Spot Data Availability and Stock Monitoring Report
2009

A report to the South Atlantic State-Federal Fisheries Management Board
from the Spot Plan Review Team

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I. Introduction

At the request of the South Atlantic State-Federal Fisheries Management Board (Management Board), the Spot Plan Review Team (PRT) reported on available fishery-independent and fishery-dependent indices of abundance from Maryland, Virginia, and North Carolina in 2007 and 2008. Also in 2008, the PRT developed age-length keys for Virginia and North Carolina caught spot for available years and characterized commercial catch at age in Maryland, Virginia, and North Carolina. Some of the trends presented suggested a decline in the long-term abundance of spot, thus the Management Board asked for an update of all information, including additional information from South Carolina, in 2009. Additionally, the Management Board tasked the PRT with reviewing spot data availability for stock assessment purposes.

This document presents the PRT's report on spot data availability, and provides an overview of the state monitoring reports from Maryland, Virginia, North Carolina, and South Carolina, as well as additional fishery-independent indices from New Jersey and Delaware.

II. Data Availability

The PRT used a spreadsheet template to request commercial, recreational, and survey spot data availability from all states within the management unit (New Jersey-Florida) and compiled a coastwide data availability workbook. The PRT provides an overview and conclusions below.

A. Commercial Data Availability

- Harvests (weight) available from National Marine Fisheries Service (NMFS) since 1950, by gear; additional historical harvests available from NMFS since 1880s, by state for the South Atlantic and Chesapeake Bay regions
- Harvests (weight) available from seven states; six states' data since at least 1994, three states' data since before 1985; generally available by gear and month
  - NJ since 2004, DE since 1984, MD since 1929 (by gear since 1945, by month since 1957), VA since 1993, NC since 1994 (includes "scrap" landings sold as bait; also available in numbers), GA since 1972, FL since 1991
- Effort data available from seven states; three states' data since early 1990s, two states' data since early 2000s
  - NJ since 2004, DE since 1993, MD since 1990, VA since 1993, NC since 1994, GA since 2002, FL since 1991
- Harvest length data available from four states since late 1980s to early 1990s, and one state one year
  - DE in 1994 (limited sampling), MD since 1993, VA since 1989, NC since 1994 (includes scrap landings), FL since 1992 (limited sampling since 2003)
- Harvest age data available from two states since late 1990s, three states in one to three years
  - DE in 1994 (limited sampling), MD since 2007 (not processed), VA since 1998, NC since 1997 (2007/08 not processed; includes scrap landings), FL in 1993, 1994, 2000 (limited sampling)
- Discards data (total weight and subsample of lengths) available from Northeast Fishereis Observer Program since 1994: includes coverage of 181 trips directed at spot (primarily gill net and beach seine in VA and NC) and coverage of 27 trips directed at other species and

discarding >100 lbs spot (in RI, NJ, MD, VA, primarily trawl); shrimp trawl discard characterization study in southern NC in 2007 (report pending)
- No discard age data available

B. Recreational Data Availability

- Harvests (weight and/or numbers) available by wave, mode, and area from NMFS since 1981, and from two state programs, one short-term and one long-term (although of limited use)
  - MD headboat creel survey in 1997-1999, SC creel survey since 1991
- Effort data available from NMFS since 1981, and MD headboat creel survey in 1997-1999
- Harvest length data available from NMFS since 1981, MD headboat creel survey in 1997-1999, and SC creel survey since 1991
- No harvest age data available
- Discards (numbers) available from NMFS from 1981, MD headboat creel survey in 1997-1999, and SC creel survey since 1991
- Discard length data available from MD headboat creel survey in 1997-1999
- No discard age data available

C. Fishery Independent Data Availability

- At least twenty-two fishery-independent surveys conducted along the Atlantic coast from New Jersey through Florida collect spot
- Young-of-year relative abundance indices currently available from 10 surveys
  - DE Delaware Bay 16ft Trawl Survey since 1980, DE Inland Bays 16ft Trawl Survey since 1986, MD Chesapeake Bay Trawl Survey since 1989, MD Chesapeake Bay Seine Survey since 1959, MD Coastal Bays Trawl Survey since 1972 (standardized since 1989), MD Coastal Bays Seine Survey since 1972 (standardized since 1989), VIMS Juvenile Trawl Survey since 1955 (standardized from 1988), NC Estuarine Trawl Survey since 1979 (available from 1994), NC Pamlico Sound Trawl Survey since 1987 (available from 1994), SC Electroshock Survey since 2001
  - An additional two young-of-year indices could be generated: GA Ecological Monitoring Trawl Survey since 2003, FL Fishery Independent Monitoring Survey since 1990
- Adult or aggregate relative abundance indices currently available from 8 surveys
  - NJ Delaware River Seine Survey since 1980, NJ Delaware Bay Trawl Survey since 1991, NJ Ocean Trawl Survey since 1989, DE Delaware Bay 30ft Trawl Survey since 1966 (disjunct timeseries before 1990), ChesMMAP Trawl Survey since 2002, NC Independent Gillnet Survey since 2001, SC Trammel Net Survey since 1991, SEAMAP since 1989 (for states and region)
  - An additional two adult or aggregate indices could be generated: GA Marine Sportfish Population Health Survey since 2002, FL Fishery Independent Monitoring Survey since 1996
- Length data (juvenile, sub-adult, and/or adult) available from most surveys listed above, and additional length data may be available from other surveys for which indices were not reported
- Age data (juvenile, sub-adult, and/or adult) available from four surveys listed above, and additional age data may be available from other surveys for which indices were not reported
  - ChesMMAP Trawl Survey since 2002, VIMS Juvenile Trawl Survey since 1988, NC Independent Gillnet Survey since 2001, SEAMAP in 2001

D. Data Availability Conclusions

- Commercial landings data appear adequate for a spot assessment; however, discard data are limited. The level of commercial biological sampling is on par with other species having assessments performed.
- The adequacy of recreational harvest and harvest length data is comparable to other species which rely primarily on MRFSS data. Limited discard length data are available and discard mortality rates are unknown; however, less recreational discarding of spot occurs than for many other species.
- The number, timeseries, and distribution of fishery-independent indices appear adequate for stock assessment purposes. Biological data appear ample from several surveys; however, the amount and representativeness of samples from each survey has not been investigated in detail.
- Additional investigation into the quality and quantity of commercial, recreational, and indices data for a spot stock assessment would need to take place through a data workshop.
- The limiting factor for a spot stock assessment is likely life history information (e.g., reproduction, fecundity, maturity, movement), which the Spot PRT did not address in this review of data availability. The Spot PRT proposes to compile and report on available life history information in 2010.

III. Stock Monitoring

The PRT consists of representatives from Maryland Department of Natural Resources (MD DNR), Virginia Marine Resources Commission (VMRC), North Carolina Division of Marine Fisheries (NC DMF), and South Carolina Department of Natural Resources (SC DNR), thus monitoring reports were generated for these states only. Additional data were provided by representatives from New Jersey Division of Fish and Wildlife (NJ DFW) and Delaware Division of Fish and Wildlife (DE DFW). Provided below is a brief overview of the included fishery dependent and independent indices of relative spot abundance; see the attached monitoring reports for detailed descriptions and discussion.

A. Fishery Dependent Data

1. Commercial Harvest, Effort, and Catch Per Unit Effort (CPUE)

Commercial harvest and effort data for Maryland, Virginia, and North Carolina were provided by MD DNR, VMRC, and NC DMF via their respective mandatory reporting systems. All 2008 data are preliminary. Commercial CPUE was developed for seven fisheries. Catch per unit effort trends per commercial dataset are as follows:

MD Inshore Pound Net Fishery: pounds per trip generally increased from 1980 through 2005, declined sharply in 2006 and 2007, and increased in 2008 to 6th highest value.

MD Inshore Gill Net Fishery: pounds per net yard hour were zero 1980-1984, moderate and variable through the 1990s, peaked in 2002, decreased to a moderate value in 2005 and remained stable through 2008.

VA Inshore Gill Net Fishery: pounds per trip exhibit limited variability 1994-2008, with slightly decreasing trend 2003-2008.

VA Haul Seine Fishery: pounds per trip were variable around the mean 1994-2006, with greatly increased values in 2007 and 2008.

NC Long Haul: pound per trip were variable with a slightly increasing trend 1994-2000, but have declined nearly consistently 2001-2008, reaching the timeseries' low in 2008.

NC Inshore Gill Net: pounds per trip exhibit limited variability since 1994, but show four years of consecutive decline 2005-2008, reaching the timeseries' low in 2008.

NC Ocean Gill Net: pounds per trip vary widely since 1994, but show four years of consecutive decline 2005-2008, reaching the timeseries' low in 2008.

2. Recreational Harvest, Effort, and Catch Per Unit Effort (CPUE)

Recreational harvest and effort data for Maryland, Virginia, North Carolina, and South Carolina were provided by NMFS from the Marine Recreational Fisheries Statistics Survey (MRFSS). Recreational CPUE was developed for each state, with effort being limited to trips in which anglers caught or targeted spot from private/rental boats and shore components. Additional recreational indices were developed from five state datasets: two citation programs, two survey programs, and one logbook program. All 2008 data are preliminary. Catch per unit effort trends per recreational dataset are as follows:

MD MRFSS: CPUE widely variable, but generally decreased 1981-1999, generally increased 2000-2006, and decreased 2007-2008.

VA MRFSS: CPUE widely variable, but generally average 1981-1988, high 1989-1991, average 1993-1998, lowest in 1999, and increased back to average by 2008.

NC MRFSS: CPUE shows inter-annual variability, but the overall trend since 1981 is increasing, although decreased in 2008.

SC MRFSS: CPUE variable since 1981 and even more so since 2002, with a peak in 2007 and decline in 2008 to a level still well above the mean.

MD Charterboat Logbook: catch per angler generally decreased 1993-2004, rebounded in 2005-2006, decreased in 2007, and stable in 2008.

MD Citation Program: distribution of citations for spot >12" was low 1994-1998, high 1999-2004, and similarly low 2005-2008.

NC Recreational Commercial Gear License Survey: pounds per trip were consistent 2002-2005, decreased 2006-2007, and leveled off near the low in 2008.

NC Citation Program: distribution of citations for hook and line caught spot >1 lb was low 1994-2000, increased drastically to a 2001 maximum, decreased but remained high to moderate 2002-2006, and became low or non-existent 2007-2008.

SC Finfish Survey: number of spot per trip has ranged widely since 1991; not a reliable CPUE because anglers per trip often unknown.

3. Characterization Data

Data from MD, VA and NC were used to produce commercial catch-at-age (CAA), weight-at-age (WAA), and length-at-age (LAA) for MD, VA, and NC fisheries where possible.

MD Commercial Pound Net Fishery: 1998-2008 CAA include ages 0-6, but dominated by age 1 and sometimes age 2; ages 3-6 not present every year and are small proportion of catch; no clear trend in CAA, but lighter WAA and shorted LAA for ages 0-3 in recent years.

VA Commercial Fisheries: 1998-2008 CAA for gill net (GN), pound net (PN), and haul seine (HS) caught spot includes ages 0-6, but only age 1 and 2 always present, and age 1 generally dominates; no clear trend in CAA, although trends observed in WAA and LAA for ages 1-3 (those with sufficient samples): WAA declined for age 2-3 GN spot 2001-2008, age 1-3 HS spot, age 1 PN spot, age 2-3 PN spot 2001-2007; LAA declined for age 3 GN spot, age 1-3 HS spot, age 3 PN spot 2002-2007.

NC Commercial Fisheries: 1998-2006 CAA includes ages 0-6, but only 0-3 present all years; age 1 generally dominates, followed by age 2; decreasing trend in age 1 catch and increasing trend in age 3 catch 1998-2005; no WAA or LAA information.

B. Fishery Independent Data

1. Juvenile Relative Abundance Indices

Young-of-year (YOY) relative abundance indices from eight surveys were documented in the state monitoring reports. Additionally, two YOY indices were submitted by DE DFW. The surveys and index trends are as follows:

DE Delaware Bay 16ft Trawl Survey: available since 1980, generally higher prior to 1996, consistently low 1995-2004, although recent moderate recruitments in 2005 and 2008.

DE Inland Bays 16ft Trawl Survey: generally increases every 1-2 years since 1986 (the continuous timeseries), peak values in 1988 and 1994, low 1998-2003, increase in 2008.

MD Chesapeake Bay Trawl and Seine Surveys: low with a few spikes in abundance 1989-2006, but increasing trends 2007-2008.

MD Coastal Bays Trawl and Seine Surveys: low with a slight downward trend 1989-2007, but increased in 2008.

VIMS Juvenile Trawl Survey: variable over time but generally higher prior to 1992, although increasing from 2006-2008.

NC Estuarine Trawl Survey: wide fluctuations with no clear trend; increase in 2007 from 2006 (2008 data not available).

NC Pamlico Sound Trawl Survey: extremely variable with no clear trend; significant increase in 2008 from 2007.

SC Electroshock Survey: increasing trend 2001-2008 except for a 60% drop in 2006 (corresponding with an increase in mean annual temperature).

2. Adult or Aggregate Relative Abundance Indices

Adult or aggregate (mix of YOY and older spot) relative abundance indices from three surveys were documented in the state monitoring reports. Additionally, NJ DEP provided three indices and DE DFW provided one index. The surveys and index trends are as follows:

NJ Delaware River Seine Survey: variable with high and moderate peaks 1980-1997, low 1998-2008 with a small peak in 2005.

NJ Delaware Bay Trawl Survey: generally low and stable since 1991, with a spike in 2005, and consecutive increases 2007-2008 to timeseries high.

NJ Ocean Trawl Survey: limited variability since 1989, timeseries high in 2008.

DE Delaware Bay 30ft Trawl Survey: variable during disjunct portion of timeseries, then generally a decreasing trend 1990-2004, then increasing 2005-2008.

NC Independent Gillnet Survey: CPUE variable from 2001-2004, with peak in 2001, declining 2005-2007, and leveled off in 2008 at the low.

SC Trammel Net Survey: CPUE variable 1991-2002 with peaks in 1994 and 1999, before dropping to lowest value in 2003 and slowly increasing since then to near the mean.

SEAMAP, NC-FL: CPUE decreasing 1991-2002, increasing 2003-2005, and decreasing 2006-2008; similar trends for individual states.

C. Stock Monitoring Conclusions

Although some fishery independent and dependent indices previously demonstrating declines exhibited increases in 2007 and/or 2008, the PRT remains concerned about the status of spot given other declining index trends and the fact that spot is a short lived species, meaning that their abundance can change rapidly given poor environmental conditions amidst high fishing pressure. For this reason, the PRT recommends that the Board request another year of monitoring reports in 2010. This would give the PRT the time necessary to compile and develop life history information on spot, which has not previously been reported by the PRT and is currently limited. Should the majority of index trends increase through 2009, the PRT may recommend monitoring on an every 2-3 year basis, whereas if the majority of index trends decline through 2009, the PRT may recommend that a spot stock assessment be initiated.

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

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Evaluation of the status of Spot in Maryland - 2008

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Introduction

Recent declining trends in spot landings have raised some concern about the long term health of the stock. In the absence of a coast wide stock assessment, the South Atlantic State/Federal Fisheries Management Board (The Board) requested that the Atlantic States Marine Fisheries Commission (ASMFC) Spot Plan Review Team compile and summarize catch per unit effort (CPUE) data for spot in 2007 using data through 2006. The relationship between landings and abundance is not clear and before an amended spot plan is prepared, it should be determined if CPUE is actually declining. Participating states were to prepare individual reports using state specific data. A report for Maryland was completed in March of 2007. The board has requested each state continue to further develop and report on spot catch and biological information in 2008 and 2009.

Spot commercial CPUEs were updated through 2008 by making several assumptions and applying spatial and temporal limitations to the data. Recreational CPUEs were generated using the Marine Recreational Fishery Statistics Survey (MRFSS) estimates and updated Maryland charter boat log data through 2008. Juvenile indices (JI) were also updated, through 2008, using data from existing surveys conducted by the Maryland Department of Natural Resources (MD DNR). In addition, data from Maryland pound net sampling was summarized from 1993-2008, and catch at age, mean weight at age and mean length at age calculated from 1998-2007.

Methods

Juvenile Indices

Four juvenile indices were utilized in this evaluation, two from the Maryland portion of Chesapeake Bay and two from the Maryland coastal bays. The first JI is derived from the MD DNR Blue Crab Trawl Survey (BCS). The survey uses a 16ft bottom trawl at fixed stations in six areas of Maryland's Chesapeake Bay. Survey details can be found in Davis et al. (1995). The BCS juvenile index is calculated as the geometric mean catch per tow and was updated through 2008. The survey has been conducted since 1980, but a review of the raw data revealed data entry omissions for spot in years prior to 1989. This data is currently being entered from the original data sheets, but was not available for this report.

The second JI was derived from the Striped Bass Juvenile Seine Survey (JSS). This survey uses a 100ft long by 4 foot deep beach seine at fixed stations in five areas of Maryland's Chesapeake Bay. Durell and Weedon (2005) describe the survey methods and index calculation in detail. The JSS index is calculated as a geometric mean from 1959 -2008. The JSS has permanent and auxiliary sites, both of which were used in past spot JI calculations. However, for this report only permanent sites were used in JSS index calculations and analysis.

The two coastal bay JIs are calculated from trawl and seine data collected by MD DNR Fisheries Service's Atlantic Program (AP). The trawl survey uses the same type of trawl as the BCS at 20 fixed stations once a month from April through October (Luisi et al, 2005). The Coastal Trawl Index (CTI) was calculated using all 20 sites to derive an annual geometric mean. The seine portion of the AP sampling utilized a seine similar to the JSS, except for depth (6 ft vs. 4 ft) and the addition of a single central bag. Nineteen fixed stations were sampled once a month from June through September, and the corresponding Coastal Seine Index (CSI) was calculated using all sites to derive an annual geometric mean. Both AP sampling efforts have been conducted since 1972, but sites and frequency were not standardized until 1989 (Angel Bolinger personal communication, 2007). Therefore, only 1989-2008 data was used for this analysis.

Commercial Indices

Commercial CPUEs were calculated from data collected by the MD DNR mandatory reporting system. Effort data was only available for 1980-1984, 1990 and 1992 - 2008, and consequently are the only years commercial CPUEs were generated. **Maryland 2008 commercial effort and catch data are preliminary at this time.** The landings data will change, since some 2008 commercial landings logs have not been received. Generally only minor changes in landings occur, but occasionally one or more larger scale fishermen send in later reports causing a more substantial increase in landings. CPUE was calculated for pound nets and gill nets, since they are the primary gears used to harvest spot in Maryland waters. The majority of fishermen did not indicate a target species when using either gear, so other criteria had to be developed to determine which fishermen to include for each CPUE.

Pound net CPUE was limited to two regions that consistently produced spot annually, the main stem of Chesapeake Bay from the Chesapeake Bay Bridge south to the Maryland border with Virginia and the Maryland Potomac River tributaries. Any pound net set in either of these regions was included in this analysis. Only pound nets fished from May through October were included. Since Maryland reporting requirements did not require daily catch and effort entries prior to 2006, pound net data was reported monthly as the average number of nets fished and the number of days fished. For data prior to 2006 the catch per trip was calculated by dividing the catch for each month by the number of days fished for that month. Trip level catch and effort information is available for 2006 – 2008, so the pound net catch per trip was calculated directly from the data base for those years.

Since gill net catches were more sporadic and widely distributed than pound net catches, the area method for CPUE calculation was impractical, Atlantic Ocean catches were excluded from this analysis, and only fishermen that caught at least 100 pounds of spot in a given month were included. Due to some minor inconsistencies in the recording of effort data by some fishermen, high variability in the time fished and the amount of gear used and the fact that data are averaged by month prior to 2006, a catch per trip and an amount of net per hour CPUE were calculated for comparison. Net hour effort for gill

nets was reported monthly as average length of net per day in yards, hours fished per day and days fished. CPUE effort was calculated by multiplying the average net length by hours fished multiplied by number of days (yards of net*hours fished*days fished). Gill net yard hour CPUE was the total effort for each year divided into the total catch in pounds for the year. The effort for the trip level gill net CPUE was derived using the days fished per month prior to 2006 and the daily trip information for data from 2006 to the present. The two gill net CPUEs were compared to determine if the simpler trip based effort could be used in place of the net yard hour method.

Recreational Indices

The first recreational index was derived from MRFSS estimates of numbers of spot harvested and trips directed at spot through 2008 (National Marine Fisheries Service, Fisheries Statistics Division, personal communication). **2008 data are still considered preliminary at this time.** Directed trips were from anglers that reported catching or targeting spot. Modes of fishing were limited to the private/rental boat and shore components and area fished was limited to Maryland inland waters. Annual CPUE was calculated for each year from 1981 to 2008.

The second recreational index was derived from the Maryland charter boat log data base. Charter captains are required to maintain daily logs of where they fish, how many fish of each species they catch and how many anglers participated. No indication of target species is recorded, so the CPUE includes only trips in which spot were captured. The number of anglers was used as effort and the number of spot captured was used as catch. The annual number of spot per angler was calculated for 1993-2008. **The 2008 data is preliminary but should not change significantly.**

Maryland anglers who catch spot of a minimum length may apply for a Maryland state citation. Until 2003 the minimum length required was 10 inches but was raised to 12 inches in 2004. Lengths of submitted entries were available from 1994 through 2008, excluding 2000, so only 12 inch and greater spot were included for each year. The 2000 data was unavailable for inclusion in this report.

The different JI and CPUE indices were compared to each other and to Maryland landings when appropriate. Linear regression was used where appropriate and any regression with P values of 0.01 or less was considered significant. Juvenile indices were lagged one year when compared to landings and commercial and recreational CPUEs. For example, the 1990 landings would be compared to the 1989 BCS index. The juvenile indices lagged one year should be comparable to harvest since the majority of harvested spot are age one and few fish reach older ages (Piner and Jones 2004).

Characterization Data

From 1993- 2008 commercial pound nets were sampled from the mouth of the Potomac River and the lower portion of Maryland's Chesapeake Bay. Each area was sampled once every two weeks, weather and fisherman's schedule permitting. The commercial fishermen set all nets sampled as part of their regular fishing routine. Net soak time and manner in which they were fished were consistent with the fishermen's day-to-day operations. All spot captured were measured from each net when possible. In instances when it was not practical to measure all fish, a random sample of spot was measured and the remaining individuals enumerated if possible. All measurements were to the nearest mm total length (TL). Length frequency distributions were constructed for spot, using pound net length data divided into 20 mm length groups (i.e. 130 mm length group comprised fish from 130-149 mm).

Catch at age was estimated in pounds and numbers from 1998-2007 using Maryland pound net length frequency data, Maryland commercial landings data, Virginia Marine Resources Commission (VMRC) and North Carolina Department of Marine Fisheries (NCDMF) age data and VMRC length weight relationships by year. Length frequencies were in one centimeter size groups, and fish under 15 cm were not included, as they most likely would not be marketed and would not be part of the landings data. VMRC age data was used when available and NCDMF data was only used in the absence of VMRC data for spot in the smallest size classes. NCDMF data for 2007 was not available in time to be used to in 2007 Maryland calculations. A weighted mean weight and length at age were calculated for each year and the mean weights were used to convert the catch at age to numbers.

Results and Discussion

Both Chesapeake Bay JIs remained relatively low from 1992 to 2006, with a few spikes in abundance, but have shown an increasing trend the past two years (Table 1; Figure 1). The JSS and BCS indices were significantly correlated ($p = 0.0005$, $R^2 = 0.50$) from 1989 to 2008 (Table 2). The significant agreement between Chesapeake Bay JIs is encouraging, especially since different gears are utilized in different habitats, and neither was designed to capture spot. The 2008 BCS GM of 25.3 fish per tow was the 5th highest of the 1989-2008 time series. The 2008 JSS GM of 0.87 fish per haul ranked 24th in the 50 year time series indicating a more average year class. The differences in the relative strength of the Chesapeake JIs are influenced by the longer time frame of the JSS, which for many years prior to 1989 had higher GMs than recent years.

