fish. Landings for 2006 were 23% below the 2007 TAL.

References:

SAW Southern Demersal Working Group. 2006. Summer Flounder Stock Assessment Summary for 2006. National Marine Fisheries Service. Northeast Fisheries Science Center. Woods Whole, MA.

List of Tables

List of Figures

Table 1. Summary of Summer Flounder Regulations and MVASFS data for the Atlantic Coastal Bays 2002–2006.

Year	2002	2003	2004	2005	2006
Regulations Creel @ Minimum Size (inches)	8 @ 17	8 @ 17	3 @ 16	4 @ 15.5	4 @ 15.5
Number of Individuals Submitting Surveys	107	102	103	65	46
Total Number of Trips	723	597	658	496	559
Total Number of Trips without catches (Skunked Trips)	97	95	86	42	58
Total Number SF Caught	7982	5494	16800	7204	7385
Total Number SF Measured	5212	4063	6421	4549	4952
Measured and Kept	663	653	502	619	1026
Measured and Released	4549	3401	5759	3898	3922
Unknown Fate	0	9	160	32	4
Mean Length (inches) of Measured SF	13.7	13.4	13.5	13.4	13.8
% of Measured SF ≥ Minimum Size	14%	15%	8%	13%	22%
Total Angler Hours (A-Hr)	25860	18785	17771	15451	20741
CPUE (Fish/A-Hr)	0.35	0.31	1	0.47	0.37
CPUE (Measured Kept SF/A-Hr)	0.03	0.04	0.06	0.06	0.07
CPUE (Measured Legal SF/A-Hr)	0.04	0.04	0.03	0.05	0.05
CPUE *Bay Bee*	0.33	0.31	1.03	0.46	0.31
CPUE without *Bay Bee*	0.41	0.34	0.87	0.51	0.6

The Cooperative Angler Striped Bass and Volunteer Angler Summer Flounder surveys are designed to obtain recreational harvest and release data that are not otherwise available to the Maryland Department of Natural Resources (MD DNR). These data are used to calculate:

- population length distribution;
- perform creel (minimum size) analysis;
- and guide the management approach for Atlantic vs. Chesapeake Bay populations.

In addition, these data can also be used for:

- catch-at-age analysis, which gives us information about the population structure, and helps guide creel and minimum size limits;
- provide a relative measure of population abundance (effort data);
- and as a comparison with federal harvest data.

By simply submitting your fishing trip information when targeting these species, you can become an active participant in their management. For information on the Volunteer Angler Summer Flounder Survey, contact Angel Bolinger at 410-643-6801 ext. 108 or via email at abolinger@dnr.state.md.us. Participate online at URL: http://www.dnr.state.md.us/fisheries/survey/sfsurveyintro.shtml

To learn more or to become involved with the Cooperative Angler Striped Bass Survey, contact Harry T. Hornick or Craig Weedon at 1-877-620-8DNR ext. 8305 or 8309 or via email at hhornick@dnr.state.md.us or cweedon@dnr.state.md.us. Participate online at URL: http://www.dnr.state.md.us/fisheries/survey/sbsurveyintro.shtml.

Contact either Angel Bolinger or Craig Weedon to schedule a presentation of these surveys results from February through May 2006.

Figure 1. Copy of MVASFS promotional text placed in the December 2005 MSSA newsletter.

Get Involved With Chesapeake Bay and Atlantic Coast Striped Bass and Summer Flounder Management!

The Cooperative Angler Striped Bass and Volunteer Angler Summer Flounder surveys are designed to obtain recreational harvest and release data that are not otherwise available to the MD DNR. Simply by submitting your fishing trip information when targeting these species, you can become an active participant in their management. To learn more or to become involved with the Cooperative Angler Striped Bass Survey, contact Harry T. Hornick at 1-877-620-8DNR ext. 8305 or via email at hhornick@dnr.state.md.us. Participate online at URL: http://www.dnr.state.md.us/fisheries/survey/sbsurveyintro.shtml.

For information on the Volunteer Angler Summer Flounder Survey, contact Angel Bolinger at 1-877-620-8DNR ext. 8311 or via email at abolinger@dnr.state.md.us. Participate online at URL: http://www.dnr.state.md.us/fisheries/survey/sfsurveyintro.shtml.

Figure 2. MVASFS promotional message printed with all 2006 Maryland fishing license sales.

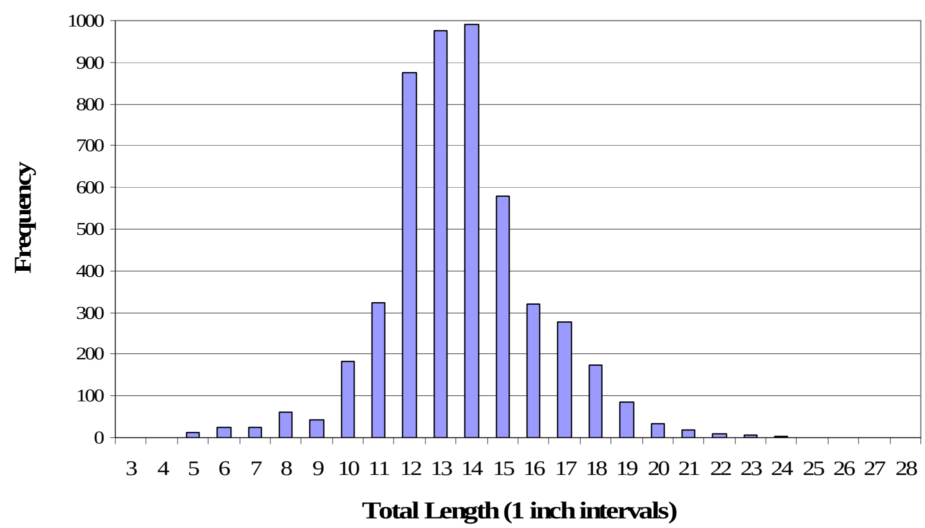
Maryland Department of Natural Resources (DNR) Fisheries Service
2006 Maryland Volunteer Angler Summer Flounder Survey Summary
December 2006

THE ANGLERS...

- 5,332 anglers fished
- 53 anglers reported
- Most were from MD, PA, DE
- 36% belonged to an organization

THE FISH...

- 7,457 fish reported caught
- 5,022 fish measured
- Average length: 13.8 inches
- The length distribution of the overall summer flounder catch has been steady for the past 5 years (2002-2006).



Length frequency of kept and released 2006 Atlantic Coast and Chesapeake Bay fish from the Maryland Volunteer Angler Summer Flounder Survey, n = 5,022.

THE TRIPS...

- 589 trips reported: 559 trips along the Atlantic Coast (95%) and 30 trips in the Chesapeake Bay (5%)
- 58 skunked trips: 58 Atlantic coast trips (10%) and 10 Chesapeake Bay (25%)

USES OF THESE DATA...

These data are used to calculate:

- population length distribution;
- perform creel (minimum size) analysis;
- and guide the management approach for Atlantic vs. Chesapeake Bay populations.

CONCLUSIONS...

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

For 2007, please continue to:

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

Figure 3. 2006 MVASFS Angler summary for the MD DNR Fishing Report, winter edition (Jan. 2007).

Get Involved with Maryland Chesapeake Bay and Atlantic Coast Summer Flounder Management!

The Maryland Volunteer Angler Summer Flounder Survey (MVASFS) is designed to obtain recreational harvest and release data that are not otherwise available to the MD DNR. Simply by submitting your fishing trip information when targeting summer flounder, you can become an active participant in summer flounder management. These data are used to perform minimum size analysis, as a comparison to the federal harvest data, and much more! To learn more or to become involved with the Maryland Volunteer Angler Summer Flounder Survey, contact Angel Bolinger at 410-643-4601 ext. 101 or via email at abolinger@dnr.state.md.us.

Web URL: www.dnr.state.md.us/fisheries/survey/sfsurveyintro.shtml

Figure 4. Text placed off the MD DNR Home Page to promote the survey. This was advertised for a week each which started on the following dates, April 1, 2006, May 2, 2006, June 20, 2006, and July 4, 2006.