The Maryland Coastal Bays JIs indicated a relatively low level of abundance with a slight downward trend, for the 1989 to 2007 time period, with an increase in abundance in 2008 (Table 1, Figure 2). The CTI and CSI were significantly correlated for the standardized years ($p<0.0001$, $R^2 = 0.76$; Table 2). The 2008 CSI GM of 33.9 fish per haul was the 3rd highest of the 1989-2008 time period. Similarly, the 2008 CTI GM of 140.4 fish per tow was 2nd highest during the same 20 year time period. The

JSS was not significantly correlated to the coastal bay indices, but both the CSI ($p = 0.0054$, $R^2 = 0.36$) and the CTI ($p = 0.0133$, $R^2 = 0.30$) were correlated to the BCS (Table 2).

Maryland spot landings increased through much of the 1930's and 1940's, peaking in the mid 1950's before crashing in the early 1960's. Landings remained low, except for a few high years, until the late 1980's. Commercial landings have been variable at a relatively moderate level, staying above 75,000 pounds from 1989 – 2005 (Table 3; Figure 3). In 2006 landings dropped sharply to 37,774 pounds, but 2007 landings jumped to 380,633 pounds the highest landings since 1970. Three gill net fishermen, who had not report landing spot in 2006, accounted for 85% of the total commercial harvest in 2007. Maryland's 2008 preliminary landings were 89,671 pounds. Maryland's long-term average harvest (1929 – 2007) is 143,029 pounds. None of the juvenile indices, or one year lagged indices, were significantly correlated to commercial harvest.

MRFSS recreational estimates of spot harvest in Maryland were highly variable early in the time series, fairly stable and near the mean from 1989-1995 and fairly stable below the mean from 1996-2002. The past several years estimates have gone from the third highest in 2003, to below average in 2004 but then increased steadily to the time series high in 2007 (Table 3, Figure 4). The 2008 preliminary estimate decreased to 2,339,846 fish harvested, but still was above the 1981-2007 time mean of 1,694,511 fish. The majority of recreational spot catch is from inland waters (Figure 5). None of the juvenile indices, or one year lagged indices, were significantly correlated to Maryland MRFSS harvest estimates.

When evaluating Commercial CPUEs for Maryland, it is important to consider that neither pound or gill net, or any other gear, are generally used to target spot in Maryland. The majority of spot landings is by-catch or is selected from a mixed catch when more desirable species are unavailable. However, decreasing stocks of crabs and other fish species may result in a greater directed effort toward spot in the gill net fishery. A unit of effort for gill net may vary considerably from year to year, as mesh sizes and set locations change as watermen target more profitable species. These effects would be exacerbated if spot are targeted in some years and only by-catch in others, a likely possibility in the Maryland gill net fishery. Spot may be targeted when more profitable; their dockside value adjusted to 2007 dollars has generally decreased slightly in Maryland until 2006 (Figure 6). The 2007 and 2006 adjusted price per pound increased rapidly to the second and third highest levels, respectively, for the 22 years data are available, and may be responsible for the sudden increase in gill net effort and catch. Price per pound was not available for 2008. Because of the shifting nature of Maryland's spot gill net fishery, conclusions concerning year class strengths should be considered tenuous. Effort for deriving a gill net CPUE was examined as both trip based and net yard hour based, and while they did follow the same general trend, variations occur (Figure 7). CPUEs using this corresponding effort indicated conflicting trends for several years (Figure 8) and were not significantly correlated. The net yard hour gill net CPUE

would better capture shifts in effort and it was selected for use; the trip based gill net CPUE was not further evaluated.

The gill net CPUE had zero values for 1980-1984, were moderate and variable through the 1990s, and then increased, peaking in 2002 (Table 4, Figure 9). Since 2002 the gill net index decreased back to a moderate level in 2005, and has remained stable through 2008. Gill net catch has generally followed effort, particularly in more recent years (Figure 10). None of the JIs, or lagged JIs, had a significant relationship to the gill net CPUE (Table 2).

The pound net commercial CPUE index generally increased through 2005 and then declined sharply in 2006 and 2007(Table 4, Figure 11). The preliminary 2008 pound net CPUE indicates an increase to the 6th highest catch per trip of the 23 years of available data. The trend in pound net catch generally followed effort until 2006 and 2007, when effort remained fairly stable while catch declined (Figure 12). In 2008 effort remained similar to the previous 5 years, but catches increased. Years with very high JI values generally correspond to higher pound net CPUE values. It would appear that strong year classes begin to appear in the pound net fishery at age zero, influencing the composition of the catch. However, none of the JIs, lagged or not, are significantly correlated to pound net CPUE (Table 2). The pound net index was significantly correlated to the gill net index ($p=0.0022$, $R^2 = 0.37$; Table 2; Figure 13).

Pound net caught spot may also be landed as bait, either mixed with Atlantic menhaden or sold live to recreational fishermen. It is unclear how or if watermen report these landings. It is possible they are reported as menhaden when sold dead as bait. Spot sold live as bait often command much higher prices, but may be going unreported, or under reported, since they may not be sold through a dealer. The potentially changing proportion of spot landed as bait, because of their size or the price at the time they were landed is a primary concern with a Maryland pound net CPUE.

The lack of correlation between the commercial CPUEs and the JIs would indicate spot JIs are not a good predictor of future commercial landings in Maryland. Contributing factors could include the high mortality rate of spot, particularly juveniles, and the fact that some age zero fish are being harvested. Changes in predator abundance and/or the proportion of age zero spot being harvested, could also significantly alter the number of age one and older spot available for harvest in subsequent years. Therefore, under certain conditions, a strong year-class alone may not guarantee the availability of spot in the following year.

The Maryland MRFSS CPUE varied widely, with a slight generally decreasing trend through 1999 and a generally increasing trend from 2000 to 2006 (Table 4, Figure 14). The 2008 Maryland MRFSS index decreased for the second straight year, and ranked 17th in the 28 year time series. The MRFSS index also was not significantly correlated to any of the JIs or commercial CPUEs (Table 2). The MRFSS indicates higher catches in the early part of the time series when JIs were generally higher but the commercial CPUEs either indicated zero catch or were missing values.

The Maryland charter boat CPUE declined slightly from 1993 to 2004, before rebounding in 2005 and 2006 (Table 4, Figure 14). The 2007 CPUE declined slightly to near the time series mean. The 2008 Charter CPUE of 19.6 spot per angler was similar to the 2007 value of 19 spot per angler. Both the MRFSS and charter boat indices did appear to follow a similar trend of general decline over time with some recovery over the past several years (Figure 14),but these recreational indices were not significantly correlated (Table 2). The charter boat CPUE was significantly correlated to the one year lagged BCS JI ($p=0.0055$, $R^2 = 0.43$; Table 2) and the one year lagged JSS JI ($p=0.0044$, $R^2 = 0.45$; Table 2) but not the other two juvenile indices. The charter boat fishery for spot was prosecuted entirely in Chesapeake Bay as are the BCS and JSS, indicating charter boat catches are most likely comprised of age one fish. Submissions of 12 inch or greater spot to the Maryland citation program were very low (0-3 fish) from 1994 to 1998, increased rapidly to 141 in 2002, and then decreased sharply from 130 fish in 2003 to 0 fish in 2007 (Table 4). There were 2 submissions of 12 inch citation spot in 2008.

Spot mean length from Maryland pound nets in 2008 was 198 mm TL, the 6th lowest of the 16 year time series (Table 5). The length frequency distribution in 2008 was somewhat truncated, with fish between 190 and 229 mm TL accounting for 69% of the catch (Figure 15). Percent jumbo spot remained low in 2008, with less than 1% of the 2008 sample comprised of spot >254 mm TL (<1% in 2007, <2% in 2006, 3% in 2005, 13% in 2004 and 10% in 2003), confirming the decrease in large spot indicated by decreasing citation numbers.

Catch at age estimates for Maryland's commercial spot harvest in pounds and numbers were dominated by age one spot (Table 6, Figures 16 and 17). Age two spot were present each year, and occasionally represented a large portion of the catch. Age zero spot were present every year except 2007, but since VA 2007 age samples only include 1 fish each in the 15 and 16 cm length groups (both age one), the smaller size groups may not be accurately represented. In previous years the NC spot age length key was used to fill in such cases, but it was not yet available for use. Spot age three through six were not present every year, and only accounted for a very small portion of the catch in any given year. Catch at age in pounds and numbers was highly variable with no clear trends evident. However, the estimated number at age was derived solely from pound net length frequencies and utilized VMRC length weight relationships and age structure. While the Virginia biological data is probably representative of the age and weight characteristics of Maryland spot, small differences in age structure or the length weight relationship could cause a noticeable shift in numbers. Harvest from other gears may also produce different length frequencies than pound net caught fish.

Mean weight at age for pound nets was more variable between years than expected, but did indicate lighter weights at a given age in recent years for age zero through three spot (Table 7, Figure 18). Age four through six sample sizes were too low to make reasonable comparisons between years for weight or length at age. Mean length at age for ages zero through three were also generally shorter in recent years (Table 8, Figure 19). As with catch at age in numbers, the mean weights at age may not be

accurate if spot in Maryland had different length weight characteristics than those in Virginia for any of the years examined.

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Table 1. Maryland juvenile spot indices, 1959-2008.

	Chesapeake Bays		Coastal Bays	
Year	JSS (Seine)	BCS (Trawl)	CTI (Trawl)	CSI (Seine)
1959	0.21			
1960	0.06			
1961	0.04			
1962	0.36			
1963	0.45			
1964	0.09			
1965	0.02			
1966	0.51			
1967	0.02			
1968	0.60			
1969	1.23			
1970	0.08			
1971	0.86			
1972	1.16		1437.92	80.42
1973	3.26		139.51	83.35
1974	2.30		347.62	25.64
1975	4.42		24.78	51.00
1976	3.19		109.96	152.88
1977	6.89		27.42	44.37
1978	3.36		48.83	12.98
1979	2.71		62.32	28.45
1980	2.53		36.91	19.84
1981	1.65		257.48	186.54
1982	2.25		182.82	133.92
1983	1.07			
1984	3.43		24.21	
1985	1.50		4.63	
1986	1.77		824.36	
1987	1.17		1.41	2.39
1988	4.50		726.78	177.79
1989	0.70	41.61	23.08	13.12
1990	1.05	46.33	18.99	17.94
1991	0.81	19.52	14.11	8.12
1992	0.44	1.72	0.91	1.37
1993	1.42	10.53	4.20	5.48
1994	1.49	53.00	148.42	97.89
1995	0.10	0.36	2.00	3.33
1996	0.28	2.71	1.20	1.91
1997	1.34	15.32	57.98	46.51
1998	0.44	2.43	2.86	2.63
1999	0.61	2.86	6.38	8.08
2000	0.83	7.21	26.82	14.08
2001	0.37	2.02	1.84	1.71
2002	0.36	1.35	57.20	19.70
2003	0.31	1.77	2.22	2.88
2004	0.80	4.03	4.20	4.32
2005	3.49	52.96	38.97	16.18
2006	0.34	7.50	5.35	4.40
2007	0.61	14.09	19.37	12.58
2008	0.87	25.27	140.36	33.38

Table 2. Matrix of regression results for Maryland spot indices and landings comparisons. Positive correlations with p values of 0.01 or less are represented with a **YES** in the table.

	Pound Net	Gill Net	Charter	MRFSS	Com Landings	Rec Landings	BCS	JSS	CTI
Gill Net	**YES**								
Charter	NO	NO							
MRFSS	NO	NO	NO						
Com Landings			NO	NO					
Rec Landings	NO	NO	NO		NO				
BCS	NO	NO	NO	NO	NO	NO			
BCS Lagged	NO	NO	**YES**	NO	NO	NO			
JSS	NO	NO	NO	NO	NO	NO	**YES**		
JSS Lagged	NO	NO	**YES**	NO	NO	NO			
CTI	NO	NO	NO	NO	NO	NO	**YES**	NO	
CTI Lagged	NO	NO	NO	NO	NO	NO			
CSI	NO	NO	NO	NO	NO	NO	**YES**	NO	**YES**
CSI Lagged	NO	NO	NO	NO	NO	NO			

Table 3. Maryland spot commercial landings in pounds, 1929-2008, and recreational numbers harvested and released, 1981-2008. Shaded 2008 values are preliminary.

Year	Recreational Harvested	Recreational Released	Commercial Pounds
1929			117,557
1930			126,295
1931			100,526
1932			47,877
1933			30,527
1934			62,100
1935			18,000
1936			36,700
1937			27,600
1938			59,900
1939			171,200
1940			141,000
1941			141,000
1942			138,000
1943			
1944			186,803
1945			208,827
1946			129,328
1947			120,630
1948			111,950
1949			248,713
1950			100,725
1951			128,554
1952			420,098
1953			283,817
1954			258,178
1955			407,699
1956			300,502
1957			589,001
1958			593,120
1959			84,904
1960			498,376
1961			10,519
1962			26,900
1963			15,200
1964			33,900
1965			600
1966			4,100
1967			248,300
1968			45,600
1969			20,700
1970			572,600
1971			20,300
1972			73,700
1973			27,100
1974			37,000
1975			102,900
1976			16,400
1977			16,400
1978			31,300
1979			10,600
1980			6,265
1981	948,931	1,331,316	14,214
1982	2,864,603	1,677,415	6,154
1983	1,600,362	1,114,795	129,377
1984	904,793	1,150,599	43,318
1985	1,028,391	735,873	7,640
1986	3,789,796	2,720,343	104,373
1987	3,180,704	248,973	252,152
1988	277,964	716,258	57,975
1989	1,154,314	730,580	116,043
1990	2,120,655	1,811,434	103,991
1991	1,841,555	2,123,582	216,035
1992	1,671,897	493,597	255,010
1993	1,880,043	1,573,486	183,357
1994	1,761,701	1,037,498	149,889
1995	1,099,658	253,827	330,021
1996	591,300	208,897	89,149
1997	713,657	1,316,341	76,193
1998	1,327,259	633,914	261,523
1999	655,289	618,742	214,656
2000	1,389,505	1,080,310	137,438
2001	1,088,997	577,417	220,072
2002	690,515	501,111	127,914
2003	3,300,594	670,382	169,298
2004	1,375,285	577,223	177,914
2005	2,006,925	2,185,865	84,254
2006	2,644,537	1,467,344	37,774
2007	3,842,569	1,421,513	380,633
2008	2,339,846	2,049,836	89,674

Table 4. Maryland spot CPUE indices and number of 12 inch plus spot submissions to the citation program, 1980-2008. Shaded 2008 values are preliminary.

Year	Pound Net	Gill Net	MRFSS	Charter	# of Citations
1980	0.00	0.000			
1981	0.00	0.000	4.11		
1982	3.06	0.000	5.85		
1983	3.24	0.000	4.33		
1984	2.82	0.000	2.26		
1985			3.67		
1986			5.63		
1987			6.97		
1988			2.61		
1989			3.82		
1990	2.02	0.001	3.80		
1991			2.99		
1992	1.08	0.031	4.92		
1993	4.79	0.014	2.84	17.19	
1994	14.05	0.019	3.77	24.29	0
1995	12.94	0.025	4.12	23.45	3
1996	6.69	0.011	5.19	13.10	2
1997	4.72	0.013	2.02	19.09	3
1998	7.92	0.022	3.31	21.99	1
1999	8.89	0.016	2.24	17.53	35
2000	7.66	0.024	2.58	18.89	
2001	13.00	0.040	3.07	14.57	101
2002	10.50	0.055	3.50	16.42	141
2003	19.79	0.031	7.27	18.09	129
2004	9.89	0.050	3.49	15.07	70
2005	17.17	0.025	3.73	19.06	10
2006	7.90	0.026	4.93	22.73	4
2007	3.46	0.023	4.85	19.04	0
2008	10.55	0.027	3.57	19.60	2

Index	Units
Pound Net	Pounds per Trip
Gill Net	Pounds per Yard Hour of Net
MRFSS	Fish per Trip
Charter Boat	Catch per Angler

Table 5. Mean total length (mm), standard deviation, and sample size of spot from Maryland Chesapeake Bay pound nets, 1993-2008.

Year	Mean Length (mm)	Standard Deviation	Number Sampled
1993	184	28	309
1994	207	21	451
1995	206	28	158
1996	235	28	275
1997	190	35	924
1998	230	16	60
1999	213	25	572
2000	230	21	510
2001	239	33	126
2002	184	36	681
2003	216	30	1,354
2004	208	36	882
2005	197	37	2,818
2006	191	29	2,195
2007	208	23	519
2008	198	21	1195

Table 6. Catch at age for the Maryland commercial spot fishery in Numbers and pounds, 1989-2007.

Catch numbers

	0	1	2	3	4	5	6
1998	42,160	564,537	4,149	0	0	0	0
1999	42,454	601,572	30,044	218	0	0	0
2000	30,412	318,798	12,625	833	0	0	0
2001	146,954	322,849	39,596	5,639	98	0	0
2002	179,735	434,061	7,664	2,005	315	28	0
2003	38,329	474,372	17,230	1,254	469	54	0
2004	40,353	406,511	168,289	3,034	104	135	0
2005	15,450	237,502	32,221	6,777	98	15	55
2006	53,201	108,693	5,346	655	355	0	0
2007	0	902,367	518,556	26,085	1,366	0	0

Catch Pounds

	0	1	2	3	4	5	6
1998	15,140	243,804	2,308	0	0	0	0
1999	9,440	191,110	13,804	302	0	0	0
2000	5,483	125,278	6,091	586	0	0	0
2001	43,115	142,044	28,574	6,236	103	0	0
2002	28,212	93,458	4,302	1,658	255	28	0
2003	5,359	152,542	9,782	1,075	476	63	0
2004	5,584	98,742	71,336	1,971	125	155	0
2005	15,450	237,502	32,221	6,777	98	15	55
2006	9,173	25,815	2,227	316	244	0	0
2007	0	212,062	158,217	8,888	1,470	0	0

Table 7. Mean weight at age, in grams, of spot from Maryland commercial pound nets, 1989-2007.

	0	1	2	3	4	5	6
1998	162.9	195.9	252.4	0.0	0.0	0.0	0.0
1999	100.9	144.1	208.4	628.7	0.0	0.0	0.0
2000	81.8	178.2	218.8	318.8	0.0	0.0	0.0
2001	133.1	199.6	327.3	501.6	474.8	0.0	0.0
2002	71.2	97.7	254.6	375.0	367.4	448.0	0.0
2003	63.4	145.9	257.5	388.8	460.2	529.6	0.0
2004	62.8	110.2	192.3	294.7	545.7	520.1	0.0
2005	71.7	125.5	177.1	224.1	414.1	422.1	461.4
2006	78.2	107.7	188.9	218.6	311.3	0.0	0.0
2007	0.0	106.6	138.4	154.5	488.0	0.0	0.0

Table 8. Mean length at age in, centimeters, of spot from Maryland commercial pound nets, 1989-2007.

	0	1	2	3	4	5	6
1998	21.6	23.2	25.2	0.0	0.0	0.0	0.0
1999	19.0	21.4	24.0	34.5	0.0	0.0	0.0
2000	18.2	23.2	24.6	27.8	0.0	0.0	0.0
2001	21.2	23.9	28.0	31.7	31.5	0.0	0.0
2002	17.4	18.8	26.0	29.7	29.5	31.5	0.0
2003	16.5	21.5	26.3	29.9	31.8	33.5	0.0
2004	16.0	19.4	23.7	27.8	34.7	34.1	0.0
2005	16.7	20.5	23.4	25.2	31.7	32.3	33.4
2006	17.7	19.4	23.8	24.9	28.2	0.0	0.0
2007	0.0	19.9	21.8	22.7	32.5	0.0	0.0

Figure 1. Comparison of Maryland Chesapeake Bay juvenile spot geometric mean indices, 1980-2008.

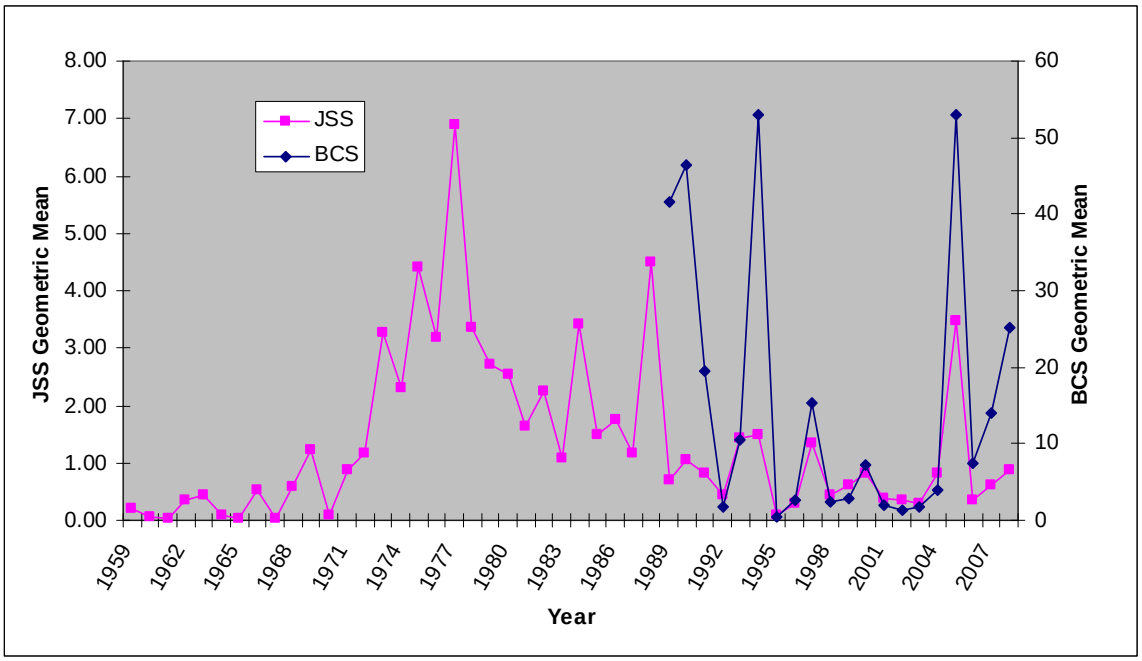


Figure 2. Comparison of Maryland Coastal Bay juvenile spot indices, 1972-2008. Both indices are geometric means (neither survey was standardized until 1989, indicated by the black vertical line).

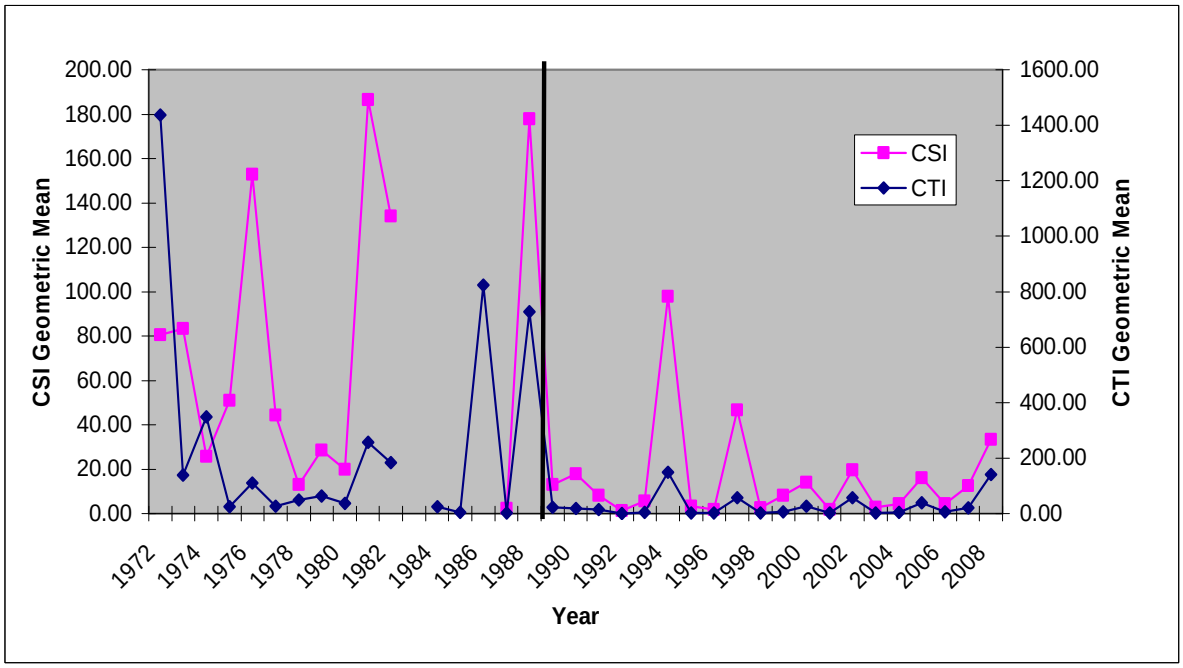


Figure 3. Maryland's spot commercial landings in pounds, 1929-2008. **2008 data are preliminary.**

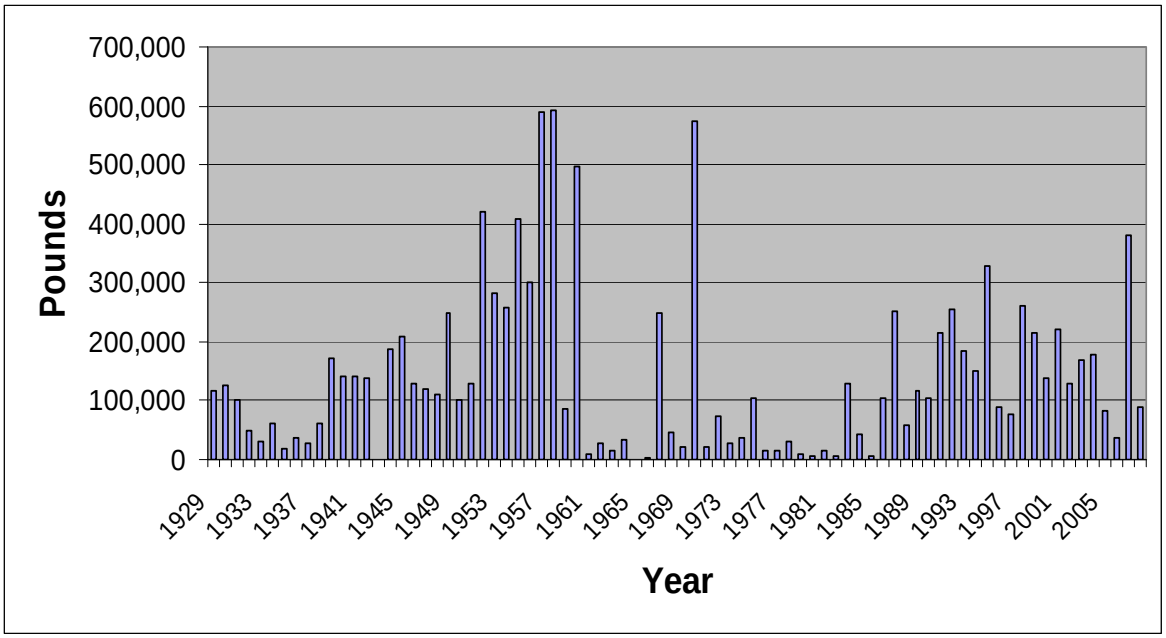


Figure 4. MRFSS estimates of Maryland spot harvest and releases, 1981-2008. **2008 data are preliminary.**

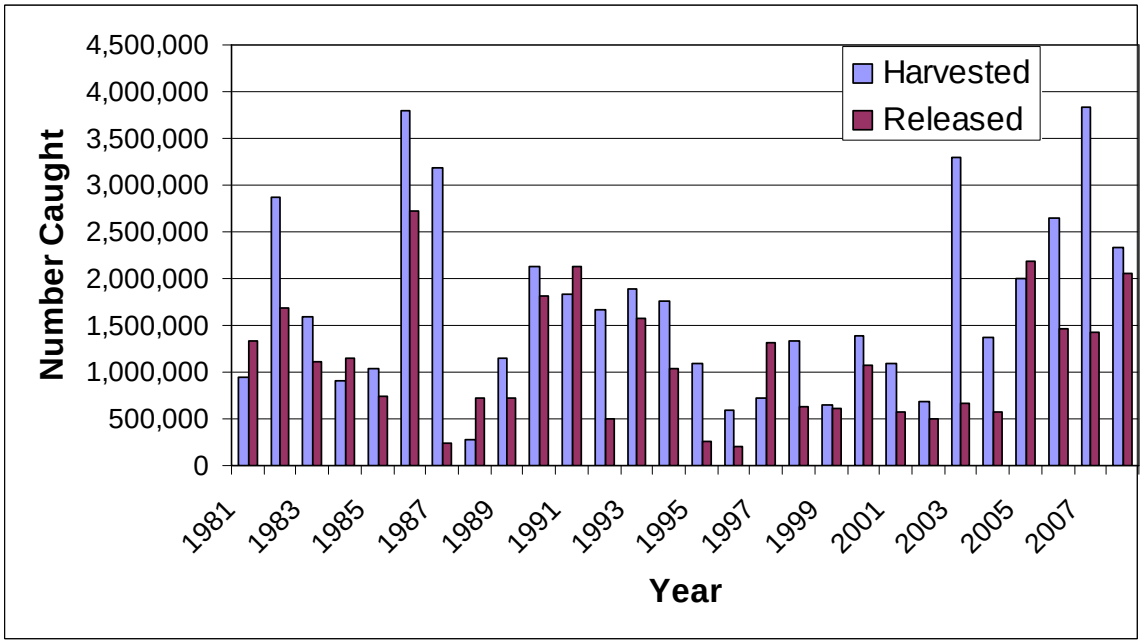


Figure 5. MRFSS estimates of Maryland spot harvest for all areas and inland waters, 1981-2008. **2008 data are preliminary.**

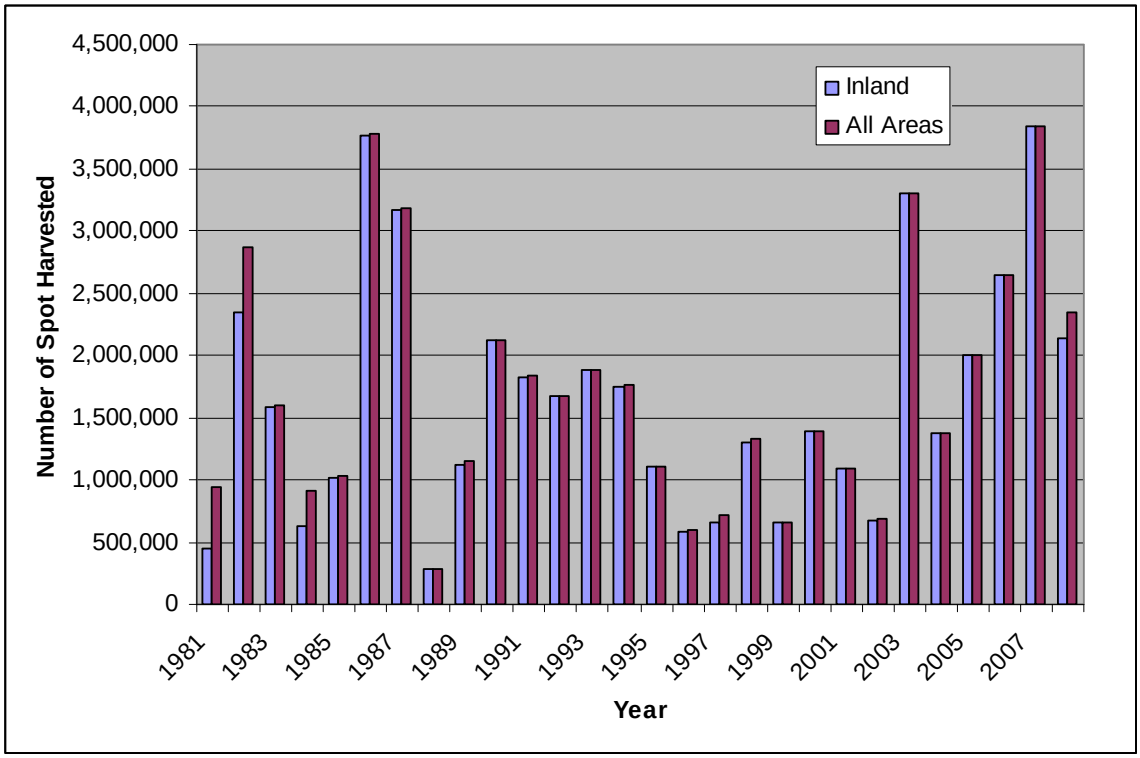


Figure 6. Price per pound, in 2007 dollars, for spot sold in Maryland, 1980-2007.

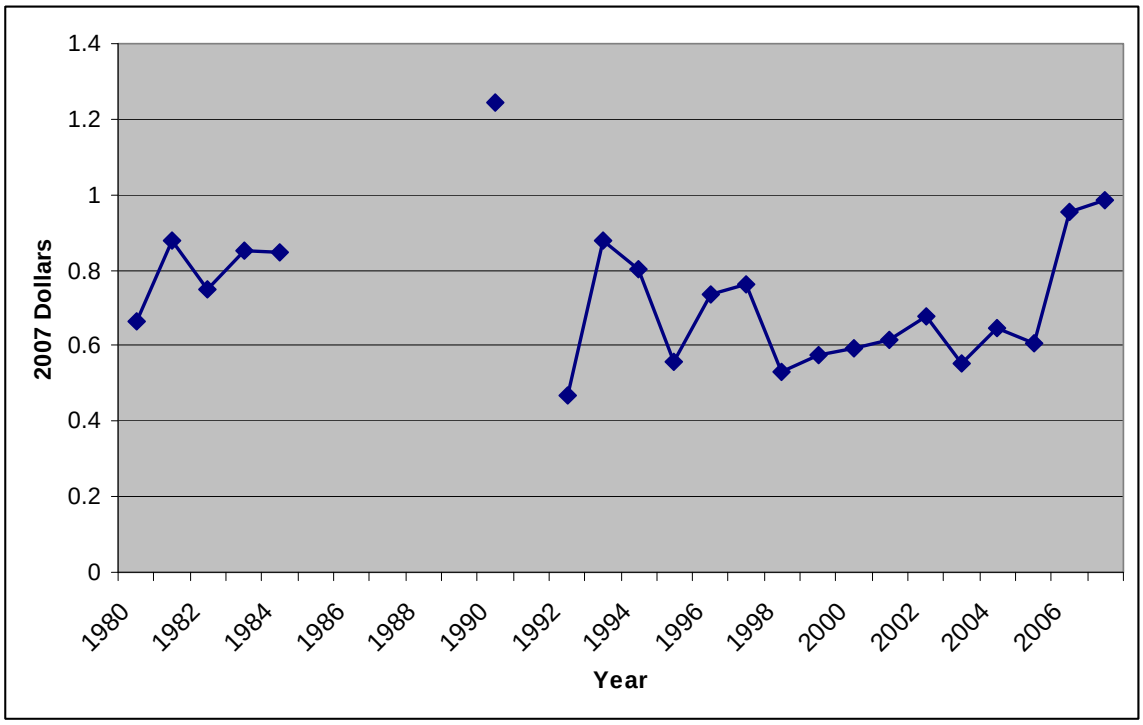


Figure 7. Gill net effort in trips and net yard hour, 1990-2008, excluding years where effort was unavailable or equal t zero. 2008 data is preliminary.

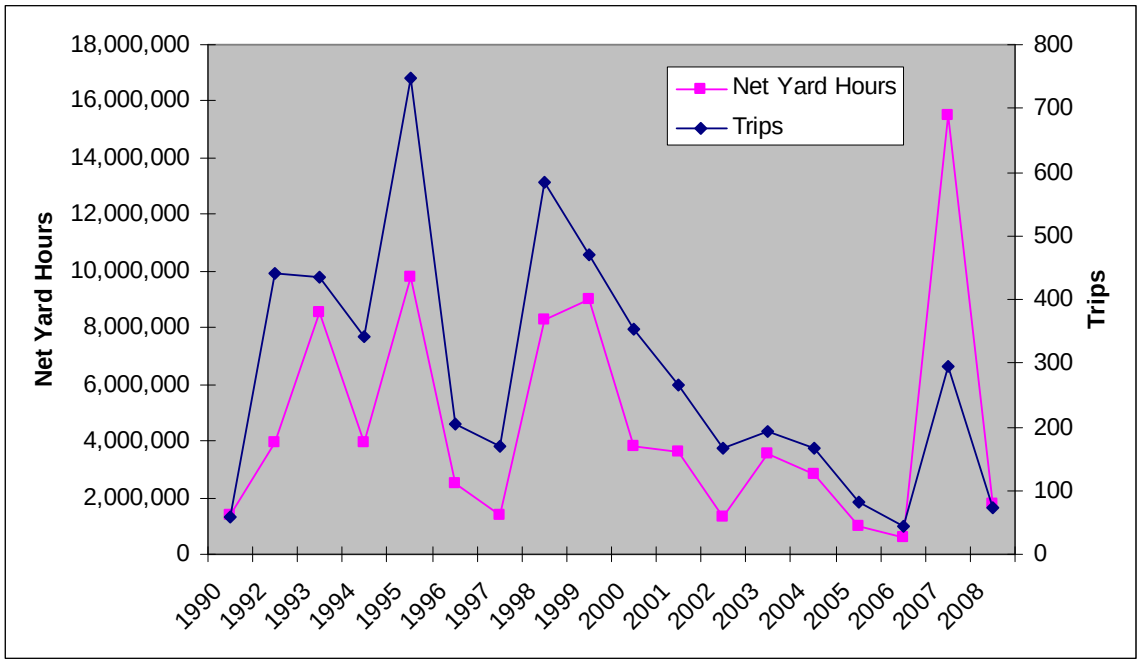


Figure 8. Gill net CPUE using catch per trip and catch per net yard hour, 1990-2008, excluding years were effort was unavailable or equal t zero. 2008 data is preliminary.

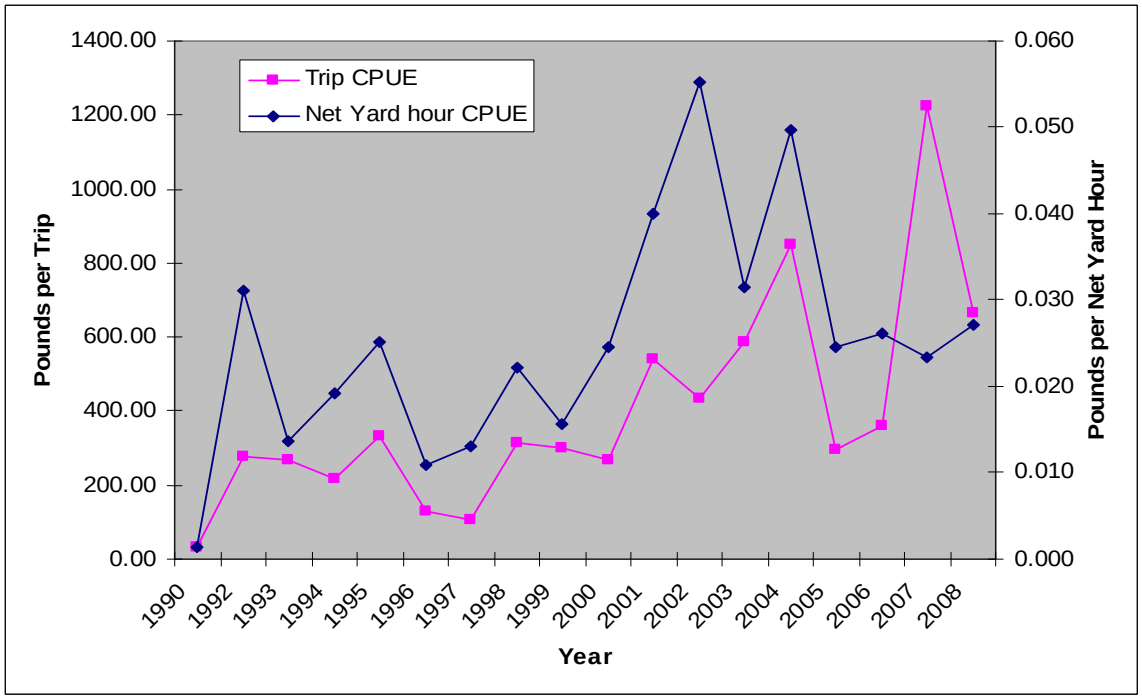


Figure 9. Maryland commercial spot gill net CPUE index, 1980-2008, excluding years were effort was unavailable. 2008 data is preliminary.

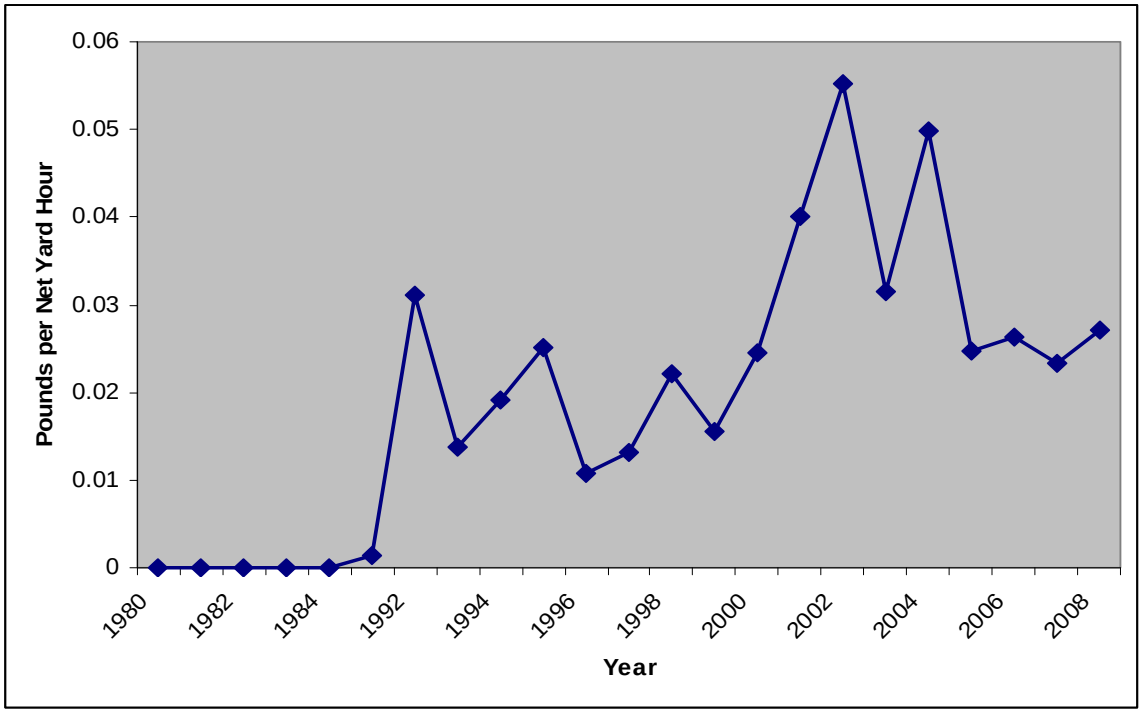


Figure 10. Maryland gill net catch and effort used in the derivation of the gill net CPUE, 1980 – 2008, excluding 1985-1989 and 1991.

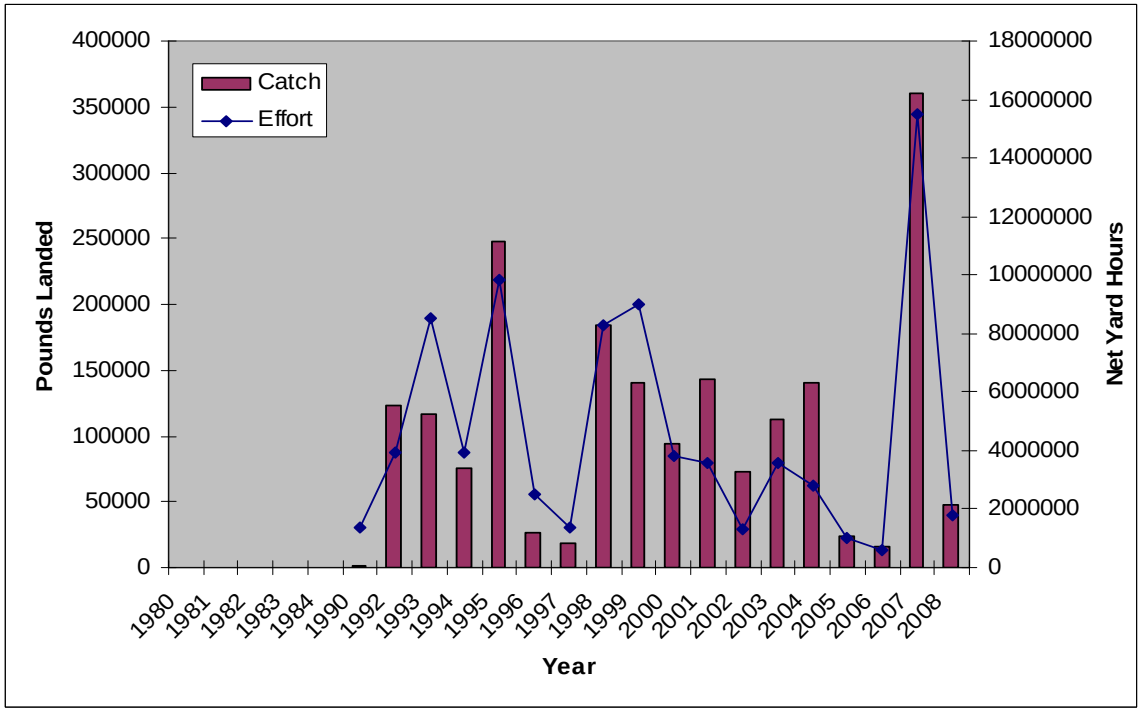


Figure 11. Maryland commercial pound net CPUE index, 1980-2008, excluding years were effort was unavailable. 2008 data is preliminary.

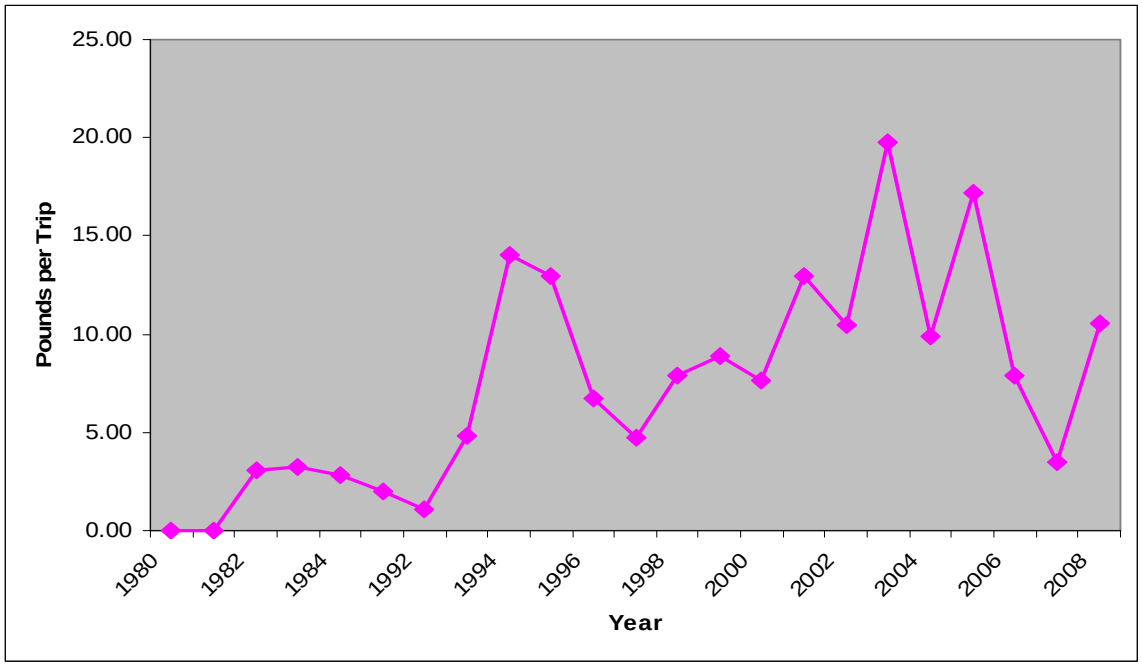


Figure 12. Maryland pound net catch and effort used in the derivation of the pound net CPUE, 1980 – 2008, excluding 1985-1989 and 1991.