Volunteer Angler Summer Flounder Survey Instructions

Thank you for interest in the Summer Flounder Volunteer Angler Survey. The information you provide will help the Maryland Department of Natural Resources obtain length data from summer flounder caught by recreational anglers in Chesapeake Bay and along the Atlantic Coast. In addition, the survey data will be used to augment and enhance existing federal data from the National Marine Fisheries Services' (NMFS) Marine Recreational Fisheries Statistics Survey (MRFSS).

- The survey will run through October of each year.
- All survey information must be submitted online or mailed by November 1st of the current year.
- Information may be submitted online at http://www.dnr.state.md.us/fisheries/survey/sfsurveyintro.shtml or through the mail.
  Mailing to: Maryland Department of Natural Resources
  Fisheries Service
  Tawes State Office Building, B-2
  Annapolis, MD 21401
- If you submit the information online, please DO NOT mail in a paper version.
- Please fill out one survey for each trip even if no fish are caught.
- If more than one survey participant is fishing on the same boat, only one designated individual should fill out the survey form for the group for that day.
- Please record your legal first name. Please do not use abbreviations or nick names.
- Please record your legal last name.
- Please record your phone number.
- Please record the date that you are completing the form.
- Please indicate if you are a member of the Coastal Conservation Association (CCA), Maryland Saltwater Sports Fishermen's Association (MSSA), or Pasadena Sportfishing Group.
- Please record your location code on the survey form. The location codes may be found on the map on the back of the survey form.
- Please record the date of the fishing trip.
- Please record the time that the fishing trip started.
- Please provide the number of hours that fishing lines were in the water.
- Please provide the number of anglers on the trip.
- Please circle where you fished from on the survey form.
- Please circle what method was used to target summer flounder.
- Please record the total number of flounder your party kept and the total number of flounder your party released.
- Please record the total number of fish you caught. However, record the length for ***only*** the first 20 summer flounder you catch. It is very important to record the lengths from the first 20 fish whether they are kept or released. Do not provide a range of sizes (ex. 5 fish 17 - 22 in).

If you have further questions contact Angel Bolinger via e-mail abolinger@dnr.state.md.us, or call 410-643-4601 ext. 101.

Figure 5. Instructions provided with paper forms for the 2006 MVASFS.

Summer Flounder Survey Form

First Name:___________________ Last Name: ____________________________

Phone No. _______ - _______ - ________ Today's Date:_________________________

Member of CCA, MSSA, or Pasadena Sportfish Yes:___ No:___

Location Code (See Map): _________ Date Fished:_________________________

Time Start: ________________AM./PM. Hours Fished:_________________________

Number of Anglers: ____ Fished from (circle one): shore • surf • pier • boat • charter

Method (circle one): drifting • trolling • casting • bottom fishing • fly fishing

Catch Information

Total number of summer flounder kept:____ Total number of summer flounder released:____

For each trip, measure the first 20 summer flounder caught, whether kept or released. Place an X or √ in the appropriate column to indicate if the fish was kept or released.

Count	Total Length	Kept	Released
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Figure 6. Copy of the MVASFS paper form.

Summer Flounder Survey Form for the MSSA Atlantic Chapter

Please PRINT the requested information.

First Name:__________________ Last Name: ___________________________

Phone No. _______ - _______ - ________ Date Fished:_________________________

Hours Fished:________________________ Number of Anglers: ___

Fished from: **BOAT** Method: **BOTTOM FISHING**

Circle the primary area where you fished: Sinepuxent Isle of Wight Chincoteague Assawoman Atlantic Ocean

Catch Information

Total number of summer flounder kept:____ Total number of summer flounder released:____

For each trip, measure the first 20 summer flounder caught, whether kept or released.
Place an X or √ in the appropriate column to indicate if the fish was kept or released.

Count	Total Length	Kept	Released
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Figure 7. Copy of the MVASFS paper form created specifically for boating members of the MSSA Atlantic Chapter.

Summer Flounder Survey Form for the MSSA Atlantic Chapter

Please PRINT the requested information.

First Name:__________________ Last Name: ___________________________

Phone No. _______ - _______ - ________ Date Fished:_________________________

Hours Fished:________________________ Number of Anglers: ___

Fished from: **SHORE** Method: **BOTTOM FISHING**

Circle the primary area where you fished: Sinepuxent Isle of Wight Chincoteague Assawoman Atlantic Ocean

Catch Information

Total number of summer flounder kept:____ Total number of summer flounder released:____

For each trip, measure the first 20 summer flounder caught, whether kept or released.

Place an X or √ in the appropriate column to indicate if the fish was kept or released.

Count	Total Length	Kept	Released
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Figure 8. Copy of the MVASFS paper form created specifically for shore based anglers of the MSSA Atlantic Chapter.

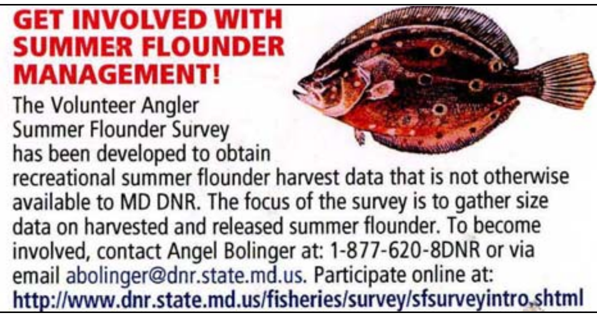


Figure 9. Copy of the MVASFS business cards, which were distributed at fishing shows, Maryland Sport Fishing Tournament Citation Centers, and presentations.

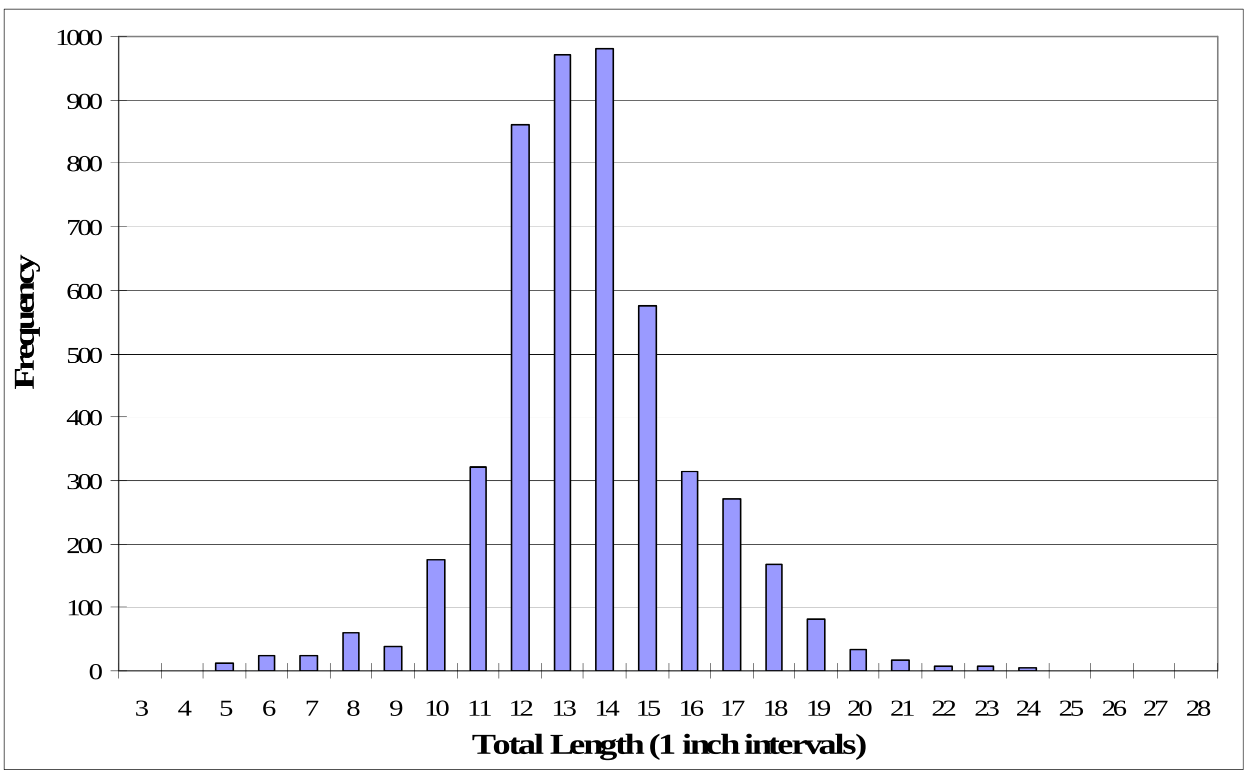


Figure 10. Length frequency of kept and released 2006 Atlantic Coast measured data collected from the Maryland Volunteer Angler Summer Flounder Survey, n=4,952.

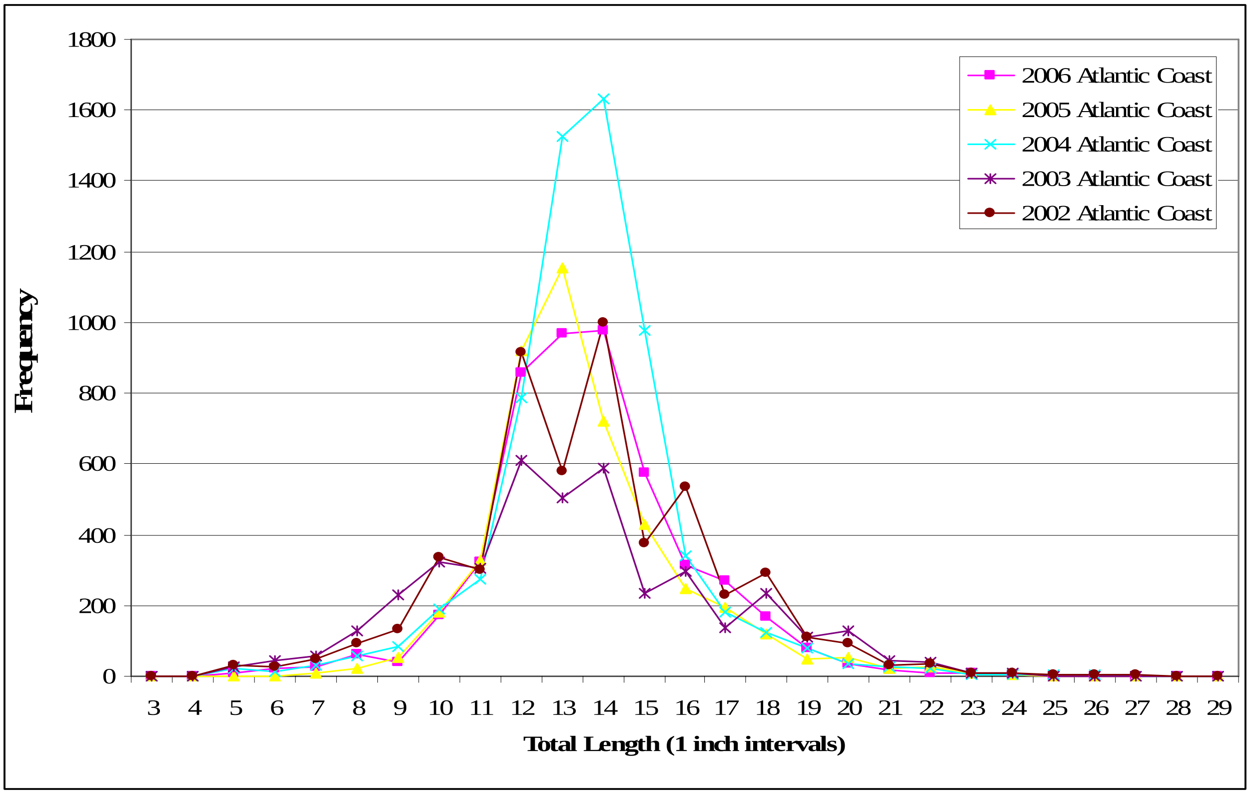


Figure 11. Length frequency of kept and released 2002-2006 Atlantic Coast measured data collected from the Maryland Volunteer Angler Summer Flounder Survey, n = 25,197.

List of Appendices

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.														
♂ Blue Crab						0102						♀ Blue crab		
Cts														
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●												Tot. Crabs		

All fish length measurements are Total Length (TL) mm

Silver Perch 0079				Spot 0082				SpecName SpecCode				SpecName SpecCode			
Cts				Cts				Cts				Cts			
Total				Total				Total				Total			

SpecName SpecCode				SpecName SpecCode				SpecName SpecCode				SpecName SpecCode			
Cts				Cts				Cts				Cts			
Total				Total				Total				Total			

Spec Name	SpecCode	Counts	Total

Fish Name Abbreviations

Anchovy, Bay ≡ BA
Anchovy, Striped ≡ SA
ATL ≡ Atlantic
Black Sea Bass ≡ BSB
Bluefish ≡ BF
Croaker, Atlantic ≡ AC
Drum, Black ≡ BD
Drum, Red ≡ RD
Flat Fish
- Left Handed Flounder
  - Fourspot ≡ FSF
  - Smallmouth ≡ SMF
  - Southern ≡ SOF
  - Summer ≡ SF
  - Windowpane ≡ WP
- Right Handed Flounder
  - Winter ≡ WF
- Sole
  - Hogchoker ≡ HC
- Tonguefish
  - Blackcheek ≡ BCT

Goby, Green ≡ GG
Goby, Naked ≡ NG
Horseshoe Crab ≡ HSC
Kingfish, Northern ≡ NK
Mullet, Striped ≡ SMU
Mullet, White ≡ WMU
Mummichog ≡ MUM
Northern ≡ N
Pipefish, Northern ≡ NPI
Pipefish, Dusky ≡ DP
Puffer, Northern ≡ NPU
Searobin, Northern ≡NSR
Searobin, Striped ≡ SSR
Seatrout
- Weakfish ≡ WK
- Spotted ≡ SS

Silverside, Atlantic ≡ AS
Silverside, Inland ≡ IS
Silverside,Tidewater ≡ TS
Southern ≡ S
Striped Anchovy ≡ SA
Striped Bass ≡ SB

MD DNR Coastal Bays Trawl Data Sheet

Date (mm/dd/yyyy) ______/_____/2006	**Start Time**		**Collector**	**Set#**
Site# T0	**Station Desc.**			
Latstrt 38° .	**Longstrt** 75° .		**Latstop** 38° .	**Longstop** 75° .
Tide	**Weather**	**Secchi**	**Wind** Direction Speed	**Bottom Type** 1. 2.
Temp (C) Surface ____________ Bottom		**Sal (ppt)** Surface ____________ Bottom	**DO (ppm)** Surface ____________ Bottom	**Depth** Start ____________ Stop

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
NT ≡ not taken

SpecName	Spp. Code	Specvol (L)	Estimatevol (L)	Estimatecnt

These 3 categories are only for macroalgae, sulphur sponge, jellies or subsamples of fish.
Specvol: Actual volume of algae, ctenophores, jellies, sulphur sponge, etc measured in liters.
Estimatecnt: Visual estimate of the total count of individuals for a particular species from the sample
Estimatevol: Visual volume estimate

Unknown ID is a unique # (date+Station ID+ sequential number starting at 1) assigned to each specimen. Gray boxes for office ID.