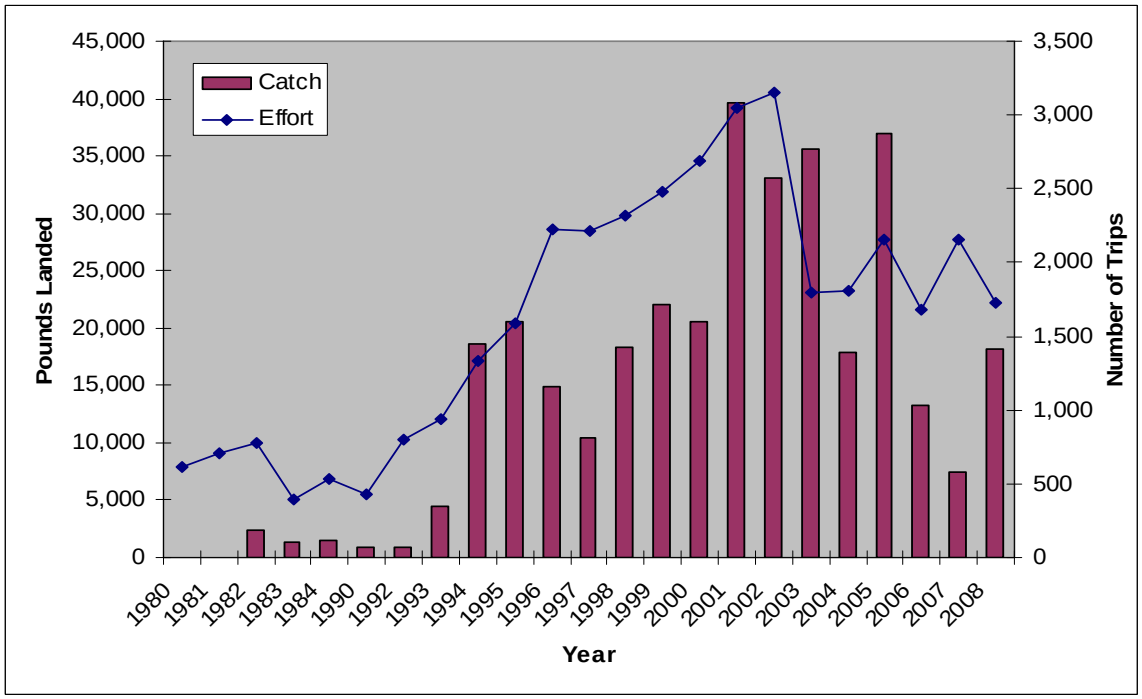


Figure 13. Maryland commercial spot pound net and gill net CPUE indices, 1980-2008, excluding years were effort was unavailable. 2008 data is preliminary.

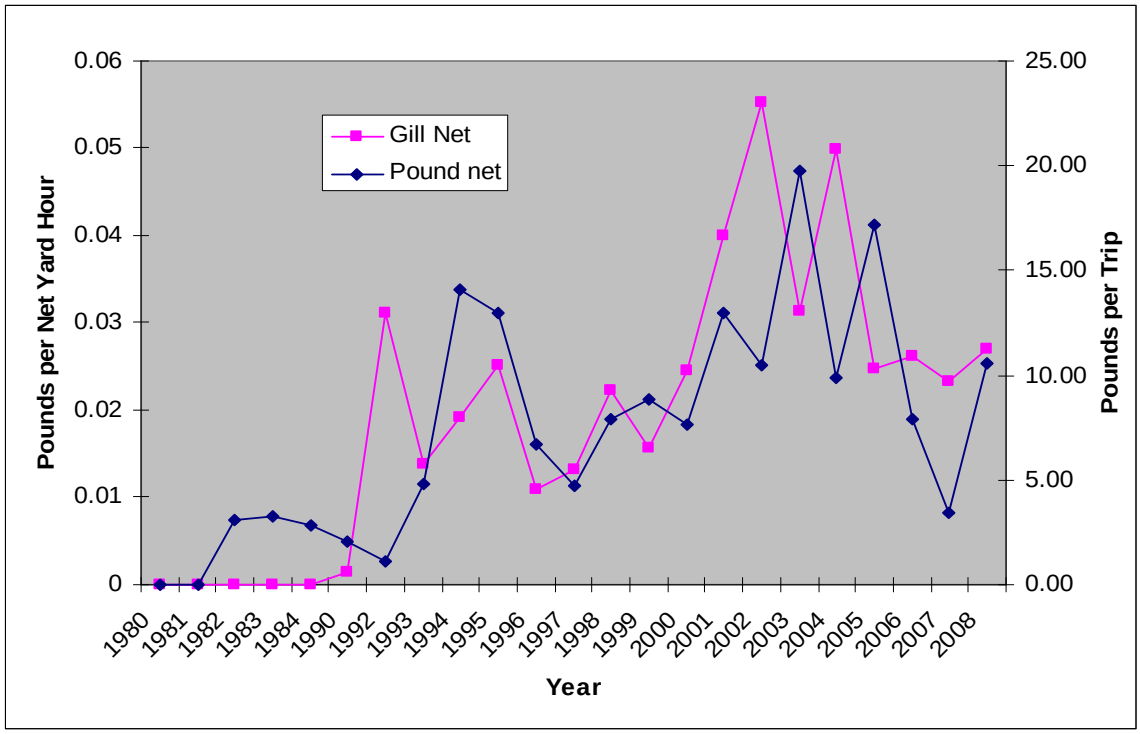


Figure 14. Maryland charter boat CPUE, 1993-2008 and inland MRFSS CPUE, 1981-2008.

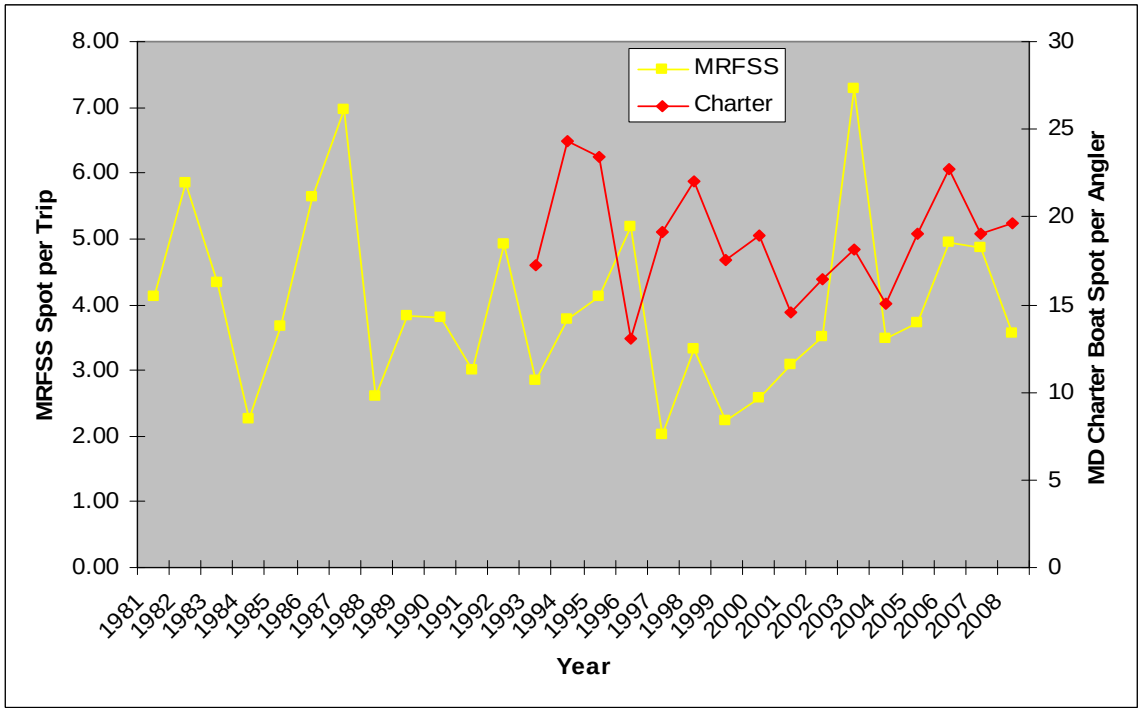


Figure 15. Spot length frequency distributions from pound nets, 2005-2008.

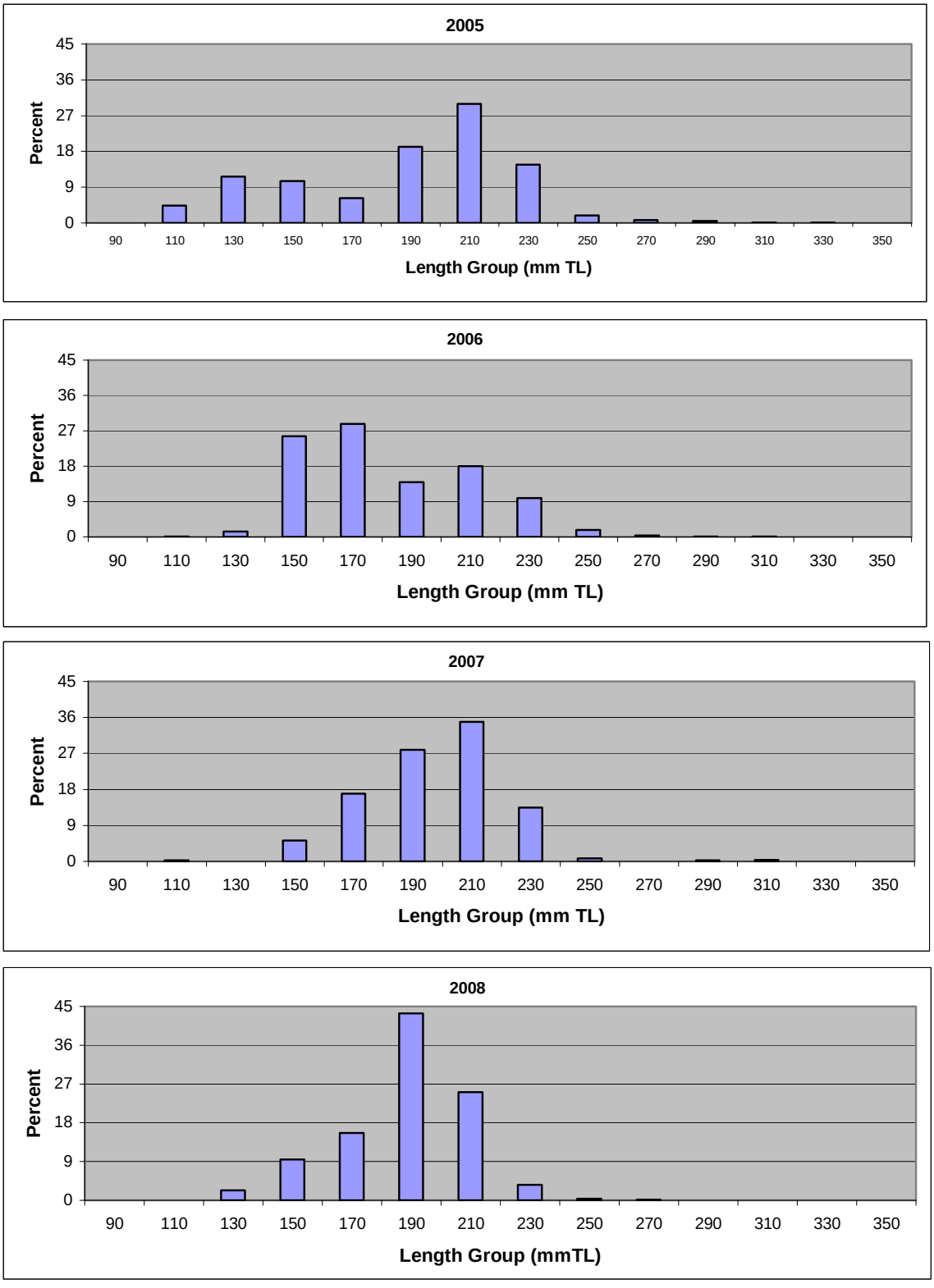


Figure 16. Spot catch at age in pounds for Maryland's commercial fishery, 1998-2007.

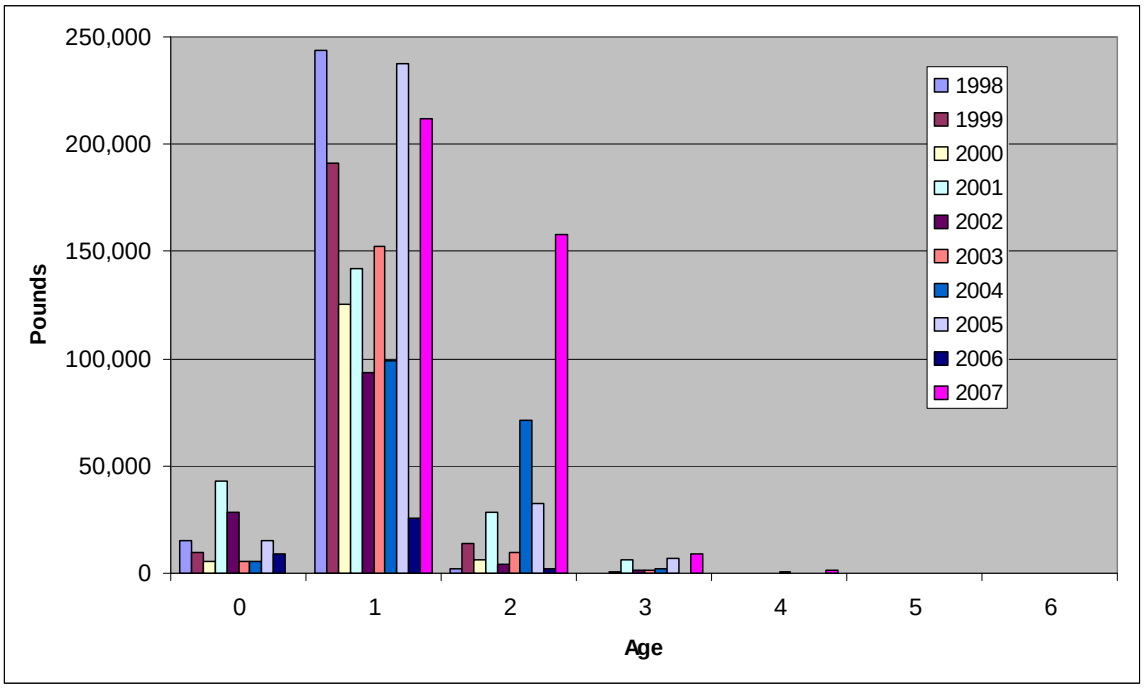


Figure 17. Spot catch at age in numbers for Maryland's commercial fishery, 1998-2007.

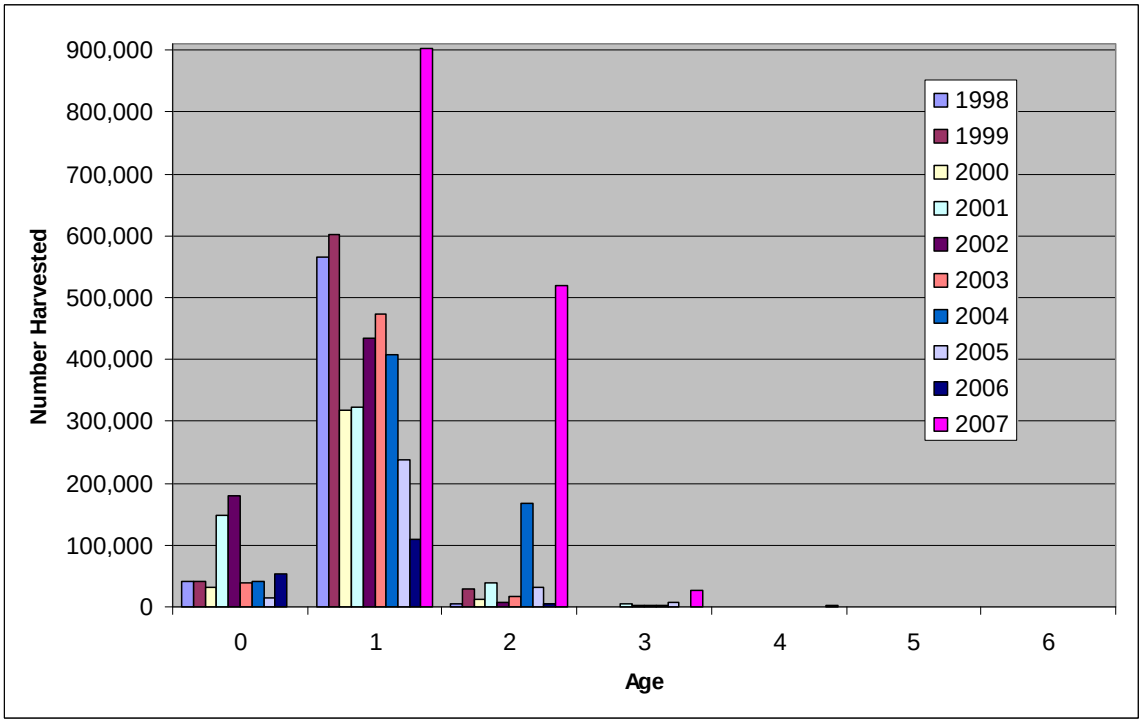


Figure 18. Spot mean weight at age in grams for Maryland's commercial pound net fishery, 1998-2007.

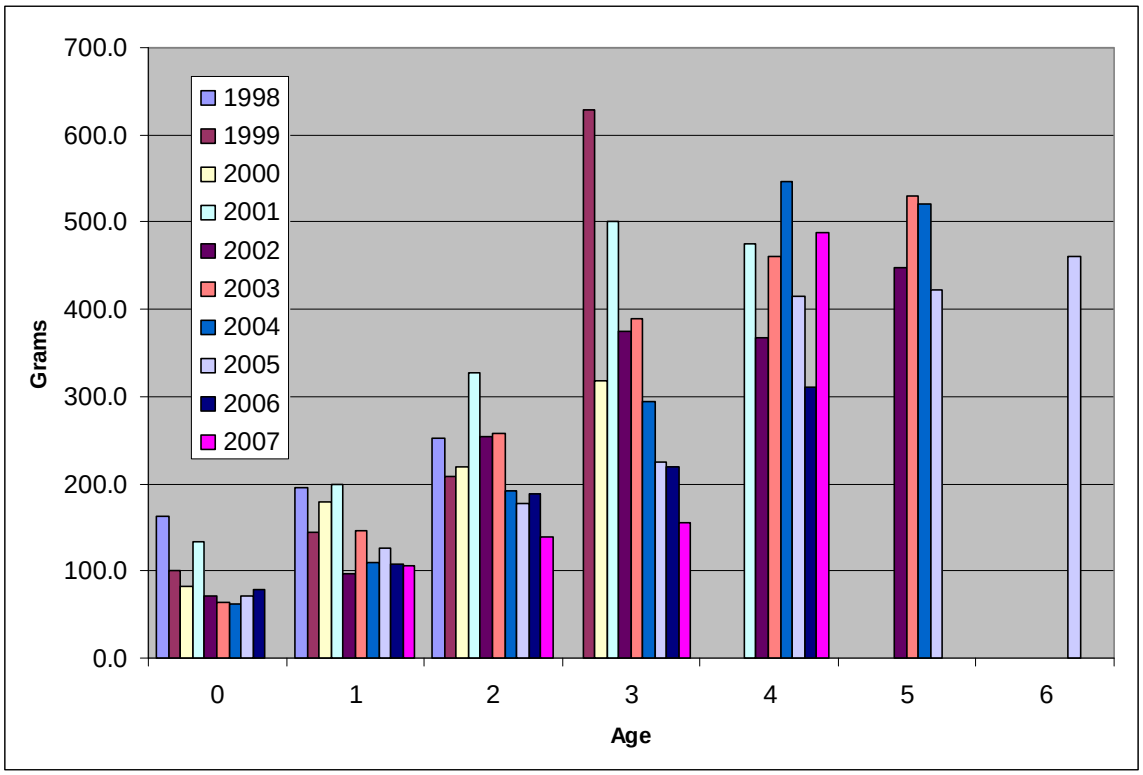
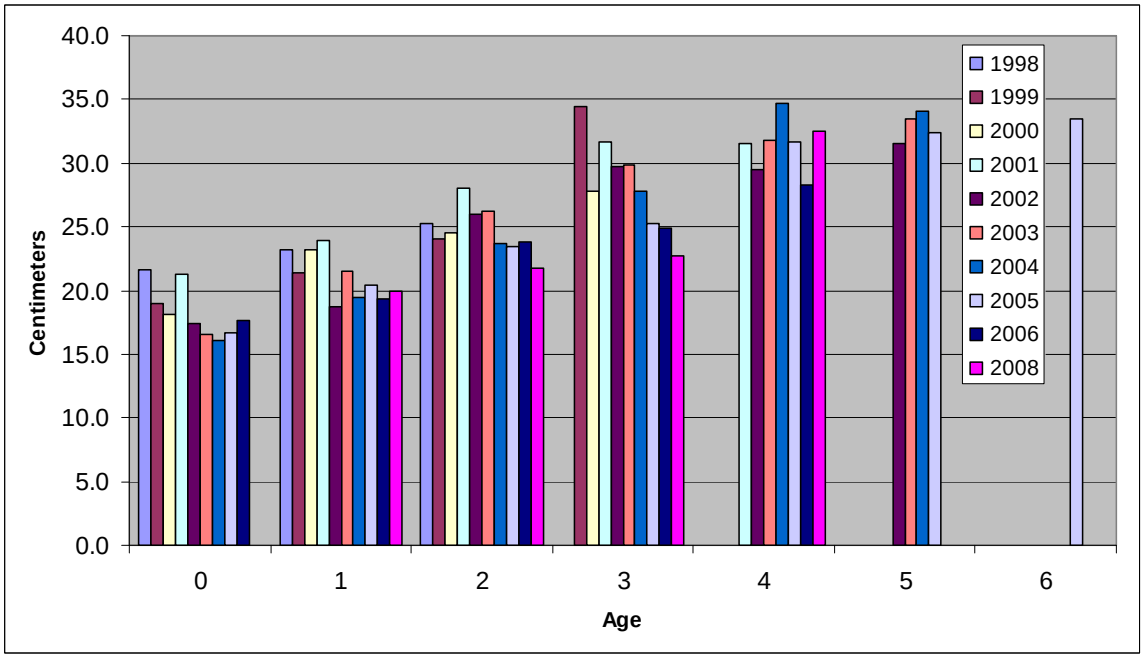
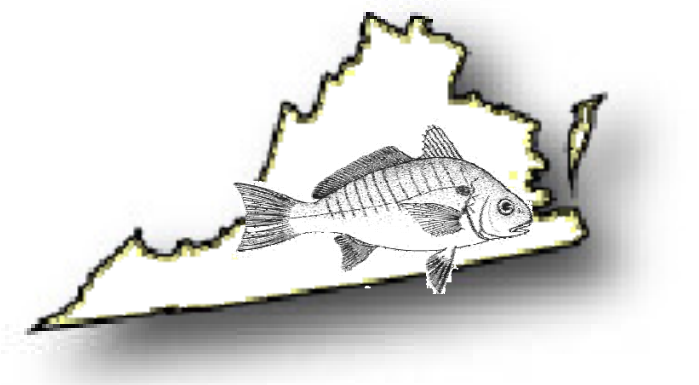


Figure 19. Spot mean length at age in centimeters for Maryland's commercial pound net fishery, 1998-2007.



Annual Monitoring Report for Spot, *Leiostomus xanthurus*, Occurring in Virginia Waters



Report to the Atlantic States Marine Fisheries Commission

April 2009

Prepared by:

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Introduction

The Atlantic States Marine Fisheries Commission's (ASMFC) South Atlantic Board requested that the Spot Plan Review Team (PRT) review and update available data relevant for the spot resource. This report summarizes data specific to the state of Virginia and includes data through 2008 where possible.

Management

The Virginia Marine Resources Commission (VMRC) currently has no regulations governing commercial or recreational fisheries for spot in Virginia's marine waters.

Fishery-Dependent Monitoring

Commercial Fishery

Commercial fisheries data were obtained from the VMRC's mandatory reporting database. Note that 2008 estimates of commercial harvest are considered preliminary and should be interpreted with caution.

Virginia's commercial fisheries have harvested an average of over 3.3 million pounds of spot from 1994 through 2008 (Table 1). Commercial harvest has ranged from a high of almost 4.5 million pounds in 1998 to a low of 1.8 million pounds in 2008 over this time period. Commercial harvest in 2008 was the lowest on record for these years, though the 2008 estimate is still considered preliminary. The majority of commercial harvest of spot has been taken by gill nets (including anchor, drift, and staked), accounting for 83% of the harvest between 1994 and 2008 (Table 2). Gill net harvest of spot ranged between 2.5 and 3.7 million pounds from 1994 through 2004, and then decreased to 2.1 and 1.6 million pounds in 2005 and 2006, respectively. Commercial harvest by gill nets in 2007 was similar to values prior to 2005, bringing in an estimated 2.9 million pounds of spot. However, gill net harvest in 2008 decreased to 1.2 million pounds. Recall that 2008 estimates of commercial harvest are considered preliminary. From 1994 to 2008, haul seines accounted for 10% (0.3 million pounds per year) of the commercial harvest while pound nets accounted for 6.5% (0.2 million pounds per year) of the commercial harvest. Commercial harvest of spot by all other gear types has been variable from 1994 through 2008, though the trend has been generally increasing since 1994. All other commercial gears accounted for less than 0.20% (~ 5.5 thousands pounds per year) of spot commercial harvest for this time period.

The VMRC Biological Sampling Program collects biological data from Virginia's commercial fisheries. Fish samples are measured and weighed and selected species are further processed for ageing. Age data are available from 1998 to 2008, though 2008 data are considered preliminary. The age distribution of spot in Virginia's commercial catches was estimated using samples from all gears. Spot ranging in age from 0 to 6 have been observed in Virginia's commercial harvest during the available time series (Table 3). The commercial harvest has been dominated by age-1 spot for most of the time series.

Estimates of average length at age and average weight at age were calculated using data collected from commercial gill nets, haul seines, and pound nets by gear. Sample sizes for fish aged 0 and aged 4–6 were typically small and so biological characterizations for these ages should be interpreted with caution. Trends in average weight of age-1 spot sampled

from the commercial gill net fishery were variable over the time series (Table 4). The biological samples demonstrated evidence of a decline in the average weight of age-2 and -3 spot harvested by gill nets from 2001 through 2008. The average weight of spot aged 1 through 3 sampled from commercial haul seines decreased over the time series (Table 5). Spot samples collected from commercial pound nets showed a decline in the average weight of age-2 and -3 fish from 2001 through 2007, but an increase in average weight for both ages was observed in 2008 (Table 6). Age-1 spot sampled from pound nets demonstrated an overall decrease in average weight over the time series. The average length of spot sampled from commercial gill nets exhibited no apparent trend over time for fish aged 1 or 2 (Table 7). Samples from the gill nets suggested a slight decline in the average length of age-3 spot over the time series. The commercial haul seine data provided evidence of a slight decrease in the average length of age-1, -2, and -3 spot over the time period (Table 8). Age-3 spot sampled from the commercial pound net fishery exhibited a declining trend in average length from 2002 through 2007 (Table 9). No clear trend in average length was evident for age-1 or age-2 spot sampled from the pound nets.

Fishery-dependent indices of catch-per-unit-effort (CPUE) were developed for Virginia's commercial inshore gill net and haul seine fisheries. Directed trips for the commercial inshore gill net fishery were defined as those trips that harvested greater than or equal to 100 pounds of spot. The inshore gill net CPUE exhibited limited variability between 1994 and 2008 (Figure 1). The series ranged from a low of 582 pounds per directed trip in 2006 to a high of 1,010 pounds per directed trip in 1998. The haul seine CPUE has been slightly more variable than the inshore gill net CPUE over the time series. The highest values observed for the haul seine index occurred in the two most recent years—1,835 pounds per trip in 2007 and 1,555 pounds per trip in 2008.

Recreational Fishery

Recreational fisheries statistics for spot caught in Virginia waters were provided by the Marine Recreational Fisheries Statistics Survey (National Marine Fisheries Service, Fisheries Statistics Division, Silver Spring, MD, pers. comm.). Like the commercial data, recreational statistics for 2008 are considered preliminary and should be interpreted with caution.

Recreational fisheries have accounted for nearly 25% of the total harvest (commercial plus recreational Types A and B1) of spot in Virginia during 1994 to 2008 (Table 1). During this same time period, recreational harvest (Type A+B1) of spot averaged approximately 1.1 million pounds. The lowest annual recreational harvest on record during these years occurred in 1999, at just over 0.2 million pounds of spot. Since then, recreational harvest increased to nearly 2.5 million pounds harvested in 2007. Estimated recreational harvest of spot in 2008 was just over 2.0 million pounds.

Recreational indices of CPUE were developed by H. Rickabaugh (Maryland Department of Natural Resources, pers. comm.). The Virginia recreational CPUE series was calculated by dividing spot harvest (Type A+B1) in weight (pounds) by those trips targeting spot or trips that caught spot (Type A, B1, or B2). Only data collected from the private/rental and shore modes fishing in inland waters were used. Recreational harvest CPUE was variable from 1981 through 2008, ranging from a high of 3.2 pounds per trip in 1992 to a low of 0.6 pounds per trip in 1984 (Figure 2).

Fishery-Independent Surveys

The Virginia Institute of Marine Science (VIMS) initiated a fishery-independent survey of the Chesapeake Bay estuary in 1955 (VIMS, Gloucester Point, VA, pers. comm.). The Juvenile Fish and Blue Crab Survey is a trawl survey intended to monitor the distribution and abundance of important finfish and invertebrate species occurring in the Chesapeake Bay. The VIMS develops annual indices of abundance for age-0 spot to provide a measure of relative year-class strength. The Random Stratified Converted Index (RSCI) is based on post-stratification of gear and/or vessel, using all spatially appropriate data (T. Tuckey, VIMS, pers. comm.). The RSCI index has been highly variable throughout much of the time series (Figure 3). The index suggests spot year-class strength was relatively low between 1958 and 1961 and from 1992 to the present. The index demonstrated an increase from 2006 to 2008. The VIMS also calculates indices based on fixed stations within the bay and rivers (Bay and Rivers index) and based on fixed stations within the rivers only (Rivers Only index). Both of these indices suggest relative abundance of age-0 spot has been variable over time (Figure 4). Similar to the RSCI index, the Bay and Rivers and Rivers Only indices provide evidence that relative year-class strength was generally higher prior to 1992. Also, these indices give evidence of an increase over the most recent three years.

Table 1. Commercial and recreational harvest (pounds) of spot from Virginia waters, 1994–2008. Recreational harvest represents the sum of Type A and B1 catch, as defined by MRFSS. Note: 2008 data are preliminary.

Year	Commercial *(lb)*	Recreational *(lb)*	Total *(lb)*
1994	4,268,193	1,217,036	5,485,229
1995	3,603,408	1,067,637	4,671,045
1996	2,983,071	492,982	3,476,053
1997	3,493,774	1,263,447	4,757,221
1998	4,473,830	866,619	5,340,449
1999	3,041,923	244,499	3,286,422
2000	3,907,060	252,885	4,159,945
2001	3,355,974	523,202	3,879,176
2002	3,246,315	829,972	4,076,287
2003	3,712,212	875,729	4,587,941
2004	3,417,082	1,447,697	4,864,779
2005	2,489,122	1,434,965	3,924,087
2006	2,002,283	1,463,070	3,465,353
2007	3,901,364	2,467,311	6,368,675
2008	1,821,009	2,044,864	3,865,873

Table 2. Commercial harvest (pounds) of spot from Virginia waters by major gear type, 1994–2008. Note: 2008 data are preliminary.

Year	Gill Net [1] (lb)	Haul Seine (lb)	Pound Net (lb)	Other (lb)	Total (lb)
1994	3,721,348	299,903	245,806	1,136	4,268,193
1995	3,016,095	176,098	409,242	1,973	3,603,408
1996	2,450,148	339,417	192,782	724	2,983,071
1997	3,006,742	271,308	214,435	1,289	3,493,774
1998	3,717,845	463,721	283,748	8,516	4,473,830
1999	2,581,139	327,491	131,200	2,093	3,041,923
2000	3,400,402	337,492	165,633	3,533	3,907,060
2001	2,878,385	222,321	246,327	8,941	3,355,974
2002	2,794,296	227,947	220,612	3,460	3,246,315
2003	3,042,109	350,436	312,536	7,131	3,712,212
2004	2,958,072	246,556	209,798	2,656	3,417,082
2005	2,058,865	248,244	172,675	9,338	2,489,122
2006	1,644,175	275,694	77,598	4,816	2,002,283
2007	2,959,709	734,123	193,460	14,071	3,901,364
2008	1,190,802	438,639	179,157	12,411	1,821,009

Table 3. Catch-at-age (numbers) of spot harvested by Virginia's commercial fisheries, 1998–2008. Note: 2008 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	494,492	9,584,122	174,887	0	0	0	0
1999	169,937	6,724,036	884,141	0	0	0	0
2000	11,046	7,673,785	658,017	153,991	19,806	0	0
2001	383,763	2,595,829	1,706,530	416,714	50,068	0	0
2002	162,572	4,428,114	1,009,336	524,113	197,720	14,133	0
2003	0	5,146,639	1,527,570	441,973	242,555	20,759	0
2004	0	971,396	5,327,039	347,663	21,151	23,137	1,025
2005	2,487	1,689,551	1,782,984	1,523,972	55,010	12,852	10,252
2006	75,275	3,151,106	1,240,574	289,068	126,965	0	0
2007	11,990	5,202,528	5,859,293	455,292	10,919	5,995	0
2008	11,142	3,119,014	1,436,110	218,047	10,654	0	0

[1] Gill nets include anchor, drift, and staked gill nets

Table 4. Average weight (pounds) at age of spot samples collected from Virginia's commercial gill net fishery, 1998–2008. Note: 2008 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	0.300	0.521	0.618				
1999		0.498	0.664				
2000		0.453	0.732	0.786	0.819		
2001	0.416	0.540	0.914	1.20			
2002	0.379	0.491	0.607	0.728	0.826	0.850	
2003		0.451	0.649	0.826	0.853		
2004		0.464	0.524	0.585		1.02	1.00
2005		0.526	0.667	0.677	0.756	0.983	0.930
2006		0.461	0.688	1.02	1.07		
2007		0.482	0.436	0.595		1.22	
2008		0.505	0.521	0.525	0.600		

Table 5. Average weight (pounds) at age of spot samples collected from Virginia's commercial haul seine fishery, 1998–2008. Note: 2008 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	0.360	0.453					
1999	0.170	0.499	0.735				
2000		0.478	0.502				
2001		0.527	0.848	0.987			
2002	0.230	0.312	0.660	0.753	0.885		
2003		0.354	0.485	0.660	0.695		
2004		0.258	0.507	0.666			
2005		0.284	0.419	0.556			
2006	0.142	0.342	0.392	0.500			
2007	0.059	0.257	0.311		0.769		
2008		0.290	0.365	0.469			

Table 6. Average weight (pounds) at age of spot samples collected from Virginia's commercial pound net fishery, 1998–2008. Note: 2008 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	0.780	0.530	0.695				
1999	0.280	0.334	0.595				
2000	0.219	0.442	0.610	0.466			
2001	0.290	0.481	0.827	1.08	1.07		
2002	0.213	0.375	0.649	1.02	1.02		
2003		0.335	0.539	0.823	0.743	0.949	
2004		0.380	0.510	0.803	1.02	0.852	
2005	0.270	0.272	0.518	0.747	0.930		
2006	0.216	0.275	0.391	0.503	0.618		
2007	0.100	0.421	0.433	0.402		1.04	
2008	0.122	0.215	0.796	0.943			

Table 7. Average length (inches) at age of spot samples collected from Virginia's commercial gill net fishery, 1998–2008. Note: 2008 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	8.27	9.67	9.87				
1999		9.55	10.6				
2000		9.52	11.1	11.8	11.8		
2001	9.09	9.81	11.7	13.0			
2002	8.66	9.86	10.8	11.9	12.5	12.4	
2003		9.46	10.9	12.1	12.3		
2004		9.15	10.4	11.2		13.0	13.4
2005		10.0	10.9	11.4	11.8	12.9	12.8
2006		9.48	10.7	12.4	12.7		
2007		9.81	9.54	10.5		13.7	
2008		9.84	10.2	10.0	10.3		

Table 8. Average length (inches) at age of spot samples collected from Virginia's commercial haul seine fishery, 1998–2008. Note: 2008 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	8.83	9.26					
1999	7.28	9.70	10.8				
2000		9.51	9.58				
2001		10.0	11.4	12.1			
2002	8.07	8.55	10.9	11.9	12.2		
2003		9.09	10.0	12.0	11.6		
2004		8.26	10.3	11.2			
2005		8.24	9.52	10.6			
2006	6.96	9.03	9.63	10.0			
2007	5.12	8.06	8.48		11.7		
2008		8.36	8.89	9.84			

Table 9. Average length (inches) at age of spot samples collected from Virginia's commercial pound net seine fishery, 1998–2008. Note: 2008 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	11.2	10.0	10.8				
1999	8.46	8.54	10.5				
2000	7.19	9.30	10.9	10.9			
2001	8.45	9.70	11.5	12.4	12.5		
2002	7.68	9.02	10.8	12.5	12.6		
2003		8.85	10.5	11.8	11.7	13.0	
2004		9.02	10.1	12.1	13.0	12.7	
2005	8.37	8.11	10.0	11.4	12.4		
2006	7.44	8.10	9.54	10.4	11.2		
2007	5.71	9.22	9.50	9.52		13.9	
2008	6.46	7.16	11.4	11.6			

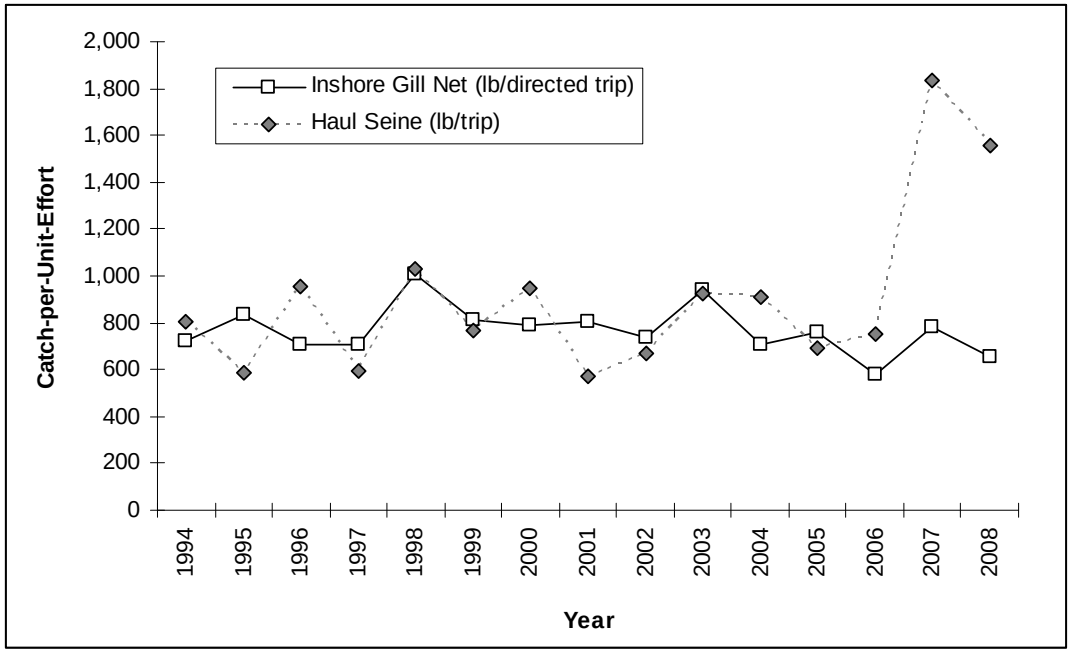

Figure 1. Catch-per-unit-effort (CPUE) of spot in Virginia's commercial inshore gill net and haul seine fisheries, 1994–2008. Directed trips for the commercial inshore gill net fishery were defined as those trips that harvested greater than or equal to 100 pounds of spot. Note: 2008 data are preliminary.

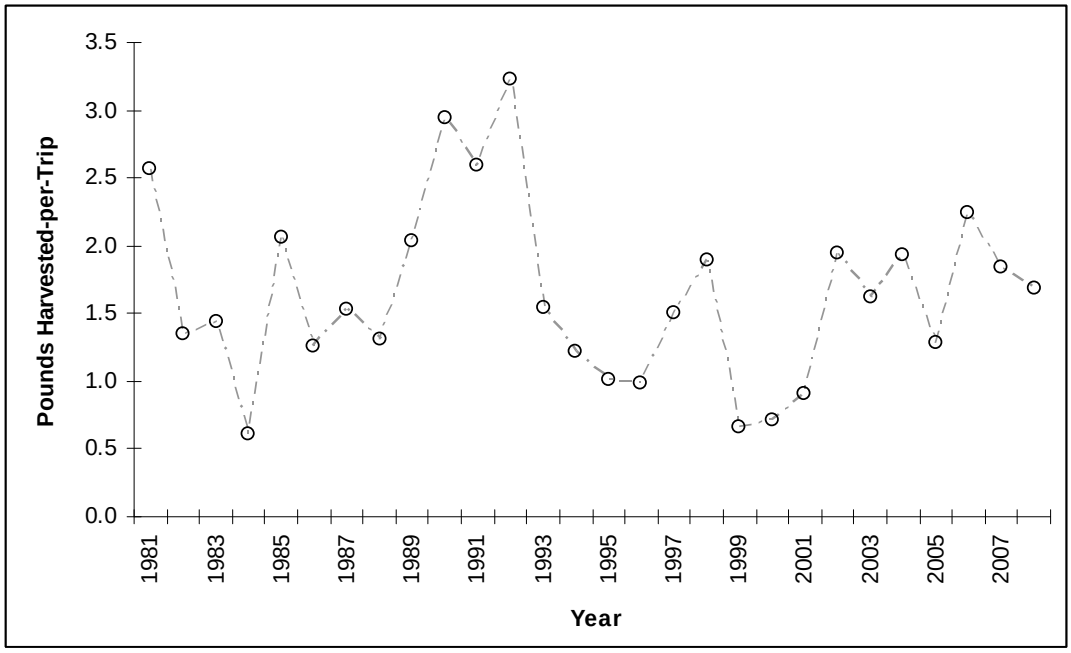

Figure 2. Catch-per-unit-effort (CPUE) of spot in Virginia's recreational fishery, 1981–2008. CPUE index computed using data from private/rental boat and shore modes in inland waters. Note: 2008 data are preliminary.

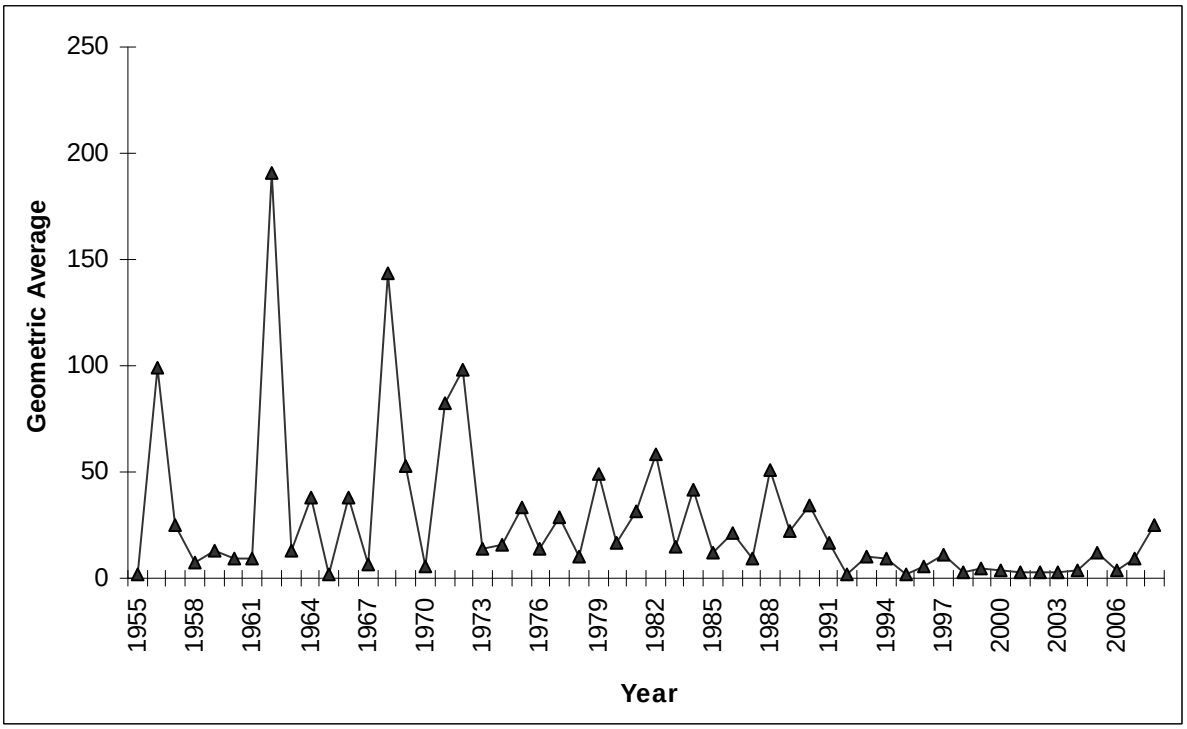

Figure 3. Annual index of juvenile spot relative abundance based on the VIMS Random-Stratified Converted Index (RSCI), 1955–2008.