Unknown ID	Description	TL	K or F	Spp.	ID By	Key Source	ID Date

Unknowns
K ≡ kept
F ≡ Field ID with book/key
ID By ≡ Initials of person that ID specimen
Key Source ≡ source used to ID specimen; Use or field ID too.
ID Date ≡ Date the ID was performed

Comments

Survey Checklist:
Datasheets/Protocol
Pencils/Sharpener
YSI, GPS
Depth Finder
Sounding Pole
AA Batteries
- YSI (6)
- GPS (1 or 2)
- Camera (2)

4 measuring boards
Stop watch
Buckets
Cell Phone
ID books/Keys
Plastic bags/sharpie/labels
Voucher buckets/fixative
Cooler with ice
Digital Camera
Secchi Disk

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

Boat Checklist:
Trawl
Sharp knife/tools
Anchors/line
Gas for generator/boat
Life Jackets, flares
Sun block/first aid kit/horn
Gas card/credit card

MD DNR Coastal Bays Seine Data Sheet

Appendix 2.

Date ______/_____/2006		**Start Time**	**Collector**	**Set#**
Site#		**Station Desc.**		
Latstrt 38° .		**Longstrt** 75° .	**Latstop** 38° .	**Longstop** 75° .
Tide	**Weather**	**Wind Direction & Speed** **Secchi (cm)**	**%SAV** 0–0 SAV in sample area 1-up to 25% 2-26-50% 3-51%-75%, 4-76%-100% 5-SAV present	**Bottom Type** 1. 2.
Temp (C) Surface ______ Bottom		**Sal (ppt)** Surface ______ Bottom	**DO (ppm)** Surface ______ Bottom	**Depth** Start ______ Stop

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
NT ≡ not taken

SpecName	Spp. Code	Specvol (L)	Estimatevol (L)	Estimatecnt

These 3 categories are only for macroalgae, sulphur sponge, jellies or subsamples of fish.
Specvol: Actual volume of algae, ctenophores, jellies, sulphur sponge, etc measured in liters.
Estimatecnt: Visual estimate of the total count of individuals for a particular species from the sample

Unknown ID is a unique # (date+Station ID+ sequential number starting at 1) assigned to each specimen. Gray boxes for office ID.

Unknown ID	Description	TL	K or F	Spp.	ID By	Key Source	ID Date

Unknowns
K ≡ kept
F ≡ Field ID with book/key
ID By ≡ Initials of person that ID specimen
Key Source ≡ source used to ID specimen; Use or field ID too.
ID Date ≡ Date the ID was performed

Comments

Survey Checklist:
Datasheets/Protocol
Pencils/Sharpener
YSI, GPS
Depth Finder
Sounding Pole
AA Batteries
- YSI (6)
- GPS (2)
- Camera (2)

4 measuring boards
Stop watch
Buckets
Cell Phone
ID books/Keys
Plastic bags/sharpie/labels
Voucher buckets/fixative
Cooler with ice
Digital Camera
Secchi Disk

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

Boat Checklist:
Trawl
Sharp knife/tools
Anchors/line
Gas for generator/boat
Life Jackets, flares
Sun block/first aid kit/horn
Gas card/credit card

MD DNR Coastal Bays Seine Data Sheet

Draw line separating ♂ and ♀ crabs. Start females in the right column and work towards the middle.														
♂ Blue Crab							0102						♀ Blue crab	
Cts														
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●													Tot. Crabs	

SpecName Silver Perch SpecCode 0079				SpecName Spot SpecCode 0082				SpecName SpecCode				SpecName SpecCode			
Cts				Cts				Cts				Cts			
Total				Total				Total				Total			

SpecName SpecCode				SpecName SpecCode				SpecName SpecCode				SpecName SpecCode			
Cts				Cts				Cts				Cts			
Total				Total				Total				Total			

Spec Name	SpecCode	Counts	Total

Abbreviations

Anchovy, Bay ≡ BA
Anchovy, Striped ≡ SA
ATL ≡ Atlantic
Black Sea Bass ≡ BSB
Bluefish ≡ BF
Croaker, Atlantic ≡ AC
Drum, Black ≡ BD
Drum, Red ≡ RD
Flat Fish
- Left Handed Flounder
  - Fourspot ≡ FSF
  - Smallmouth ≡ SMF
  - Southern ≡ SOF
  - Summer ≡ SF
  - Windowpane ≡ WP
- Right Handed Flounder
  - Winter ≡ WF
- Sole
  - Hogchoker ≡ HC
- Tonguefish
  - Blackcheek ≡ BCT

Goby, Green ≡ GG
Goby, Naked ≡ NG
Horseshoe Crab ≡ HSC
Kingfish, Northern ≡ NK
Mullet, Striped ≡ SMU
Mullet, White ≡ WMU
Mummichog ≡ MUM
Northern ≡ N
Pipefish, Northern ≡ NPI
Pipefish, Dusky ≡ DP
Puffer, Northern ≡ NPU
Searobin, Northern ≡NSR
Searobin, Striped ≡ SSR
Seatrout
- Weakfish ≡ WK
- Spotted ≡ SS

Silverside, Atlantic ≡ AS
Silverside, Inland ≡ IS
Silverside,Tidewater ≡ TS
Southern ≡ S
Striped Anchovy ≡ SA
Striped Bass ≡ SB

Appendix 3.

Atlantic Program Fish Voucher Collection Protocol

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

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

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

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

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

Label Information:

<table>
<tr><td colspan="6">Maryland Dept. of Natural Resources - Fisheries Service - Atlantic Program Coastal Bays Fisheries Investigation (CBFI)</td></tr>
<tr><td colspan="6">Scientific Name:</td></tr>
<tr><td colspan="6">Common Name:</td></tr>
<tr><td colspan="5">Body of Water:</td><td>County: Worcester</td></tr>
<tr><td colspan="6">Collection Site:</td></tr>
<tr><td colspan="3">Lat. 38°</td><td colspan="3">Long. 75°</td></tr>
<tr><td colspan="6">Collected By: MD DNR Fisheries Service Atlantic Program</td></tr>
<tr><td colspan="3">Date Collected:</td><td colspan="3">Preservation Date:</td></tr>
<tr><td colspan="2">Preservative: 70% ETOH</td><td colspan="2">Catalog #:</td><td colspan="2"># Specimens</td></tr>
</table>

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

Allow label to thoroughly dry before placing into the jar.

8. Add to voucher database
   a. Catalog ID ≡ assign a unique code. Codes start at 0001.

b. SiteID ≡ Site number used in the CBFI seine and trawl survey. SiteID is composed of a letter followed by 3 numbers. The letter S indicates the gear was a seine and T indicates the gear was trawl.
c. Family ≡ family name of the specimen. This information is located in the American Fisheries Society Special Publication 29, Common and Scientific Names of Fishes from the United States, Canada, and Mexico. 6th edition.
d. Common Name ≡ name used in CBFI database
e. Scientific Name ≡ taken from the American Fisheries Society Special Publication 29 Common and Scientific Names of Fishes from the United States, Canada, and Mexico. 6th edition.
f. Body of Water ≡ main body of water that the specimen came from. Choices include Assawoman Bay, Isle of Wight Bay, Sinepuxent Bay, and Chincoteague Bay (includes Newport Bay), Coastal Bays (generic term for when the field label was not completely filled out)
g. County ≡ county where the specimen was collected
h. Collection Site Description ≡ description of where the specimen was collected. Includes CBFI site number when possible.
i. Latitude ≡ start latitude where the specimen(s) where collected. This number should be taken off the datasheet.
j. Longitude ≡ start longitude where the specimen(s) where collected
k. Collected by ≡ program that collected the specimen(s); typically this program will be the MD DNR Fisheries Service Atlantic Program
l. Date Collected ≡ date that the specimen(s) where captured/collected. This is also when the specimen(s) would have been placed in 10% formalin for fixation.
m. Survey Name ≡ CBFI
n. No. Specimens ≡ number of specimens associated with the Catalog ID
o. Preserved by ≡ who placed the specimen(s) into the jar and added the preservative. In 2006, valid names are Angel Bolinger or Gary Tyler.
p. Preservation Date ≡ date the specimen(s) where permanently preserved. Removal from fixative would have taken place two days prior to this date.
q. Type ≡ generic label of what is in the container. Valid options include fish, mollusk, crustacean
r. Preservative ≡ chemical used to permanently store the specimens. In most situations, this will be 70% ETOH.
s. Storage Location ≡ location of where the jars are being stored
t. Species ID 1st Confirmed by ≡ who identified the specimen(s) back in the laboratory that are in the jar
u. Species ID 2nd Confirmed by ≡ who confirmed the first identification of the specimen(s) back in the laboratory that are in the jar
v. Photos ≡ Are there photos of the specimen? Photos may have been taken when the specimen was alive, dead, fixed, or preserved. Yes or no
w. Comments ≡ includes numbers by sex, combined specimens, etc.