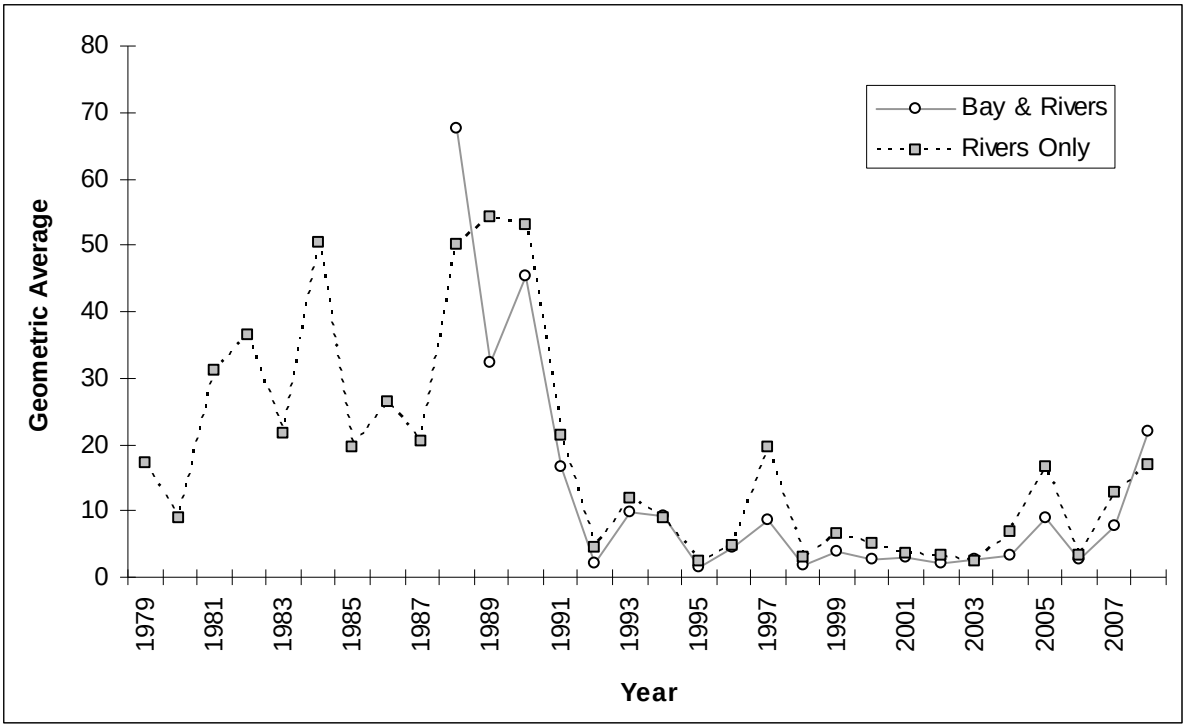

Figure 4. Annual indices of juvenile spot relative abundance based on the VIMS Bay and Rivers index (1988–2008) and the VIMS Rivers Only index (1979–2008).

SPOT HARVEST AND INDEX REPORT
FOR NORTH CAROLINA

A Report to the Atlantic States Marine Fisheries Commission

April 03, 2009
North Carolina Division of Marine Fisheries

Recent (1994-2008) Trends in North Carolina Commercial and Recreational Spot Fisheries

Dependent Data:

Commercial Harvest (North Carolina Trip Ticket Program (NCTTP)):

Data shown for 2008 are preliminary and will not be verified and finalized until later in April 2009.

- Commercial landings since 1994 have averaged 2.2 million pounds (Figure 1).
- Three major fisheries accounted for an average of 88.7% of landings, inshore gill net, ocean gill net and long haul (Figure 2) since 1994, and 94.8% for 2008.
- Since 1994 declines greater than 20% year to year occurred 5 of the 15 years, most recently in 2007 when harvest decreased 36%. There was a 16% decrease in 2008.
- Since 1994, effort has been decreasing in the ocean gill net fishery, with a 44% decrease from 2007 to 2008. Effort decreased slightly in the long haul fishery and declined quickly in 2006 and 2007 in the inshore gill net fishery. Effort increased by 61% in 2008 (Figure 3).
- The number of long haul trips has been consistent since 1999 but declined from 615 trips in 1994 to 327 trips in 2005, a decrease of 46.8%.
- Ocean gill net trips catching at least 100 lb steadily decreased from 952 trips in 1994 to 327 trips in 2005, a 64.3% decrease. Since 2001, the number of ocean gill net trips catching greater than 100 lb has been declining. There were 215 trips (> 100 lb) in 2008 (Figure 3).
- 2008 inshore gill net trips increased 61.3% year to year, long haul trips decreased 3.3 % year to year, and ocean gill net trips increased 43.7% while total commercial landings hit 15-year and historical lows, down 16.1% year to year.
- CPUEs in the long haul fishery were the lowest of the 15-year period and have decreased for 3 consecutive years. The CPUEs for the inshore gill net fishery were also the lowest of the 15-year period and have decreased for 4 consecutive years. The ocean gill net CPUEs have fluctuated the most, with CPUE values in 2008 the lowest of the 15-year period (Figures 4 and 5).

Recreational Angler Harvest Marine Recreational Fishery Statistics Survey (MRFSS):

Landings and Mean Catch Per Angler Trip - The mean catch per angler trip was examined from 1989 until 2008. It was calculated by summing Type A and Type B1 catch and dividing by the number of contributing fishermen at the interview level. Mean catch is the mean of A + B1 at the interview/trip level. Data shown for 2008 are preliminary and will not be verified and finalized until later in 2009.

- Landings in the recreational fishery have averaged 1.2 million lb (Figure 1).
- Landings in 2008 were 31.6% below the 1994-2008 mean and decreased 40.1% year to year.
- Fluctuations have been common, landings up > 100% in 2001 relative to 2000, down 45% in 2002.
- Mean catch per angler trip decreased from 11.4 fish per trip in 2007 to 7.4 fish per trip in 2008. The average catch per angler trip from 1989-2008 was 7.5 fish per trip (Figure 6).
- Trend line has a positive slope since 1989 indicating a slight increase in CPUE during the 18 year period.

Recreational Commercial Gear License (RCGL) Harvest (NC Marine Fisheries License and Statistics Section):

The RCGL allows recreational fishermen to use limited amounts of commercial gear to harvest seafood for their personal consumption. Seafood harvested under this license cannot be sold. Fishermen using this license are held to recreational size and possession limits. Data shown for 2008 are preliminary and will not be verified and finalized until later in 2009.

- NCDMF began to gather data in 2002 on RCGL license holders and spot landings have averaged 203,383 lb since 2002.
- Landings increased 7.8% from 2007 to 2008 (Figure 7), while trips increased 3.6%.CPUE (pounds/trip) also increased slightly in 2008, from the lowest on record in 2007.
- CPUE (pounds/trip) were consistent 2002-2005 but significantly decreased in 2006 and 2007 (Figure 8).

North Carolina Citation Program

North Carolina awards a citation to applicants for any spot caught by hook and line if weight exceeds 1 lb.

- Low citation years, 1994-1999, year with highest number citations was 1999 with ten.
- Beginning in 2000, many more citation sized fish applications were received, 19 in 2000, 249 in 2001, and 81 in 2005 but there were only two citations received in 2007 and none in 2008 (Figure 9).

Independent Data:

Pamlico Sound Survey - Program 195:

Fifty-two randomly selected stations (grids) are sampled in June and again in September. Stations are randomly selected from strata based upon depth and geographic location. Randomly selected stations are optimally allocated among the strata based upon all previous sampling in order to provide the most accurate abundance estimates (PSE <20). Tow duration is 20 minutes; utilizing double rigged demersal mongoose trawls (9.1-m headrope, 1.0-m X 0.6 m doors, 2.2 cm bar mesh body, 1.9 cm bar mesh cod end and a 100-mesh tailbag extension.

- Data from this survey were used to produce juvenile abundance indices for spot from 1994 to 2008 (Figure 10).
- CPUEs have been extremely variable with no clear trend.
- Most recent year (2008) showed a significant increase over 2007.

Estuarine Trawl Survey - Program 120:

Data has not been completed for 2008 and are unavailable at this time. One hundred five estuarine core stations along the coast are sampled each year without deviation to produce the JAI. Used is a two-seam 10.5 foot headrope trawl with a ¼ inch mesh in the body and 1/8 inch mesh in the tailbag. Tow duration is calibrated for 1 minute and a span of 75 yards.

- Data from this survey were used to produce JAIs for spot from 1994 to 2007 (Figure 11).
- These data also show wide fluctuations with no clear trend.
- CPUE in 2007 also showed a significant increase over 2006 and reversed a two-year decline in juvenile CPUEs.

Independent Gill Net Survey - Pamlico Sound:

This study began in 2001 and employs a stratified-random sampling design based on area and water depth. An array of nets consisting of 30-yard segments of 3, 3½, 4, 4½, 5, 5½, 6, and 6½ inch stretched mesh webbing is set. Catches from an array of gill nets comprise a single sample and two samples (one shallow, one deep), totaling 480 yards of gill nets fished, were completed in a trip. Within a month, 32 core samples were completed (8 areas x twice a month x 2 samples). Data are used to calculate annual indices of abundance for Pamlico Sound for the following target species: Atlantic croaker (*Micropogonias undulatus*), bluefish (*Pomatomus saltatrix*), red drum (*Sciaenops ocellatus*), southern flounder (*Paralichthys lethostigma*), spot (*Leiostomus xanthurus*), weakfish (*Cynoscion regalis*), spotted seatrout (*Cynoscion nebulosus*), and striped bass (*Morone saxatilis*).

- Adult spot CPUE trends decreased each year from 2004 to 2007 and leveled off in 2008 (Figure 12).
- CPUE highest in 2001, lowest in 2007 and 2008.

- Number of spot captured ranged from 2,260 in 2001 to 411 in 2007.

Aging Data:

Data has not been completed for both 2007 and 2008 and are unavailable at this time. Catch at Age for the Three Major Commercial Fisheries

- The dominant age classes in the ocean gill net, inshore gill net and the long haul fisheries are age I and age 2 (Figures 13,14 and 15).
- Very few age 0 fish are landed in these fisheries.
- Proportion of older fish (3 and 4) showed little change.

Discussion

Spot commercial landings in North Carolina's major fisheries (long haul, ocean gill net and inshore gill net) have declined significantly since 2004 and commercial landings in 2008 were at historical low. Effort, measured by trips has continued to decrease in the ocean gill net and long haul fisheries and part of this decrease is probably due to the lack of availability of the fish. The number of trips in the inshore gill net fishery during 2008 increased approximately 61% from 2007. CPUEs in the inshore gill net fisheries in 2008 were the lowest on record for both the inshore and ocean gill net fisheries. Pounds landed in the long haul fishery were at a historical low and the numbers of trips in this fishery also were at historical lows. However, it must be noted that CPUEs in the long haul fishery have been the most consistent of the major fisheries over the last ten years and decreases in landings are probably more a result of fewer long haul sets.

Both landings and CPUEs (mean catch/angler) decreased in the recreational hook and line fishery in 2008. Preliminary data indicates the spot hook and line catch decreased 40.1% in 2008 and was 31.6% below the 15-year average. Additionally, the mean catch per angler trip also decreased in 2008, but was only 1% below the 15-year average mean hook and line catch. These data are difficult to interpret relative to the apparent scarcity of fish available to the commercial fishers. The year 2007 marked the first year that the recreational harvest exceeded the commercial harvest, 2008 saw a similar trend, but the difference was nominal. Landings and trips in the Recreational Commercial Gear License fishery also decreased in 2007 reflecting the same theme of fewer adult fish available to fishers.

Juvenile abundance indices fluctuated much over the study period, a trend that is not remarkable for short-lived species such as spot. CPUEs in the Pamlico Sound Survey and the Estuarine Trawl Survey decreased in 2005 and 2006, similar to JAI dips between 1996 and 1998. However, there was an increase in 2007 and preliminary data from 2008 also indicated an increase in the juvenile indices in the Pamlico Sound and the coastwide Estuarine Trawl Survey.

The CPUE values for the Pamlico Sound adult gill net survey have trended down since the highest value in the first year of the study (2001). The CPUE value in 2007 and 2008 remained unchanged and were the lowest since the survey began and confirms the lack of adult fish available during the fishing year. This survey was expanded to the southern portion of the state in 2008 and these additional data will be

used in the future to generate a more comprehensive adult index once a time series is established.

Recent decreases in most of the indices and in the commercial landings cause concern and seem to reflect a slow gradual decrease in abundance of spot that appears to have accelerated in 2006, 2007, and 2008. The life history of spot suggests that year class strength is often determined by environmental conditions that prevail on spawning grounds and nursery areas and fluctuations in year class strengths are to be expected.

[The following three paragraphs are not updated from the previous year's report.] The catch at age in the major commercial fisheries indicate that landings in most years consist largely of only two age classes (Age 1 and 2). The strength of a given year class is most likely dependent on recruitment which is based on environmental factors. Since spot are such an estuarine dependent species, water quality/habitat degradation issues may be significantly impacting year class strengths. Coastwide development has placed many anthropogenic perturbations on their nursery areas including water quality stresses from both pollutants and freshwater runoff.

Data indicate that spot are a large component in the total biomass of south Atlantic shrimp trawlers. Studies need to be conducted to determine what effect, if any these bycatch mortalities may be having on these short-lived, high natural mortality fish. Currently, the effect of spawning stock size on recruitment is unknown.

The increasing CPUEs in the juvenile indices for 2007 and the increases in the recreational mean catch per angler are encouraging. However, these increases were offset by another 2007 decrease in commercial landings, a decrease in the adult abundance index and a decrease in RCGL landings.

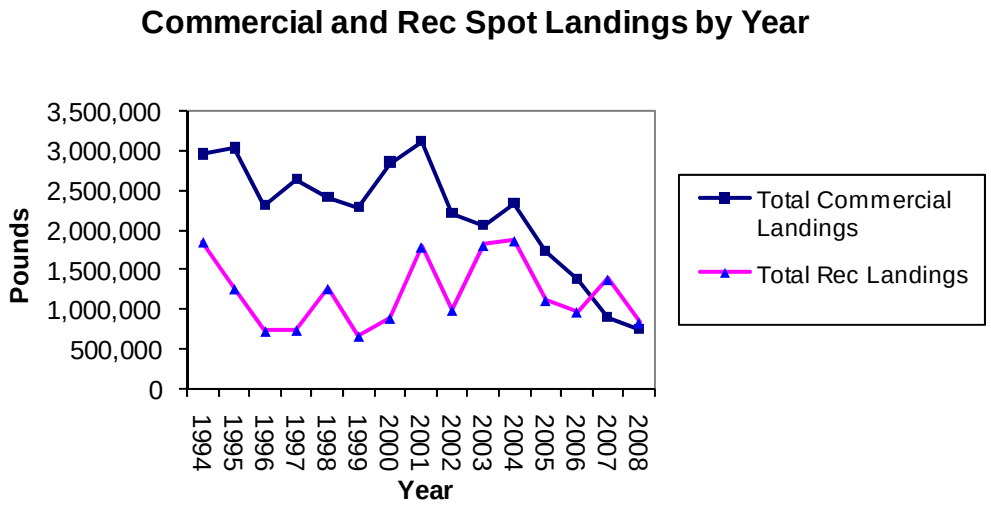

Figure 1. North Carolina commercial and recreational landings, 1994-2008.

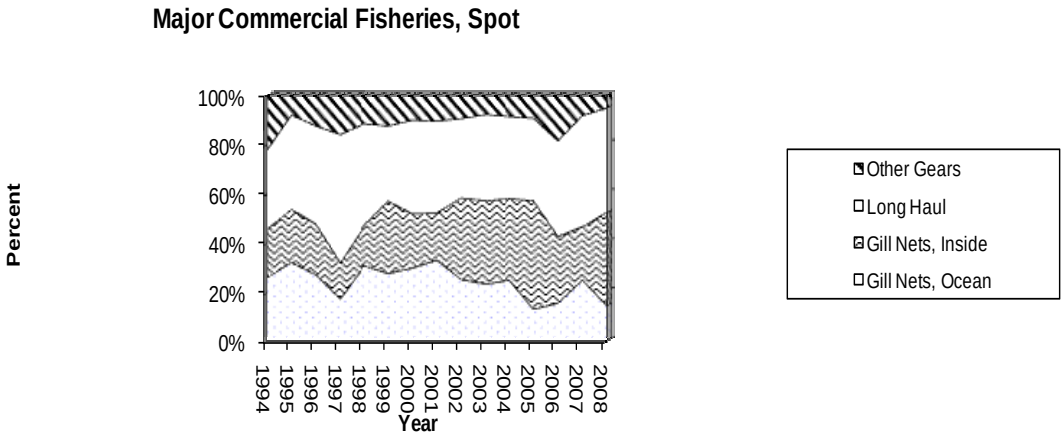

Figure 2. Major commercial gears capturing spot, 1994-2008.

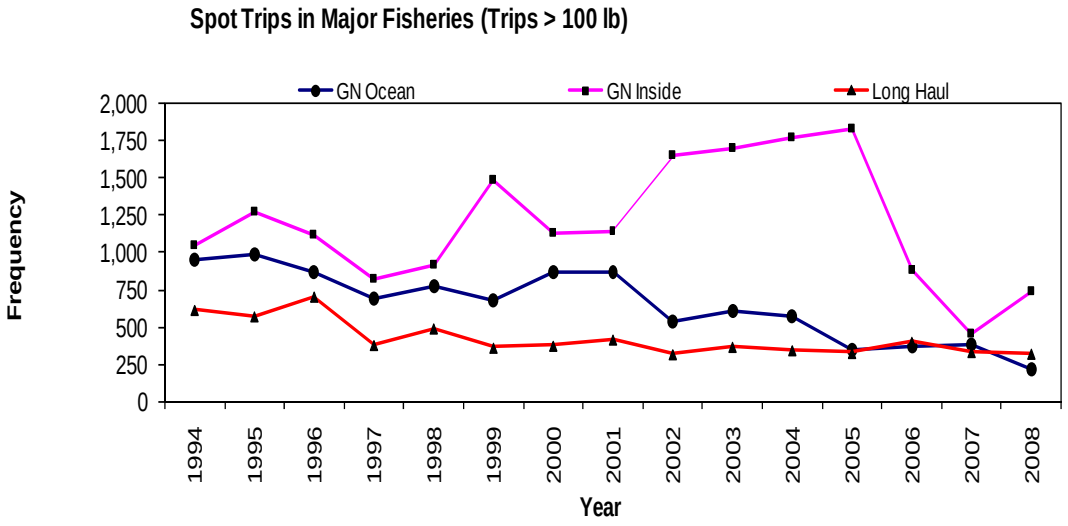

Figure 3. Spot trips in major North Carolina commercial fisheries, 1994-2008.

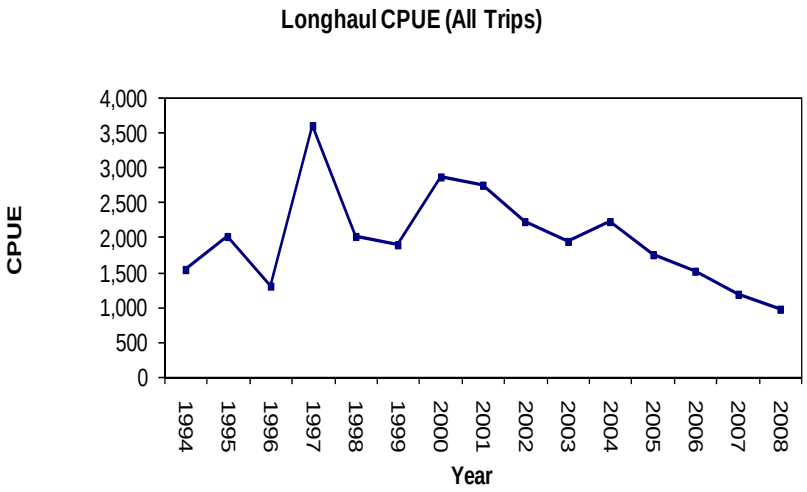

Figure 4. CPUE of long haul fishery based on NCTTP trips and landings, 1994-2008.

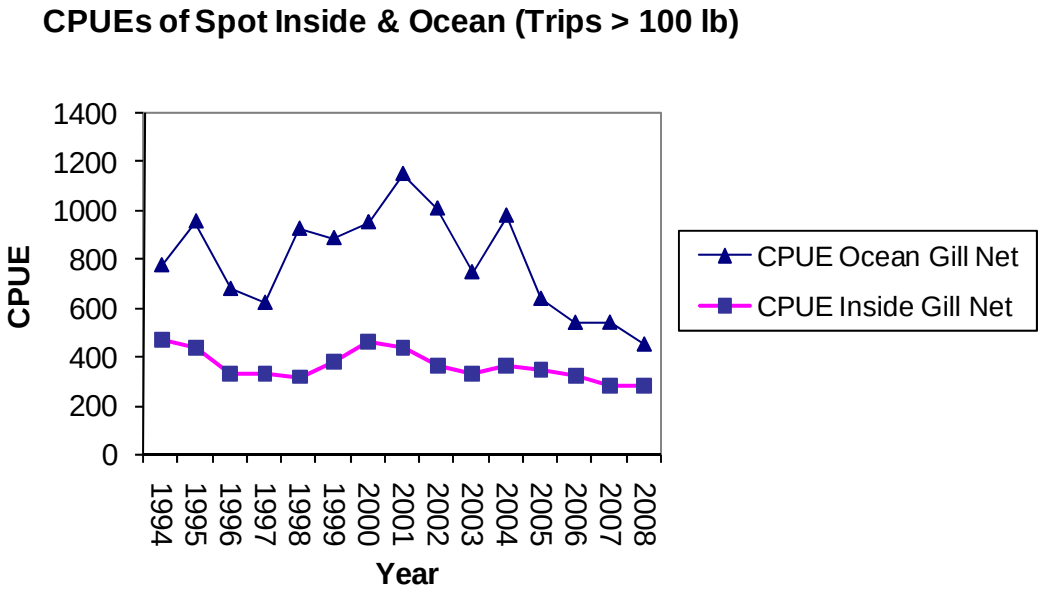

Figure 5. North Carolina ocean and inshore gill net spot CPUEs based on NCTTP, 1994–2008.

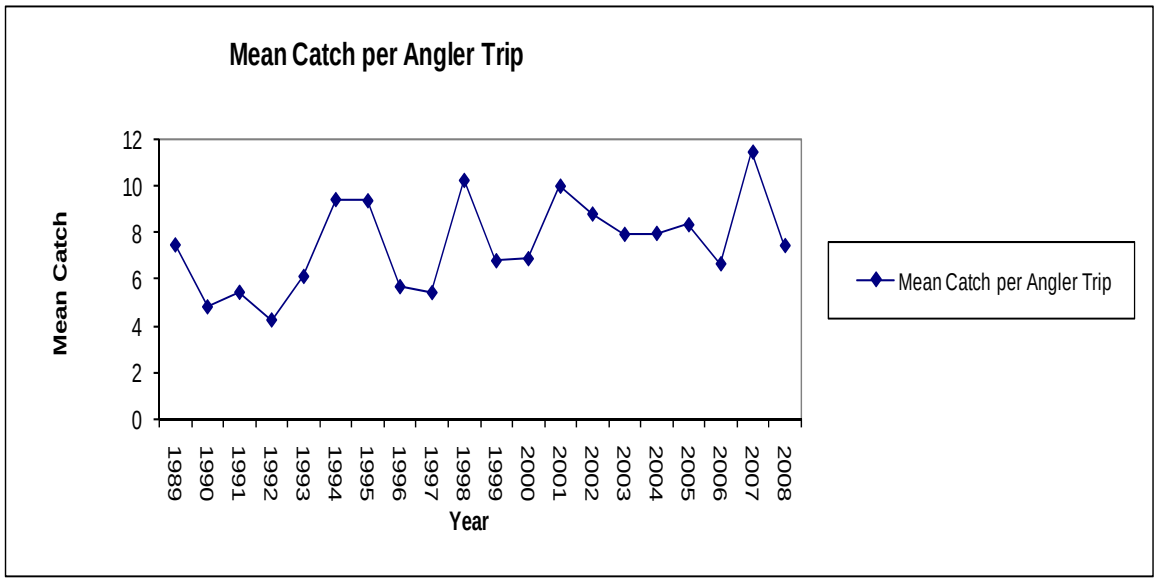

Figure 6. Spot mean catch per angler trip, 1989–2008 (from MRFSS).

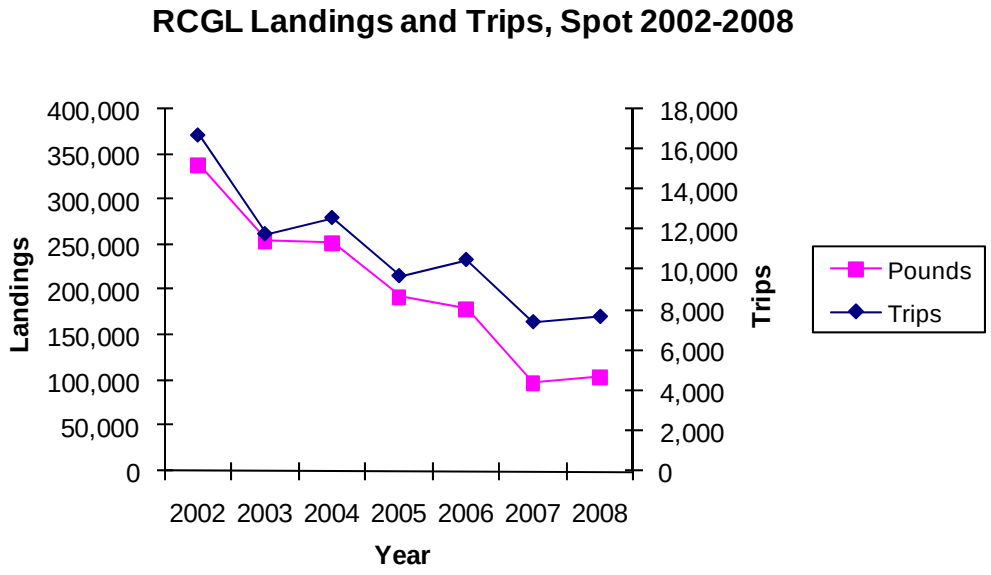

Figure 7. North Carolina spot landings and trips from RCGL license holders, 2002-2008.

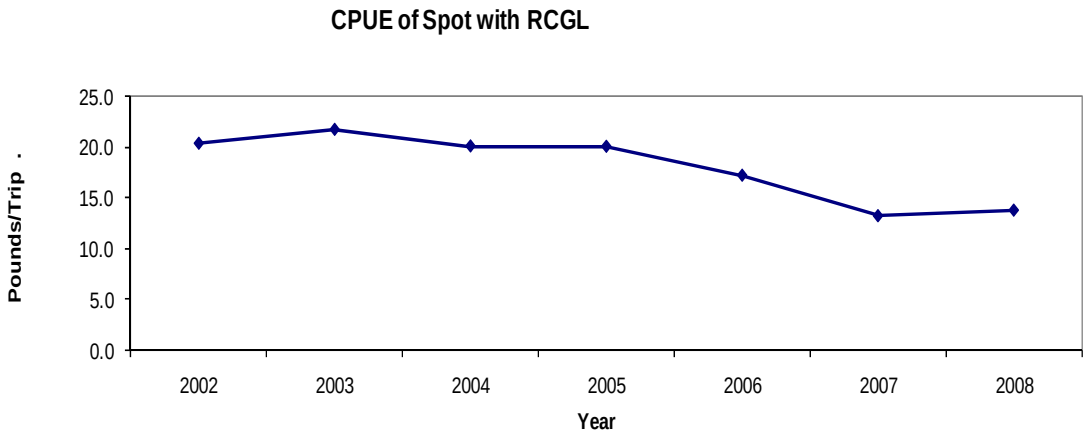

Figure 8. North Carolina spot CPUEs from RCGL license holders, 2002-2008.

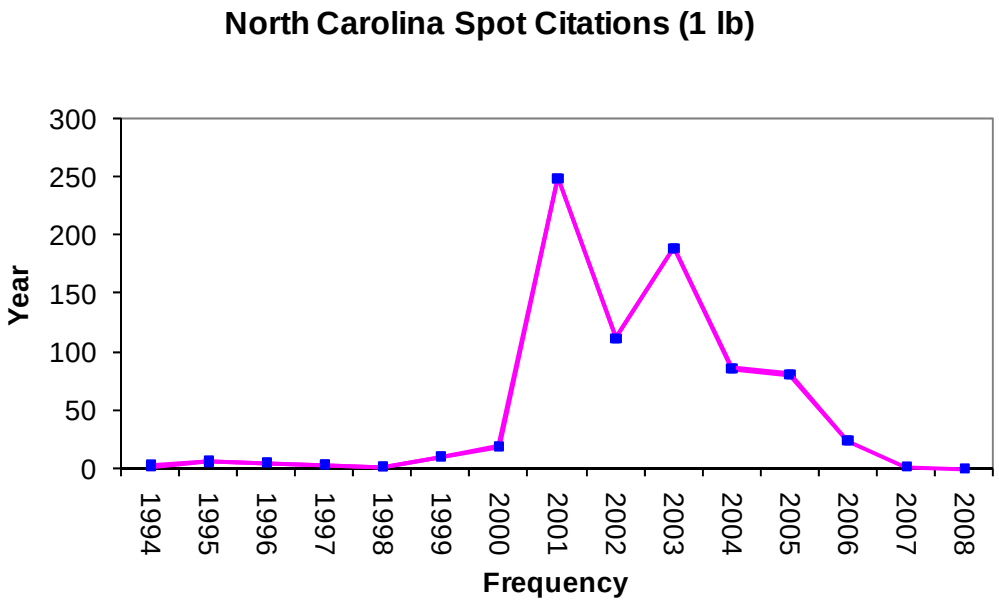

Figure 9. Number of spot citations (issued for hook and line catches > 1 lb) issued 1994-2008.

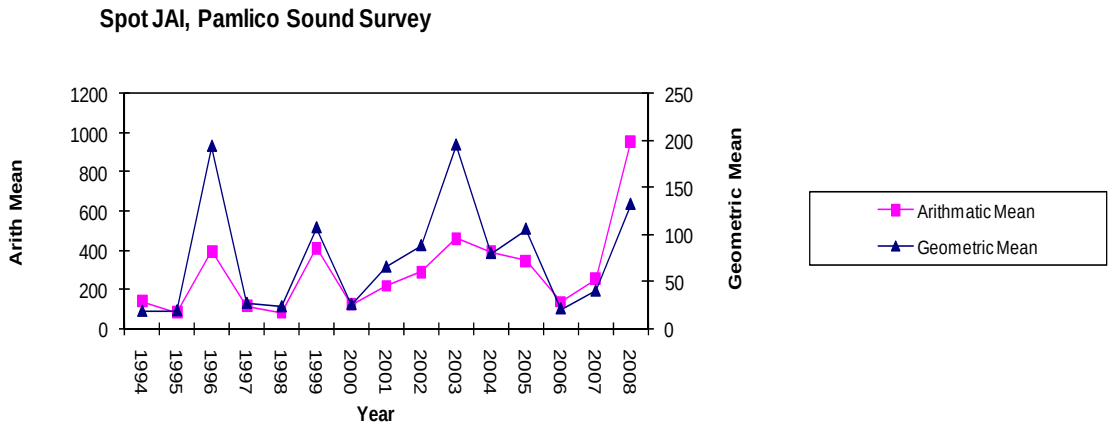

Figure 10. North Carolina Pamlico Sound Survey juvenile indices for spot 1994-2008.

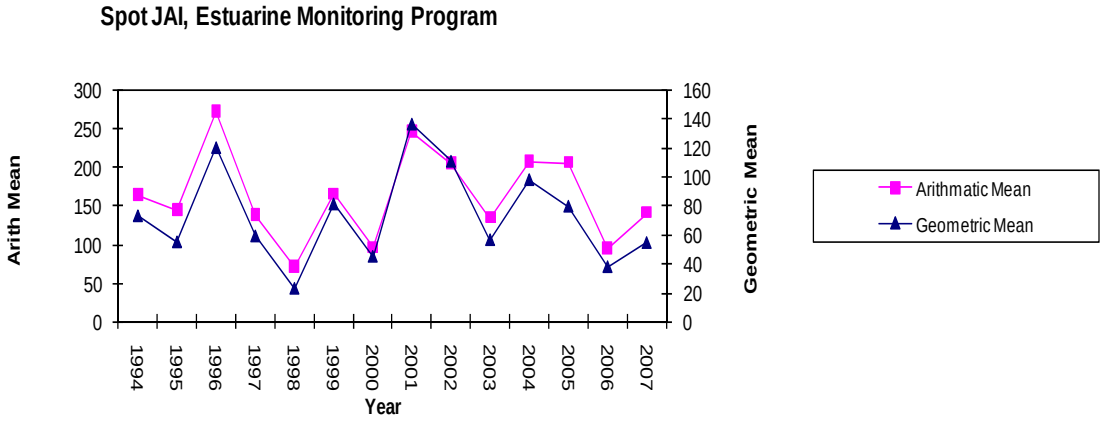

Figure 11. North Carolina Estuarine Trawl Survey juvenile indices for spot, 1994-2007.

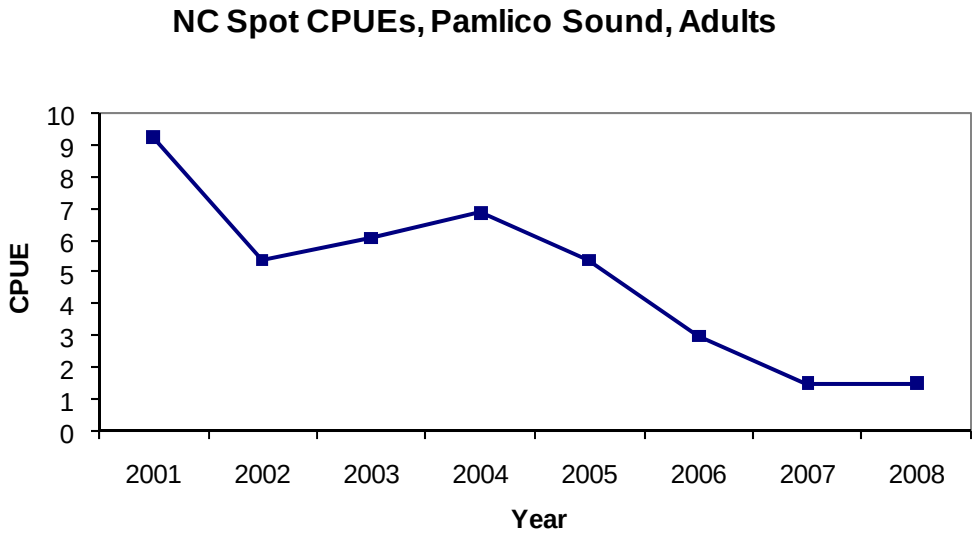

Figure 12. North Carolina spot annual weighted CPUE from Pamlico Sound Independent Gill Net Survey, 2001-2008.

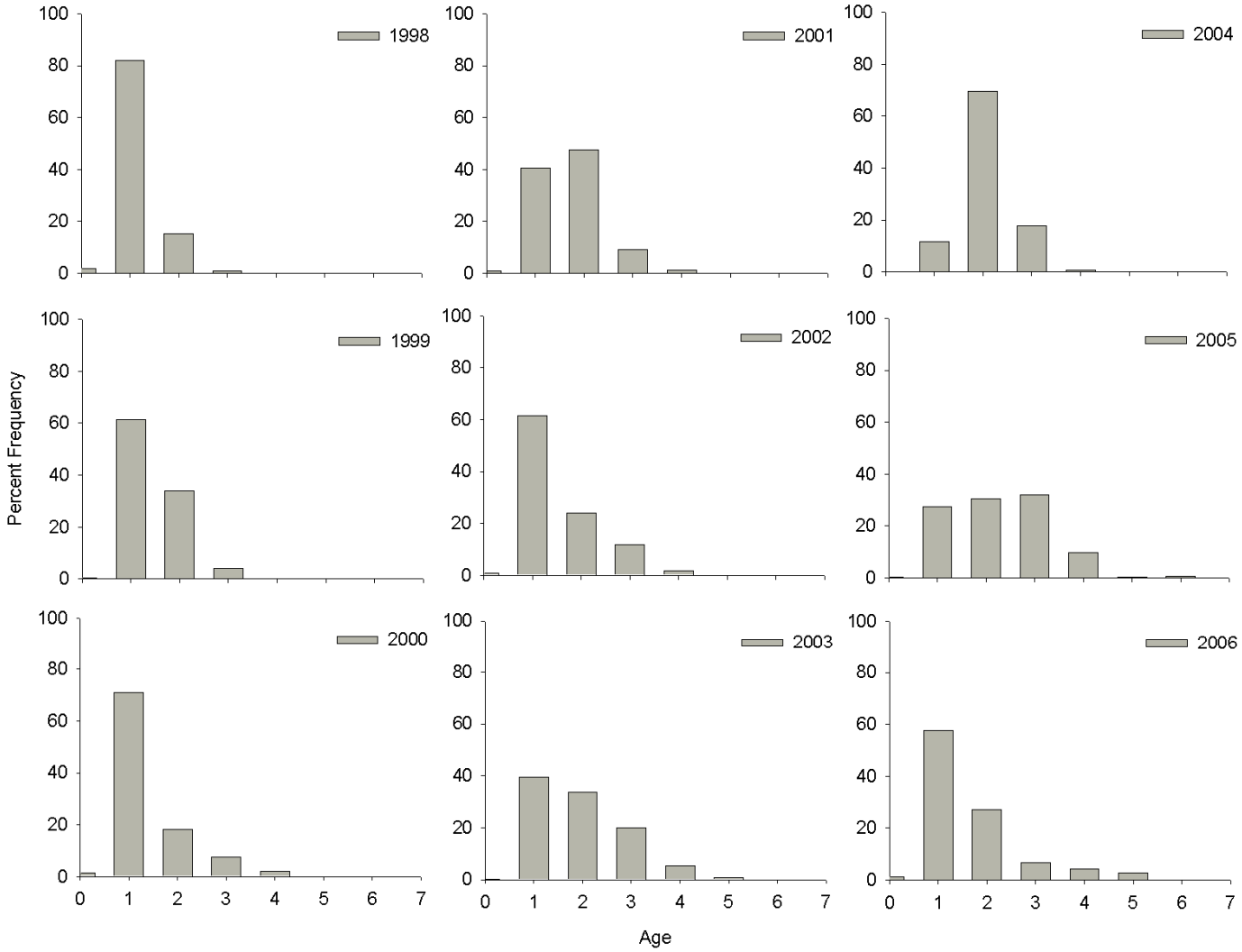

Figure 13. Age distribution of spot landed and sold in North Carolina inshore gill net fishery, 1998-2006.

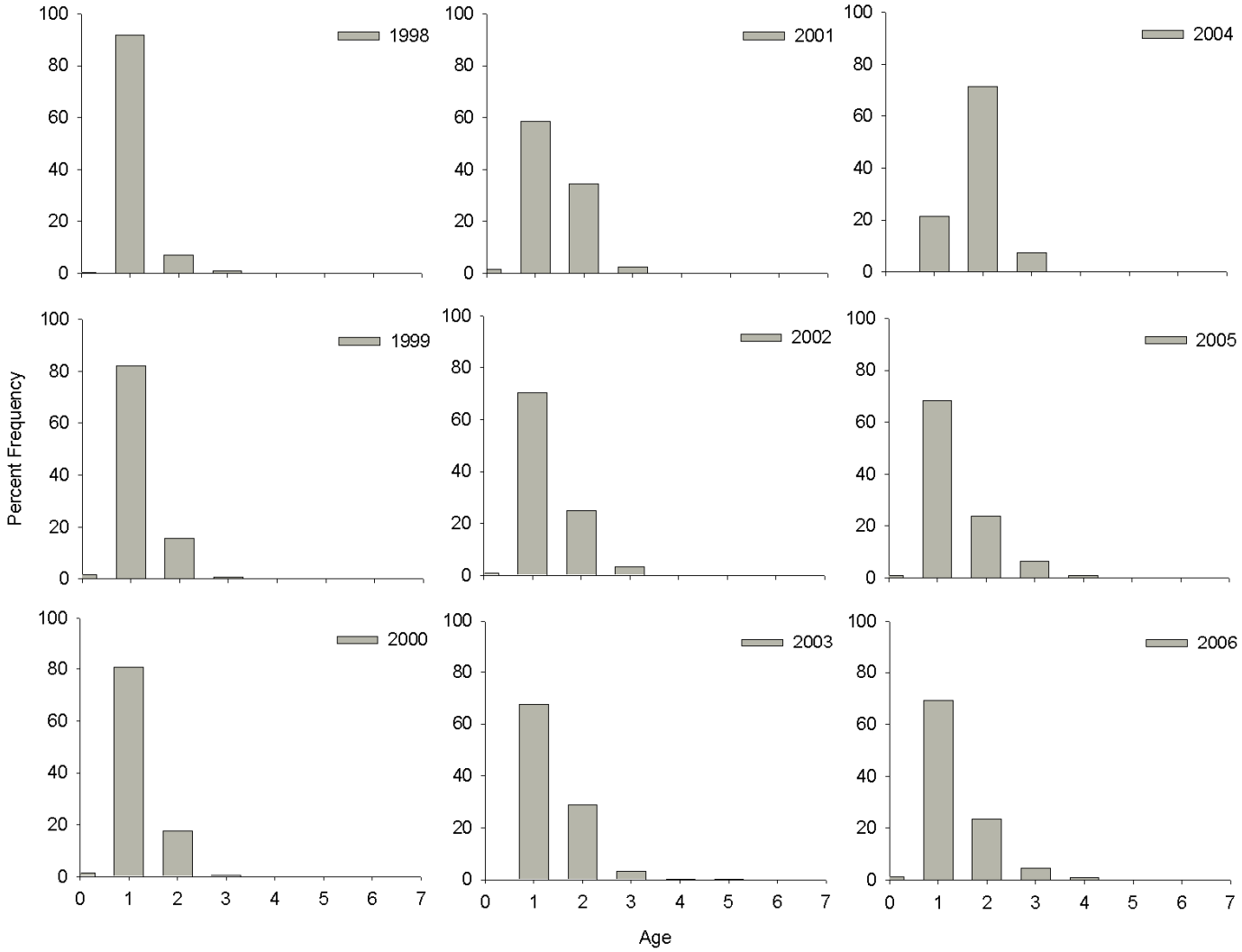

Figure 14. Age distribution of spot landed and sold in the North Carolina ocean gill net fishery, 1998-2006.

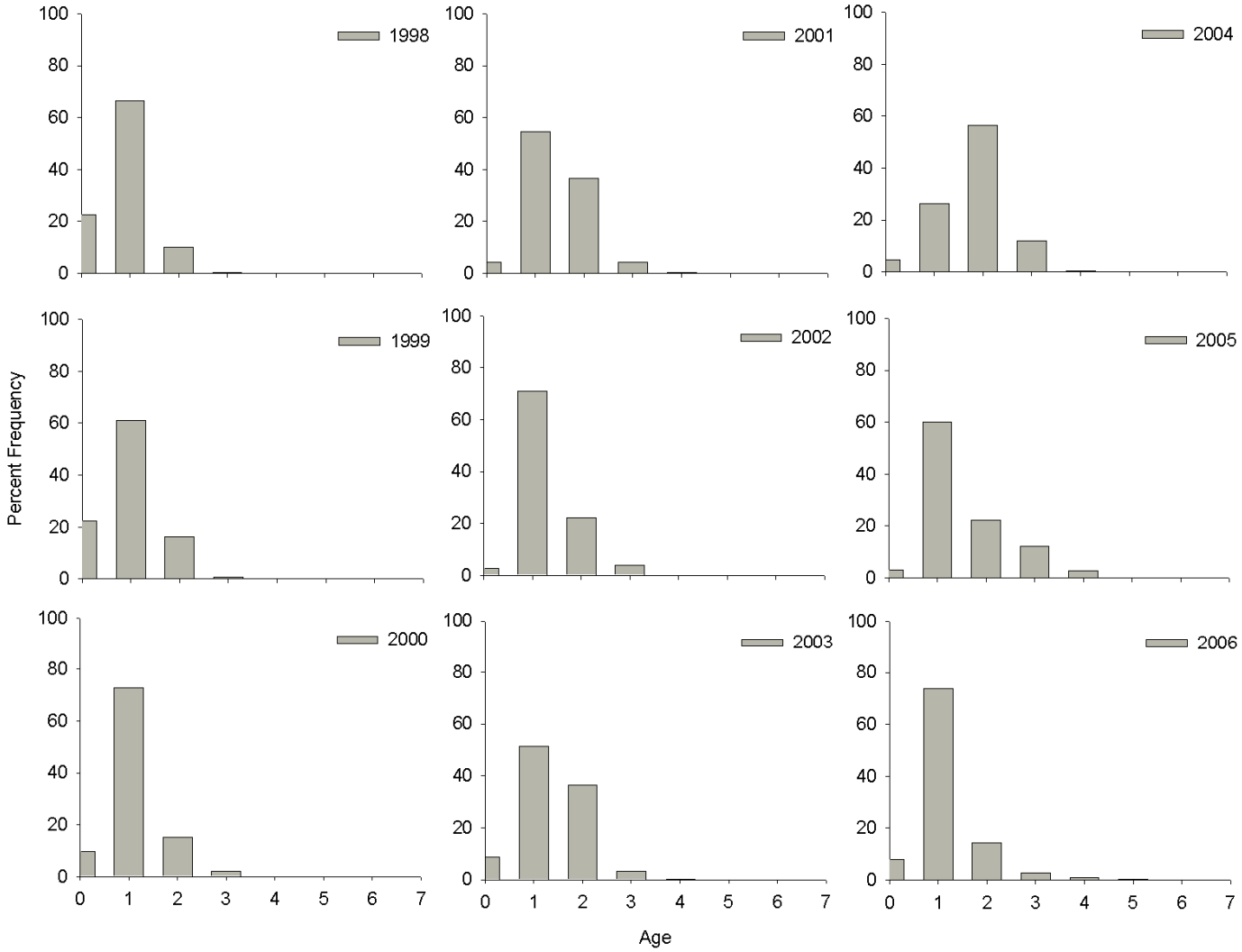

Figure 15. Age distribution of spot landed and sold in the North Carolina long haul fishery, 1998-2006.

Evaluation of Spot, *Leiostomus xanthurus*, in South Carolina: Historical Trends and Current Status

Report to the Atlantic States Marine Fisheries Commission
April 2009

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Introduction

The Atlantic States Marine Fisheries Commission's (ASMFC) South Atlantic Board requested that the Spot Plan Review Team (PRT) review and update available data relevant for Spot (*Leiostomus xanthurus*) as a resource. As this is the first time South Carolina has participated in this management exercise for Spot with the ASMFC, this report summarizes both the current and historical data available for Spot in South Carolina.

The historical fishery dependent data consisted of commercial catch records covering the period from 1950 through 2008 (NMFS, 2009). While there was a commercial fishery for Spot in the past, there is no currently directed commercial fishery for Spot in South Carolina and the only reported landings come from incidental shrimp trawl by-catch. The only current commercial fishery regulations that have jurisdiction for Spot in South Carolina is Section 50-5-1915 of the South Carolina Code, which requires for-hire boats to maintain a logbook of catch data. Section 50-5-380 of the South Carolina Code gives the SCDNR authority to require wholesale dealers and others to submit mandatory landings reports on a monthly basis. This information forms the basis for the state's commercial landings monitoring. Additionally, Section 50-5-360 requires that anyone, who buys, receives or handles any live or fresh saltwater fish or any saltwater fishery products taken or landed in the state for sale, must obtain a wholesale dealers license.