Storage of specimens:
Store in a dark and climate controlled (60-65F) location. Check jars for evaporation and lid backing off twice a year. If evaporation has occurred, then completely replace the ethanol.

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

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

References:

East Carolina University Office of Environmental Health and Safety. Formalin. Online. http://www.ecu.edu/oehs/HazWaste/formalin.htm. Accessed March 27, 2006.

Fink, William L., Karsten E. Hartel, William G. Saul, Ellie M. Koon, Edward O. Wiley. 1979. A Report on Current Supplies and Practices used in Ichthyological Collections. Online. http://www.asih.org/coms/ihcc/news/1979.pdf. Accessed March 27, 2006. American Society of Ichthyologists and Herpetologists. Ad hoc Subcommittee on Curatorial Supplies and Practices of the Ichthyological Collection Committee.

Kazyak, Paul. 2001. Maryland Biological Stream Survey Sampling Manual. Online. http://www.dnr.state.md.us/streams/pubs/2000samp_manual.pdf. Accessed March 27, 2006. Maryland Department of Natural Resources. Monitoring and Non-tidal Assessment Division. Annapolis, MD.

Millard, Chris. March 27, 2006. Maryland Biological Stream Survey (MBSS). MD DNR. Personal Communication.

National Institute of Health. Haz-Map – Occupational Exposure to Hazardous Materials. Online. http://hazmap.nlm.nih.gov. Accessed March 27, 2006.

Nelson, J.S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and Scientific Names of Fishes from the United States, Canada, and Mexico. American Fisheries Society, Special Publication 29, Bethesda, Maryland.

Nielsen, Larry A., Johnson, D.L. editors. 1983. Fisheries Techniques Chapter 14 American Fisheries Society pp. 275-282.

OSHA. Substance technical guidelines for formalin - 1910.1048 App A. Online. Accessed March 27, 2006.
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10076

OSHA. Safety and Health Topics Formaldehyde. Online. http://www.osha.gov/SLTC/formaldehyde/. Accessed March 27, 2006.

Stranko, Scott. March 27, 2006. MBSS. MD DNR. Personal Communication.

Summary of the 2006 Coastal Bays Fisheries Investigations Trawl and Beach Seine Survey Voucher Collection

The CBFI voucher collection consisted of 37 families and 59 species of fishes for a total of 146 specimens (Table 1). Most (49) of these species were frequently encountered in the seine and trawl survey. Six species were only periodically encountered in the history of the trawl and seine survey, including: blackcheek tonguefish (*Symphurus plagiusa*), Atlantic moonfish (*Selene setapinnis*), ladyfish (*Elops saurus*), bluespotted cornetfish (*Fistularia tabacaria*), gag grouper (*Mycteroperca microlepis*), harvestfish (*Peprilus paru* (=*alepidotus*). Two species, Atlantic cutlassfish (*Trichiurus lepturus*; juvenile) and slashcheek goby (*Ctenogobius pseudofasciatus*), were never previously captured in the seine and trawl survey. The identification of the slashcheek goby was confirmed by two MD DNR Fisheries Service biologists. An expert will be contacted for further confirmation since the known range does not match.

Recommendations:

- Continue collecting vouchers for species that are not already included during the 2007 field season.
- Use distilled water do dilute the ethanol for better long term preservation.

Appendix 4.

Analysis of the Maryland Volunteer Angler Summer Flounder Survey (MVASFS)

Prepared by
Linda Barker and Angel Bolinger
Maryland Department of Natural Resources
Fisheries Service

March 20, 2007

Introduction

The Maryland Volunteer Angler Summer Flounder Survey (MVASFS) provided critical data used to guide the management approach for Atlantic and Chesapeake Bay populations of Summer Flounder (SF; Barker *et al* 2004). Analysis of the data provided the following information about population structure:

- population length distribution;
- relative measure of population abundance (effort data);
- catch-at-age analysis, which provides guidance for creel and minimum size limits;
- comparison against federal harvest data from the Marine Recreational Fisheries Statistical Survey (MRFSS).

Most submissions for the Atlantic region were from *Bay Bee* party boat captain, Bobby Gowar (or his substitute). Gowar provided a large portion of the surveys data (62% of length data in 2006, 77% in 2005, 63% in 2004, 71% in 2003, and 62% in 2002) because he submitted measurements from his twice daily fishing trips from April through October. To determine if *Bay Bee* data biased the analyses, a Kolmogorov-Smirnov (KS) chi square test and Catch Per Unit of Effort (CPUE) comparisons were performed.

Methods

A KS chi-square test was performed to determine if there was a significant difference in the length frequency developed from *Bay Bee* data and those from recreational anglers' (Bolinger and Barker, 2007). The KS comparison was performed using the website located at URL: http://www.physics.csbsju.edu, accessed on January 5, 2007.

A similar concern existed that *Bay Bee* data influenced CPUE. Therefore, effort calculations were performed after separating *Bay Bee* data from the rest of the Atlantic. CPUE was calculated in the following manner using Microsoft Excel:

$$\text{Angler Hours per Trip} = \text{Number of Anglers} * \text{Number of Hours Fished} \qquad \text{Eqn1}$$

$$\text{Total Angler Hours} = \sum \text{Angler Hours per Trip} \qquad \text{Eqn2}$$

CPUE = ∑SF/Total Angler Hours Eqn3

MD DNR Fisheries Service statistician, Linda Barker, looked at the following questions pertaining to CPUE's calculated on the above referenced data:

- What was the mean of the two CPUE's?
  (Bay Bee CPUE + Atlantic without *Bay Bee)/2*
- What was the annual percent difference between the two?
  ((Bay Bee CPUE – Atlantic without *Bay Bee)/Bay Bee CPUE)*100*
- What was the mean of the absolute percent difference?
  |Annual Percent Difference|
- Was there a bias over time (*Bay Bee* CPUE consistently larger or smaller)?
- Did *Bay Bee* data influence the CPUE?
  *((*Atlantic with *Bay Bee CPUE - Bay Bee* CPUE*)/* Atlantic with *Bay Bee CPUE)*100*

Results and Discussion

The 2006 MVASFS length measurements were reviewed to determine if *Bay Bee* data created bias in the length frequency distributions. Results from the KS test indicated no differences between *Bay Bee* length data and measurements from recreational anglers (P = 0.994). Therefore, including *Bay Bee* measurements with those submitted from recreational anglers should result in an unbiased overall length frequency.

A retrospective analysis of the past five years' CPUE was conducted to investigate why the 2006 percent difference between the Bay Bee and Bay Bee-excluded CPUEs (62%) was more than triple the highest difference measured to date. The difference between all previous Bay Bee and Bay Bee-excluded CPUEs were less than 20%, and there was no consistent positive/negative pattern through time (Table 1). The *Bay Bee* CPUE had been consistently lower than the recreational anglers' CPUE except for 2004. What appears to be a "baseline" CPUE value around 0.31 – 0.33 may reflect a consistent (low) level of angler skill and pattern of operation, typical of party boats. The increase in 2004 and subsequent decrease are consistent with the entry into the fishery of the year classes of 2001-2, set against this relatively constant angler skill and pattern of operation. The CPUE for recreational anglers ("Without *Bay Bee*") showed this same jump in 2004. In contrast to the *Bay Bee* CPUE, the recreational angler CPUE did not return to a lower baseline CPUE after the movement of this year class through the fishery, but remained at a high level. We believe that this may be a function of the non-random nature of these survey data. Because this is a volunteer survey, the data are provided by more highly motivated, and possibly skilled, anglers. Additional analysis of the data could verify that participation of skilled anglers created a bias that artificially inflated the 2006 CPUE.

Recommendations

Based on these results, Linda Barker made the following recommendations:

- Annually review those data to ensure that *Bay Bee* percentage contribution to length frequency and effort data remain relatively constant.
- Annually review those data to ensure that *Bay Bee* lengths do not create bias in the frequency.

- Omit *Bay Bee* data from effort calculations for technical reports and management decisions, since effort values developed from a more heterogeneous data set are more defensible. Inclusion of *Bay Bee* data was acceptable for non-technical public presentations of survey results.
- Summarize angler participation by year to determine if regular participants of this survey are influencing the CPUE. If recreational anglers (that do not fish from a party boat) are biasing the CPUE, then an adjustment may be appropriate.

Literature Cited

Barker, Linda, Alexei Sharov, and Steve Doctor. March 2004. Fisheries Technical Report 45: Development of Summer Flounder Size Limit Options for Maryland's 2004 Fishing Season. Maryland Department of Natural Resources. Fisheries Service. Annapolis, MD.

Bolinger, Angel, Steve Doctor, Allison Luettel, Mike Luisi, and Gary Tyler. 2007. 2006 Coastal Bays Fisheries Investigation. Maryland Department of Natural Resources. Fisheries Service. Annapolis, MD.

Table 1. 2002 – 2006 Maryland Volunteer Angler Summer Flounder Survey (MVASFS) Catch Per Unit of Effort (CPUE), Percent Difference, and Percent Influence by Year and Category for its Atlantic Coast.					
Year	***Bay Bee* *CPUE***	**Without *Bay Bee CPUE***	**With *Bay Bee CPUE***	**% Difference between w/ & w/o *Bay Bee***	**% (Difference) Influence**
2006	0.32	0.6	0.37	-62	14
2005	0.46	0.51	0.47	-9	2
2004	1.03	0.87	1.00	13	-3
2003	0.31	0.34	0.31	-10	0
2002	0.33	0.41	0.35	-17	6
Mean				22*	5

* The mean % Difference between w/ & w/o *Bay Bee* was calculated using the absolute values.

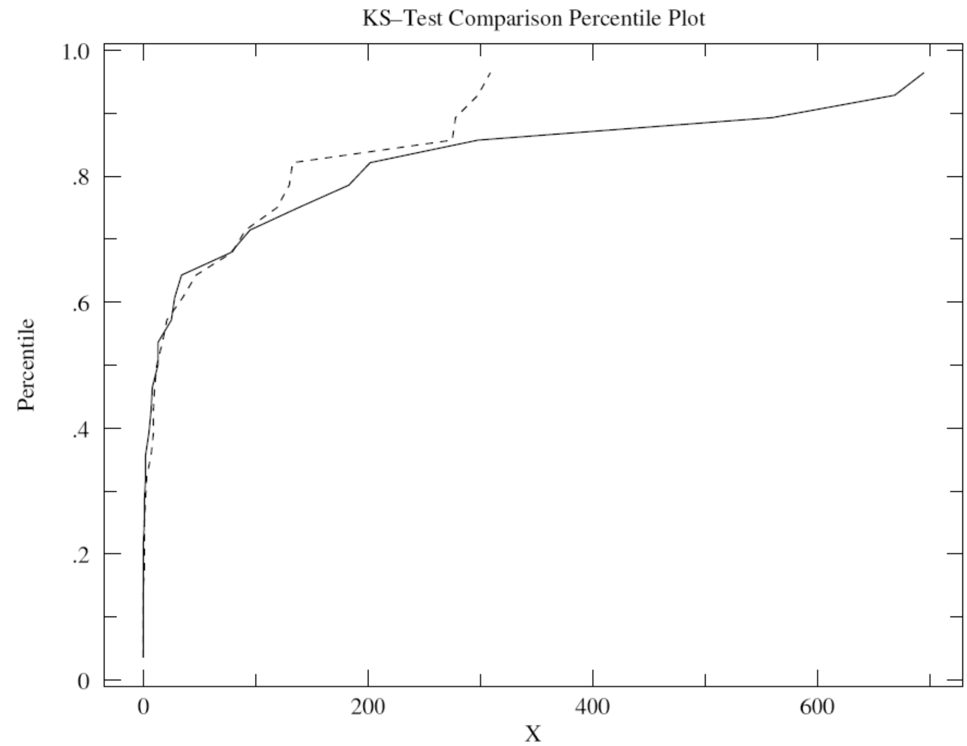


Figure 1. 2006 Maryland Volunteer Angler Summer Flounder Survey (MVASFS) Kolmogorov-Smirnov (KS)Comparison Percentile Plot from http://www.physics.csbsju.edu Accessed on January 5, 2007, n=4,944.

Appendix 5.

DEVELOPMENT OF SUMMER FLOUNDER SIZE LIMIT OPTIONS FOR MARYLAND'S 2004 FISHING SEASON

BY

LINDA BARKER

ALEXEI SHAROV

STEVE DOCTOR

Maryland Department of Natural Resources **March 2004**

Fisheries Service

Fisheries Technical Report

Number 45

INTRODUCTION

Maryland's annual summer flounder recreational landings have exceeded the Atlantic States Marine Fisheries Commission's (ASMFC) target harvest several times over the last decade. The most recent year in which the target was exceeded was 2001. In 2002 Maryland increased the minimum size from 16.5 to 17.0 inches and closed the fishery from July 25 - August 12. The estimated 2002 catch of 68,891 flounder was only 56% of the target of 122,000 fish. Maryland maintained the 17.0-inch minimum size limit but eliminated the season closure in 2003. The 2003 estimated catch of 40,240 was only 33% of the target.

This report describes the methods used to determine the minimum size/creel limit combinations that should allow Maryland recreational anglers to land the target harvest of 131,000 fish in 2004. It also presents a process for estimating size and creel limits based on Maryland's Summer Flounder Volunteer Angler Survey (MVAS) data, estimates of the annual change in stock size based on the 2003 National Marine Fisheries Service's Northeast Fisheries Science Center (NEFSC) Stock Assessment Report and the Marine Recreational Fisheries Statistics Survey (MRFSS) estimates of the recreational harvest for the most recent three-year period.

METHODS AND RESULTS

The predicted recreational harvest for 2004 was estimated for several size and creel limit combinations assuming there will be no significant change in the length frequency of summer flounder in Maryland waters from 2003 to 2004 and fishing effort will remain constant over time (equivalent to 2003). The analysis was based on length frequency data collected in the MVAS, an estimate of stock growth from 2003 to 2004 based on NEFSC data and MRFSS recreational harvest data.

Development of representative length frequency

In 2002, Maryland instituted a volunteer angler survey for summer flounder. The MVAS provides catch per trip and length information from Maryland's Atlantic coastal bays and Chesapeake Bay. Anglers record all of their targeted summer flounder trip information including: location, time spent fishing, number of fish caught, number kept, and lengths of all fish caught. Data from 1229 survey trips in 2002 and 2003 were used in the analysis. A total of 7318 summer flounder were measured during this period. These data are essential for managing the fishery because they supply information on the length structure of released fish, which is not available from the MRFSS.

The MVAS length frequency data indicates that Chesapeake Bay fish were slightly larger as a group than Atlantic coastal bay fish (Figure 1), and the length frequency of the catches in 2002 and 2003 were similar (Figure 2). Although Chesapeake Bay fish were larger than coastal bay fish, they comprised only 11% of the total reported MVAS catch across both years. Therefore, the MVAS data were combined to create an overall LF curve for 2002-2003 Maryland Atlantic coastal bay and Chesapeake Bay summer flounder (Figure 3). (Note that Maryland DNR pound net survey data were examined to determine if there were large differences in the population length frequency by year or if there was a trend over time. These data were taken from stations in the lower Chesapeake Bay. Examination of the yearly length frequency plots did not indicate that there were large annual differences or a trend in the LF over time.)

Projected 2004 harvest

Projected 2004 landings for several size and creel limit combinations were calculated using 2001-2003 MRFSS harvest data adjusted for season closures in 2001 and 2002, MVAS data, and information contained in the 2003 NEFSC Stock Assessment Report.

Adjustments to reported harvests.

The first step in predicting the 2004 harvest was to adjust historical landings to account for the effects of in-season fishery closures. In 2001, the fishery was closed from July 25 to August 6. Based on a Weibull cumulative function fitted to the MRFSS data for 1994-1998[1], 15.77% of the annual harvest was caught on average from July 25 to August 6. Therefore, the reported harvest for 2001 was increased by 15.77%. The 2002 reported harvest was increased by 21.48% to account for the July 26-August 12, 2002 closure. The average harvest for the period 2001 – 2003 was then calculated based on the adjusted harvest numbers for 2001 and 2002, and the actual 2003 harvest.

The MRFSS reported 2003 harvest was 40,240 fish. The 2002 harvest (68,891), when adjusted for the season closure, was 83,689 fish. The 2001 harvest (139,392), when adjusted for the season closure, was 161,374 fish. Therefore, the average adjusted harvest for 2001-2003 assuming no closed season was 95,101 fish at a 17.0-inch minimum size and a creel limit of 8 fish.

Adjustments for population growth from 2003 to 2004

The next step in predicting the 2004 harvest was to adjust stock size to account for the expected increase in the summer flounder stock from 2003 to 2004. This was accomplished using information from the 2003 NEFSC Stock Assessment Report (NEFSC website (Table 9, www.nefsc.noaa.gov/nefsc/publications/crd/crd0309/t97.htm, accessed 12/8/03)).

The stock size in numbers per age for 2004 was calculated as follows:

$N_{2004} = N_{2003} * e^{(-(M + (PR*F)))}$

where

N_{2003} = number of fish at age from VPA assessment;
M = natural mortality, assumed to be 0.20;
PR = partial fishing mortality at a given age as taken from the VPA assessment;
F = target fishing mortality rate (0.25).

The 2002 coastwide mean lengths of 1- and 2-year-old summer flounder were 14 and 16.5 inches, respectively. Assuming that harvest directly reflects abundance, and that the stock is fished at the target fishing mortality rate, the 2004 harvest of 1+- and 2+-year-old fish would increase by 6.4% and 14.9%, respectively (Table 1). For minimum sizes in the 15.5-16.0 inches range, the age of entry to the fishery would be about 1.5 years and the harvest would increase by 10.7% (an average % increase for 1+ and 2+ populations). For minimum sizes of 16.5-17.0 inches, the age of entry to the fishery would be 2 years and the projected harvest would increase by 14.9%. Therefore, in this analysis, calculations for minimum sizes of 15.5 and 16.0 inches were based on a 10.7 % exploited population growth and calculations for minimum sizes of 16.5 and 17.0 inches were based on a 14.9 % population growth.

Predicted 2004 harvest for various size limits at an 8 fish creel and no closed season

The predicted number of flounder that would be harvested in 2004 at a given size limit less than 17.0 inches, an 8 fish creel and no closed season (PH) was calculated as follows:

$PH = AH * [(P_1)/(P_2)] * S$

where

AH = adjusted average 2001-03 harvest at a 17.0-inch minimum size, 8 fish creel and no season closure (95,101 fish);
P_1 = % of fish measured in the MVAS above a given size limit in 2002-2003 (Fig 2);
P_2 = % of fish measured in the MVAS 17.0 inches and larger in 2002-2003 (Fig 2);
S = change in relative stock size between 2003 and 2004.

Table 2 indicates that the 2004 Maryland summer flounder harvest at size limits of 17.0 and 16.5 inches, with an eight fish creel and no closed season would be below the 2004 ASMFC target of 131,000 fish. Table 2 also indicates that reductions in either the creel limit or the season length at 16.0 and 15.5 inch minimum size limits are needed to achieve a harvest that is at or below the 2004 ASMFC target.

Projected 2004 harvest with changing creel limits

The 2002-2003 MVAS data were analyzed to determine the effect of creel limits on the harvest for size limits between 15.5 and 17.0 inches (Table 3). The total number of fish caught per angler for different creels (FPA) was estimated as:

Number of fish = Number of anglers * FPA

For example, for anglers that caught only two fish greater than minimum size of 17 inches:

565 Anglers * 2 FPA = 1130 Fish

The reduction in harvest (in numbers of fish) due to reduced creel limits was then calculated as the sum of the difference between creel limit and FPA for all creel categories greater than the creel limit in question, multiplied by the number of anglers for corresponding creel categories. For example, the loss of harvest for a minimum size of 16.5 inches and a creel limit of 6 fish (Table 3) was calculated as follows:

Reduction in harvest: (8-6)*20 + (7-6)*16 = 56 fish

Finally, percent reduction for creel limits less than 8 fish were calculated by dividing by the loss of harvest (in numbers of fish) by the total harvest for that minimum size limit with an 8 fish creel limit (Table 4). For example, percent in harvest reduction for a minimum size of 16.5 inches and a creel limit of 6 fish was calculated as follows:

Percent reduction in harvest: 56 lost / 4305 total = 1.3 %

Estimates of 2004 harvest for different minimum sizes and creel limits were calculated by multiplying the estimated 2004 harvest for a creel limit of 8 fish (Table 2) by the percent of harvest reduction due to reduced creel limits (Table 4).

These results, based on calculations performed with conservative assumptions, indicate that the 2004 ASMFC target of 131,000 fish will not be achieved by the current Maryland limits of 17.0 inch minimum size and 8 fish creel limit. However, several other combinations of creel limit and minimum size can achieve the target harvest (Table 5).

Figure 1. Cumulative length frequencies of Maryland summer flounder in Atlantic coastal bays (2002- 2003) and Chesapeake Bay (2002- 2003), based on Maryland Volunteer Angler Survey data.

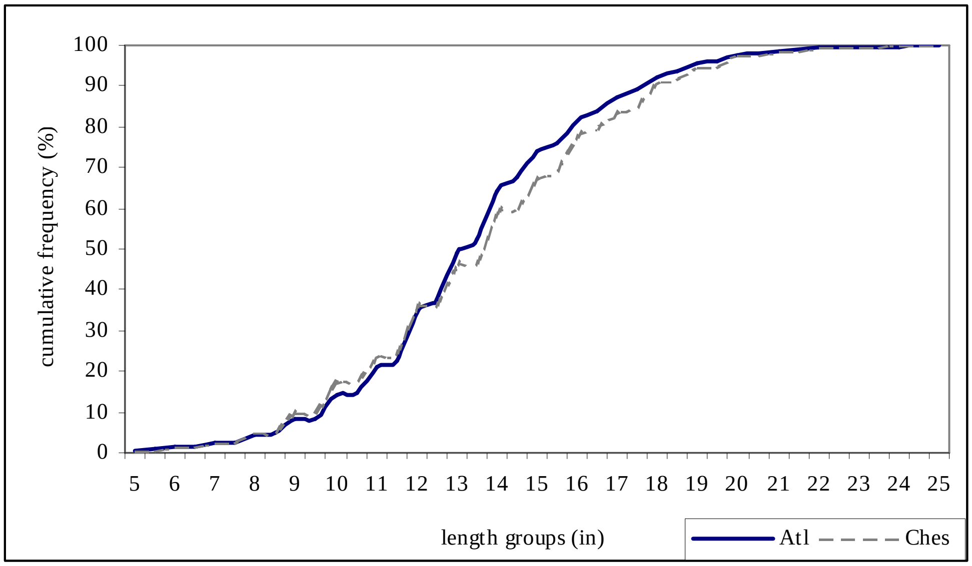


Figure 2. Cumulative length frequencies of Maryland summer flounder in Atlantic coastal bays and Chesapeake Bay, 2002-2003, based on Maryland Volunteer Angler Survey data.

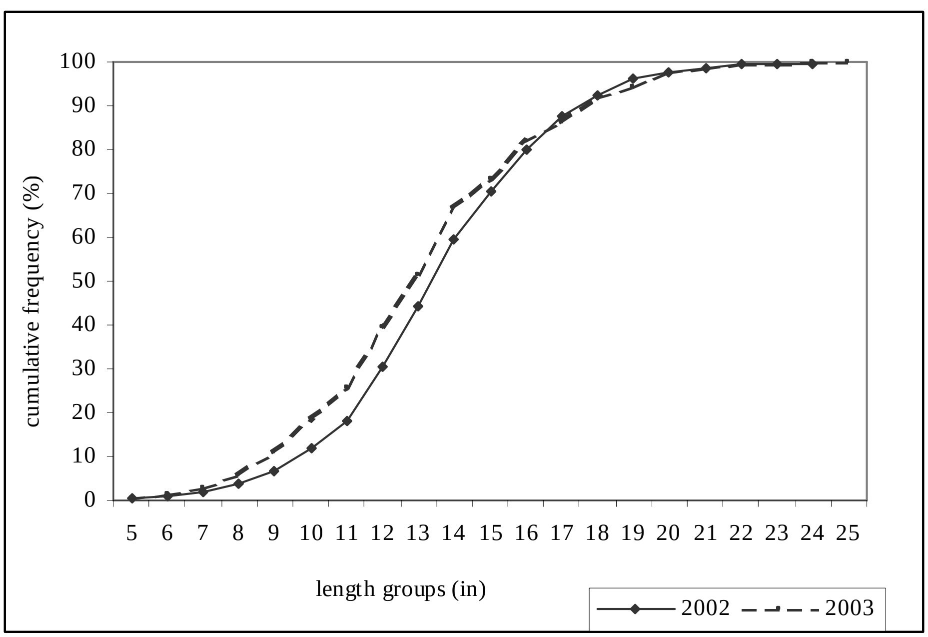
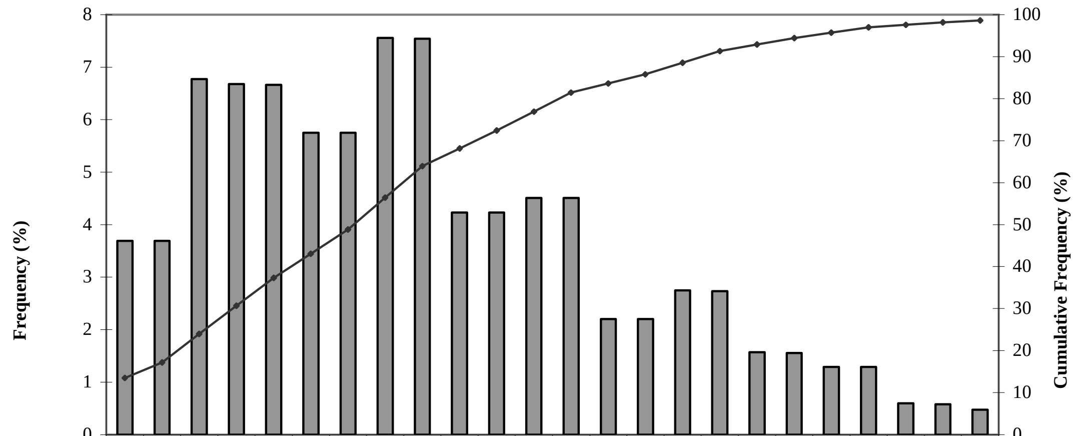


Figure 3. Length frequency of Maryland summer flounder in Atlantic coastal bays and Chesapeake Bay based on 2002-2003 Maryland Volunteer Angler Survey data.



	10	10.5	11	12	12.5	13	13.5	14	14.5	15	15.5	16
frequency	3.6932	3.6932	6.7735	6.6792	6.6635	5.752	5.752	7.5593	7.5436	4.2276	4.2276	4.5105
cum.freq.	13.52	17.21	23.98	30.66	37.33	43.08	48.83	56.39	63.93	68.16	72.39	76.90

	16.5	17	17.5	18	18.5	19	19.5	20	20.5	21	21.5	22
frequency	4.5105	2.2002	2.2002	2.7503	2.7346	1.5716	1.5559	1.2887	1.2887	0.5972	0.5815	0.4715
cum.freq.	81.41	83.61	85.81	88.56	91.29	92.87	94.42	95.71	97.00	97.60	98.18	98.65

Length Groups (in)

frequency — cum.freq.

- -

Table 1. Summer flounder population growth in numbers (as 1000s). Based on Table 9, www.nefsc.noaa.gov/nefsc/publications/crd/crd0309/t97.htm, accessed 12/8/03.

AGE	PR	2003 N	2004 N
0	0.01	35,368	35,368
1	0.17	30,964	28,885
2	0.76	19,077	24,296
3	1	15,375	12,916
4	1	5,974	9,804
5	1	4,694	3,809
6	1	2,435	2,993
7+	1	642	1,553
Total N for age 1+		**79161**	**84,255**
% Growth			**6.4**
Total N for age 2+		**48197**	**55371**
% Growth			**14.9**

Table 2. Projected 2004 Maryland recreational catch of summer flounder for different minimum sizes, with no season closure and 8-fish creel. Based on average reported catch of 2001-2003, adjusted for season closure.

Minimum Size Limit	2001 Reported Harvest	2002 Reported Harvest	2003 Reported Harvest	2001-2003 Avg. Adj. Harvest	% exploited population growth	Predicted 2004 Harvest
17.0	139,392	68,891	40,240	95,101	14.9	109,271
16.5					14.9	123,939
16.0					10.7	148,376
15.5					10.7	177,346

Table 3. Number of fish caught per creel, or Fish Per Angler (FPA), based on MVAS 2002-2003 data.

FPA	17.0		16.5		16.0		15.5	
	Anglers	**Fish**	**Anglers**	**Fish**	**Anglers**	**Fish**	**Anglers**	**Fish**
1	1510	1510	1480	1480	1338	1338	1340	1340
2	565	1130	589	1178	850	1700	865	1730
3	174	522	280	840	287	861	282	846
4	62	248	90	360	170	680	146	584
5	0	0	23	115	184	920	219	1095
6	10	60	10	60	67	402	87	522
7	36	252	16	112	0	0	20	140
8	31	248	20	160	26	208	39	312
		3970		**4305**		**6109**		**6569**

Table 4. Percent of harvest reduction due to reduced creel limits for four minimum size limits based on MVAS 2002-2003 data[1].

Creel	Minimum size (in)			
	17.0	**16.5**	**16.0**	**15.5**
1	39.8	41.7	52.2	54.4
2	17.7	17.9	26.2	29.1
3	9.8	7.7	14.2	17.0
4	6.3	3.9	6.9	9.3
5	4.4	2.4	2.4	3.7
6	2.5	1.3	0.9	1.5
7	0.8	0.5	0.4	0.6
8	0	0.0	0.0	0.0

1 Harvest reductions from seasonal closures were taken from a Weibull

curved based on state-specific 1994-1998 MRFSS data. The 1994-1998 time period is the standard time used by the technical committee to calculate seasonal reductions.

Table 5. Estimated 2004 recreational harvest of summer flounder in Maryland for different minimum sizes and creel limits[2].

Creel	Minimum size (in)			
	17.0	16.5	16.0	15.5
1	65,781	72,256	70,924	80,870
2	89,930	101,754	109,502	125,738
3	98,562	114,395	127,307	147,197
4	102,387	119,105	138,138	160,852
5	104,463	120,964	144,815	170,784
6	106,539	122,327	147,041	174,685
7	108,397	123,319	147,783	176,281
8	109,271	123,939	148,376	177,346

2 Estimates of the predicted harvest were also calculated for the four size limits under consideration using the most conservative exploited population growth rate estimate (6.4%). This change did not effect the maximum allowable creel limit for a given size minimum size.