Recreational fishery catch data were obtained from the Marine Recreational Fisheries Statistics Survey (MRFSS), for the period 1981 to 2008, and from the South Carolina State Finfish Survey (SCSFS) for the period 1991 to 2008. The State Finfish Survey is a fishery dependent program that collects catch/effort data and length measurements of selected species taken by private boat anglers in coastal and federal waters off South Carolina. There are currently no recreational fishery management regulations concerning Spot in the state jurisdictional waters of South Carolina.

There are currently no South Carolina Dept. of Natural Resources (SCDNR) programs or projects focused on gathering or analyzing fishery independent Spot data at this time. However, this species is a major component of three separate long-term surveys carried out by the SCDNR for different time periods between 1989 and 2008. Two of the surveys, carried out in estuarine waters, are a trammel net survey and an electroshock boat survey. The trammel net survey has been conducted since 1991 and is currently an ongoing program. It uses a stratified random sampling protocol from seven different estuaries (as strata) with individual sampling sites chosen at random within each estuarine area on a monthly basis. The trammel net program was designed to monitor important recreational finfish species over a broad geographic range. The electroshock sampling program began in 2001 and is also currently ongoing. The electroshock program also uses a monthly random stratified sampling design with six estuaries as strata. The electroshock boat survey was designed to complement and extend the trammel survey areas into the low salinity brackish and tidal freshwater portions of South Carolina's estuaries where trammel nets cannot be set due to water depths, currents, and underwater obstacles. Many of the important recreational finfish species utilize these low salinity areas in South Carolina's estuaries. The third monitoring program is a near-shore trawl survey that was part of the Southeast Area Monitoring and Assessment – South Atlantic Program (SEAMAP-SA) conducted by SCDNR staff. This shallow water (15 to 30 ft) trawl survey monitors the status and trends of

numerous coastal species within the South Atlantic Bight from Cape Canaveral, FL to Cape Hatteras, NC. Multi-legged cruises are conducted in spring (early April - mid-May), summer (mid-July - early August), and fall (October - mid-November). Stations are randomly selected from a pool of stations within each stratum. The number of stations sampled in each stratum is determined by optimal allocation. A total of 102 stations are sampled each season (306 stations/year) within twenty-four shallow water strata, representing an increase from 78 stations previously sampled in those strata by the trawl survey (1989-2000). Strata are delineated by the 4 m depth contour inshore and the 10 m depth contour offshore. In previous years (1989-2000), stations were sampled in deeper strata with station depths ranging from 10 to 19 m in order to gather data on the reproductive condition of commercial penaeid shrimp. Twenty-seven stations located within ten outer strata in the southern half of the SAB were sampled in spring to collect data on spawning of white shrimp. Sixteen additional stations in the seven outer strata off North Carolina were sampled in fall to gather data on the reproductive condition of brown shrimp. No stations in the outer strata were sampled in summer. Outer strata were abandoned in 2001 in order to intensify sampling in the shallower depth-zone.

Results and Discussion

Commercial Data

Spot landings in South Carolina made up a significant percentage (mean of 30.9%) of total landings on the South Atlantic coast of the United States from 1951 through 1976 (Table 1, Fig. 1). After 1976, Spot landings in South Carolina dropped off significantly as a percentage of the south Atlantic total, only accounting for a mean of 3.3% of landings from 1977-1998 and a mean of 0.31% from 1999 through 2008. Three gear types accounted for all of the commercial landings in South Carolina (gill nets , haul seines, and shrimp trawls). Haul seines reported landings in 40 of the 58 years and made up the majority of the catch over the entire time period (95.3%), particularly from 1950 through the mid 1980's (Table 2). Shrimp trawlers reported landings in all 58 years, but only made up 2.8% of the landings totals and was the only gear to report landings since 1997. Gill nets only accounted for 1.9% of the total landings for the entire time period, reporting landings during 23 of the 58 years on record. The gill net fishery was limited to inshore bays and sounds but it essentially disappeared after the mid-1980's when South Carolina instituted an inshore net ban, with one exception. There is still a small inshore commercial shad fishery in South Carolina, but there were no reported landings for Spot with this fishery in recent years. The haul seine fishery occurred primarily off the northern beaches of South Carolina and historically targeted striped mullet. This fishery has not been active since the late 1990's. The shrimp trawlers reported catches consistently throughout the entire time period and continue to account for recent landings in South Carolina.

Recreational Data

The recreational landings data from the MRFSS survey (harvested fish: A + B1's) showed that Spot in South Carolina generally made up less than 30% of the south Atlantic catch totals with a long term mean of 8.2% from 1981 through 2008. However, since proportional standard error (PSE) values for the number of Spot landed each year was generally high (> 20%) judging changes in catches from year to year using landing data alone was not reliable. Comparing catch

per unit effort (CPUE) using landings weighted by the number of trips taken per year was a better metric for estimating both effort and general abundance because PSE was at more acceptable levels (< 10%). Catch per unit effort was defined as the number of fish taken per trip and was examined annually using sampling waves 2-6. The MRFSS uses bi-monthly sampling waves (beginning in January) as it's sampling time unit, but for the purposes of this analysis data was collapsed so that only annual arithmetic means were used. Wave 1 (January – February) was not included because there was no appreciable catch recorded for Spot during this time period in most years. The annual CPUE has varied widely from year to year and has become even more variable since 2002 (Fig. 2) in South Carolina. CPUE values ranged from approximately 1 to 12 Spot per trip in South Carolina while that of the entire south Atlantic ranged from 2.5 to 6.5 Spot per trip. The long term mean CPUE for the whole south Atlantic and South Carolina was the same (4.37 Spot per trip). The number of anglers, while also variable from year to year, has steadily increased since the early 1990's (Fig. 3). This likely reflects the general increase in the coastal human population during this time. Since 2000, the CPUE in South Carolina has shown a much greater degree of variability than the rest of the south Atlantic states. Size frequency distributions for Spot from the MRFSS indicated a size range of 5-12 inches fork length (L_F), with the 7-10 inch classes making up 97.2% of all the fish (Fig. 4).

The South Carolina state finfish survey (SFS) has collected data from 1991 through 2008 with a total of 934 intercept surveys. However, not all years were well represented in the data and in several years (1992, 1994-1996), the mean number of Spot specimens measured per month was 1 or less. The number of Spot per trip (CPUE) was taken as part of the intercept survey, but intercepts were not equal across all months and years. The calculated mean annual CPUE from the SFS was significantly higher than the CPUE values from the MRFSS, ranging from 15 to 45 Spot per trip. The number of anglers per trip was not always recorded from each intercept survey, so with no way to validate the number of anglers per intercept, these data are difficult to validate. Length frequency distributions for the SFS ranged from 4 to 12 inches L_F with the 6-9 inch groups making up 90.2% of all the specimens measured (Fig. 5). In comparison to the MRFSS, mean annual fork length was significantly different ($p = 0.05$) in all but 5 years (Fig. 6). Sample sizes were generally lower in the SFS, particularly from 1994-1996 where there were fewer than 12 fish measured each year. The inconsistencies in the SFS and its incompatibility with the MRFSS make its usefulness limited, so it should only be considered as supplemental data to the MRFSS.

Fishery Independent Data

Length Conversions

Length data in all three fishery independent surveys was collected as either standard length (L_S) (trammel and electroshock), fork length (L_F) (SEAMAP, trammel), or total length (L_T) (trammel). Since not all length measurements were taken for each survey, conversion factors were calculated using a combined data set from all the gears. The conversions for length measurement were as follows:

$L_F = 1.60 + 0.93(L_T)$ $r^2 = 0.999$, df = 594
$L_S = 0.52 + 0.78(L_T)$ $r^2 = 0.998$, df = 4495

$L_F = 2.03 + 1.18(L_S)$ $r^2 = 0.998$, df = 596

Trammel Net Survey

There were 28,165 Spot captured in the trammel net survey from 1991 through 2008. Fork length ranged from 2 to 12 inches with an overall mean of 7.9 ± 0.78 inches (Fig. 7). Specimens were collected every month of the year over the entire time period. The 7-9 inch length class made up the majority of specimens seen (96.5%), which was possibly a function of gear selectivity. Spot generally recruited to the trammel gear at 6 inches L_F, so there were few specimens seen below this size. Monthly size frequency distributions were similar across all months during all years. There was no age, sex, or maturity data collected from the trammel net surveys.

Electroshock Survey

The electroshock survey captured 13,693 Spot from 2001 to 2008. Spot were collected every month of the year throughout the entire time period. Sizes ranged from 1 to 10 inches L_F (Fig. 8)with an overall mean size of 2.6 ± 1.38 inches L_F. The majority of electroshock boat samples (84.7%) were juveniles (≤ 4 inches L_F). The presence of the smaller juveniles was a function of the non-size selectivity of the electroshock boat (compared to the trammel net) and the possible greater utilization of low salinity zones of the estuary by juvenile Spot. Monthly size frequency distributions were variable and indicated that the bulk of recruitment for juvenile Spot occurred from January through April, although small Spot (1 inch L_F) were present into July (Fig. 9). There was no age, sex, or maturity data collected from the electroshock surveys.

SEAMAP Survey

The SEAMAP survey captured 3,120,123 Spot from 1989 through 2008, and processed a sub-sample of 16,987. Fork lengths ranged from 3 to 12 inches with a mean of 6.2 ± 0.64 inches. Size distributions were similar across all years and months that were sampled, as well as between states(Fig. 10). However, when the number Spot captured by size was examined by state, North and South Carolina both had approximately double the number of fish in the 5-8 inch range than either Florida or Georgia (Fig. 11). Although Florida appeared to have a larger mean size, the mean L_F by state ranged from 6.1 to 6.7 inches L_F and were not significantly different from each other ($p = 0.05$). As with the trammel net, small juveniles (< 2 in. L_F) were not seen in the SEAMAP trawls. Although, since juvenile Spot live primarily in estuarine environments they would be less likely to be caught in offshore habitats sampled during the SEAMAP cruises.

In 2001, 746 fish were taken for age, sex, and maturity assessments. Age was determined using sectioned sagittal otoliths and sex and maturity were determined from histological sections of gonad tissue. Both the gonad tissues and otoliths were processed using the standard aging and histological procedures at the SCDNR Marine Resources Center as previously described (Roumillat and Brouwer, 2004; McDonough et al., 2005). Spot ages ranged from 0- 4 years with most of the specimens (97.1%) being ages 0 and 1 (Fig. 12). Sexual maturity in Spot appeared to begin before age 1, but there were differences in size and age at maturity between males and females. Both sexes achieved 50% sexual maturity between ages 1 and 2, but males achieved

100% maturity by age 2 and 9 inches L_F, whereas females did not do so until age 3 and 10 inches L_F (Fig. 13A and 13B).

Spot spawn from December to March and can spend 2-10 days as larvae before metamorphing into juveniles at which point active water transport movement moves them into estuarine nursery habitats (Hare et al., 2006). Although the timing of first annulus deposition in Spot has not been validated, it is typical for winter spawning fish in the temperate zone of the western Atlantic to lay down the first annulus from approximately April to June (depending on the species), after their second over-wintering period. This would make most Spot older than 1 year (13 to 16 months) at the time of annulus deposition. Other species of Sciaenidae, such as spotted seatrout, can reach maturity within one year (Roumillat and Brouwer, 2004), so it is possible that Spot become sexually mature before laying down their first annuli.

Weight at length (L_F) was examined using a non-linear regression with individual specimens where both lengths and weights were available (Fig. 14). There was a highly significant relationship ($r^2 = 0.812$) between weight and length ($p < 0.001$). A von Bertalanffy growth curve was generated using the length (L_F) at age data (Fig. 15). The L_∞ was 13.5 inches L_F with a growth coefficient (k) of 0.019. The relationship of age to length while significant ($p < 0.001$) was not particularly strong ($r^2 = 0.361$) due to the wide range of lengths in the age 1 and age 2 groups.

Catch Indices

Catch indices from the three fishery independent surveys provided proxies for annual abundance. The trammel net and SEAMAP surveys captured both a larger size range of specimens (≥ 6 inches L_F for the trammel surveys, ≥ 4 inches for SEAMAP) and fewer juvenile fish than the electroshock efforts, and so both of these served as adult abundance indices. The electroshock survey captured mainly juvenile Spot (1-4 inches) and was used for the juvenile abundance index. All three surveys used randomly stratified sampling over varying geographic areas and encompassed a range of habitat types from tidal freshwater to coastal marine zones. Although the time periods varied between the surveys, all three occurred over long enough time scales to encompass a wide range of shifting environmental conditions under relatively stable sampling protocols that could illustrate changing population trends for Spot in South Carolina.

The mean annual CPUE in the trammel net survey ranged from 0.81 to 5.47 with a long term mean of 2.5 ± 0.31 fish per set (Table 3). Peak catches occurred in 1994 and 1999 but catches only exceeded the long term mean in 7 of the 18 years. There was a significant correlation between CPUE and annual mean salinity from 1994 to 2008 ($r = 0.564$, $p = 0.036$) (Fig. 16) and a significant correlation with both salinity ($r = 0.890$, $p = 0.003$) and annual mean water temperature ($r = 0.746$, $p = 0.033$) from 2000 to 2008. It should be noted that South Carolina experienced two drought periods during this time (1998 to 2002 and 2005 to 2008) and that mean annual salinity rose in all of the estuarine strata where the trammel net was used.

Mean annual CPUE for the electroshock boat was primarily a young-of-the-year (YOY) index because most of the specimens captured with this gear were less than 4 inches L_F. The CPUE was calculated for both newly recruited YOY only (specimens ≤ 4 inches L_F from January to

April) and for all specimens. This resulted in significantly higher CPUE value for YOY Spot ($t = -4.351$, $p = 0.003$) compared to all Spot captured by the electroshock boat (Fig. 17). CPUE values ranged from 7.6 to 32.5, with a mean of 22.2 ± 3.5 fish per set for YOY and from 8.3 to 20.7 and a mean of 12.9 ± 1.8 fish per set for all sizes. There was a significant negative correlation between YOY CPUE and water temperature ($r = -0.735$, $p = 0.038$) (Fig. 18) and an almost significant correlation with salinity ($r = -0.677$, $p = 0.065$). However, there was a significantly negative correlation between salinity and the overall CPUE (all specimens) from the electroshock boat ($r = -0.757$, $p = 0.030$). The overall trend in annual YOY CPUE from 2001 to 2008 was increasing except for a 60% drop in CPUE in 2006, which corresponded with a 1.6^{o} C increase in mean annual temperature. The lack of the significant negative correlation between salinity and YOY CPUE and the fact that this correlation was significant for the total CPUE indicated that either the larger fish were more affected by changes in salinity than the YOY (which was supported by the positive correlation between salinity and CPUE values seen in the trammel net data) or that low salinity areas that the electroshock boat sampled were better/preferred nursery habitat for juvenile Spot.

The mean annual CPUE for the SEAMAP data ranged from 2.3 to 40.1 Spot per trawl with a long term mean of 10.4 ± 2.18 (Table 3). Since the SEAMAP program sampled along the entire southeastern coast (NC to FL), CPUE was examined for each state as well as all areas combined. CPUE off South Carolina tracked fairly well with the long-term trends for the overall CPUE, with the only major deviations occurring in 1990 and 1991, which had low precision (Fig. 19). North Carolina and Florida had the greatest year-to-year variability in CPUE and Georgia had the lowest overall CPUE over the entire 20 year time period (Fig. 20). Overall trends showed a decrease in CPUE from 1991 through 2002, increasing from 2003 to 2005 and then decreasing from 2005 to 2008. The period of time with the lowest CPUE's occurred from 1998 to 2002. This time period (as well as the decline seen in 2005-2008) coincided with relatively severe droughts in the southeastern United States. As with the trammel data, there was a significant positive correlation between mean annual CPUE and mean annual salinity in South Carolina ($r = 0.483$, $p = 0.031$) (Fig. 21).

Summary

Commercial landings of Spot in South Carolina, averaged 656,448 pounds per year from the 1950's through the mid 1970's, but have reduced since then, primarily because of the reduction in active commercial finfish fisheries in South Carolina. The haul seine fishery (which historically targeted Spot and striped mullet) accounted for the majority (97.2%) of total landings for the entire 58 year period. Shrimp trawlers have consistently reported limited landings in South Carolina and are the only commercial fishery to have reported Spot landings here since 1997.

In recreational fisheries, the MRFSS catch and effort data have shown highly variable CPUE since the mid 1990's and there has been an increase in the number of anglers in South Carolina during the same time period. Size ranges of recreational catches have stayed consistent since the 1980's (5-12 inches L_F) with the majority of fish (97.2%) being in the 7-10 inch range. Similar size ranges were seen in the South Carolina SFS (4-12 inches L_F) but effort data with the SFS was limited and so direct comparisons with MRFSS CPUE were not possible.

The size ranges seen in the fishery independent surveys reflected the different life stage groups each gear targeted (adults or juveniles). Both the trammel net and the SEAMAP trawl surveys caught mostly adult Spot with mean sizes of 7.9 and 6.2 inches L_F respectively. The electroshock boat surveys caught mostly juvenile Spot with a mean size of 2.6 inches L_F.

The different catch indices indicated annual changes in mean abundance for each gear type. Young-of-the-year Spot were most abundant in the electroshock surveys since it was not size selective. There was an overall increase of over 400% in mean annual CPUE from 2001 to 2008 for young-of-the-year Spot with strong negative correlations to both water temperature and salinity. In contrast, CPUE's in both the trammel and SEAMAP surveys were positively correlated with salinity and temperatures (in certain years) in the adult Spot. So, it appeared that increases in both salinity and temperature corresponded with decreases in juvenile CPUE in the freshwater and low salinity brackish areas, but corresponded with increases in adult CPUE in the more coastal, higher salinity areas. While the magnitude of salinity changes was less in the SEAMAP surveys further offshore, there was still an increase in mean adult CPUE with increases in salinity. None of the CPUE indices correlated well with each other, including tests of lag periods between juveniles and adults.

Research Recommendations

- Fishery independent age and growth studies are necessary to develop more complete age-length keys for stock assessment purposes.
- Age validation of Spot in the south Atlantic Bight
- More extensive reproductive studies examining size and age at maturity, spawning seasonality, and fecundity.
- In depth fishery independent examination of the effects of environmental parameters on Spot recruitment, distribution, habitat utilization, and abundances in South Carolina's estuaries.

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Hare, J.A.; H.J. Walsh; and M.J. Wuenschel. 2006. Sinking rates of late-stage fish larvae: Implications for larval ingress into estuarine nursery habitats. J. Exp. Mar. Biol. Ecol. 330(2):493-504.

McDonough, CJ; C.A. Wenner; and W.A. Roumillat 2005. Sexual differentiation and gonad development in striped mullet (*Mugil cephalus*) from South Carolina estuaries. Fish. Bull. 103:601-619.

Roumillat, W.A. and M.C. Brouwer 2004. Reproductive dynamics of female Spotted seatrout (*Cynoscion nebulosus*) in South Carolina. Fish. Bull. 102:473-487.

Table 1. Commercial Spot landings for Spot in South Carolina (SC) and the South Atlantic (SA) coast of the United States from 1950 to 2007.

Year	SC_Pounds	SA_Pounds	SCLandings%
1950	291400	5555400	5.25
1951	2646000	7542200	35.08
1952	1821000	7754500	23.48
1953	440000	3608100	12.19
1954	498600	3370600	14.79
1955	1130300	3492700	32.36
1956	4182300	7285800	57.40
1957	2097900	4660300	45.02
1958	841900	3794400	22.19
1959	1840700	5138200	35.82
1960	2720600	6364300	42.75
1961	3468500	6452900	53.75
1962	3135000	5061400	61.94
1963	2719200	4765800	57.06
1964	3166000	5371600	58.94
1965	1174000	3035700	38.67
1966	2125500	4426700	48.02
1967	2219100	6176000	35.93
1968	2052500	4734200	43.35
1969	453500	2818300	16.09
1970	367500	3303500	11.12
1971	1285500	5372500	23.93
1972	2269200	8144100	27.86
1973	1455300	7807300	18.64
1974	358400	7729400	4.64
1975	1490800	10640600	14.01
1976	1013600	4239400	23.91
1977	294600	5135900	5.74
1978	400928	6273525	6.39
1979	418480	8593510	4.87
1980	21430	8405773	4.89
1981	127384	6445560	1.98
1982	38157	9412856	0.41
1983	240096	5458687	4.40
1984	130265	5120737	2.54
1985	104777	5586417	1.88
1986	655378	4928568	13.30
1987	159681	3971835	4.02
1988	376221	4801665	7.84
1989	31472	4432274	0.71
1990	5277	4771189	0.84
1991	3530	4130624	0.77
1992	171959	3738406	4.60
1993	251225	3750987	6.70
1994	18212	4228483	6.82
1995	209132	3774351	5.54
1996	10579	2407037	2.52
1997	87170	2942244	2.96
1998	3530	2622142	2.44
1999	6146	2344579	0.26
2000	4519	2896283	0.16
2001	12950	3139927	0.41
2002	9551	2227813	1.04
2003	17181	2069939	0.83
2004	1876	2331883	0.08
2005	1533	1746142	0.60
2006	2143	1392990	0.41
2007	3455	899771	0.38
2008			

Table 2. Commercial Spot landings for Spot in South Carolina by gear type from 1950 to 2007.

Year	Gill Nets_Lbs	Seine_lbs	Trawl_lbs
1950	18800	259000	13600
1951	93000	2548000	5000
1952	82000	1735000	4000
1953	25000	405000	10000
1954	24500	463600	10500
1955	10000	1089100	31200
1956	34000	4007500	140800
1957		2032000	65900
1958		808800	33100
1959		1819200	21500
1960		2699100	21500
1961		3427200	41300
1962		3085100	49900
1963		2662400	56800
1964	25000	3116500	24500
1965		1142200	31800
1966		2099900	25600
1967		2165600	53500
1968		2041000	11500
1969		438700	14800
1970		340000	27500
1971	1300	1164900	119300
1972	5300	2217100	46500
1973	9600	1386700	59000
1974	6400	327100	23700
1975	1300	1453200	35900
1976	2700	990000	20500
1977	2300	286500	5800
1978		369500	31428
1979	271537	124522	22421
1980	5097		16333
1981		125300	2084
1982	1463		36694
1983	18071	209353	12672
1984		118913	8486
1985	46607	56460	1710
1986	93524	555595	5717
1987	114742		44939
1988	102290	245750	28141
1989			31472
1990			5277
1991			3530
1992		138750	23691
1993		241086	9863
1994			18212
1995		185250	23817
1996			10579
1997		68738	18432
1998			7855
1999			6146
2000			4519
2001			12950
2002			9551
2003			17181
2004			1876
2005			1533
2006			2143
2007			3455
2008			

Table 3. South Carolina Spot CPUE indices (number of Spot per set) for fishery independent surveys from 1989 to 2008. All CPUE values are stratified mean annual CPUE based on randomly stratified sampling protocols.

Year	Trammel Survey	Electroshock Survey	SEAMAP-SC Survey	SEAMAP-ALL Survey
1989	-	-	14.38	19.17
1990	-	-	40.11	32.08
1991	3.95	-	29.01	40.28
1992	3.19	-	10.57	15.93
1993	1.53	-	3.43	10.53
1994	5.47	-	5.92	13.28
1995	1.52	-	15.17	19.91
1996	1.74	-	3.68	6.59
1997	1.91	-	7.05	13.69
1998	2.44	-	4.47	5.05
1999	5.04	-	2.38	3.74
2000	2.14	-	4.26	7.98
2001	3.05	8.27	4.90	8.12
2002	3.01	8.41	2.40	4.29
2003	0.81	20.65	17.60	15.62
2004	1.18	10.23	2.27	11.98
2005	1.01	16.50	11.45	26.20
2006	1.93	6.46	10.26	17.08
2007	2.39	17.05	15.12	10.17
2008	3.59	15.56	3.80	13.23

Fig. 1 Total commercial landings of spot in South Carolina from 1951 to 2007 as a percentage of the total catch for the south Atlantic coast of the United States. Data from NMFS commercial catch records.

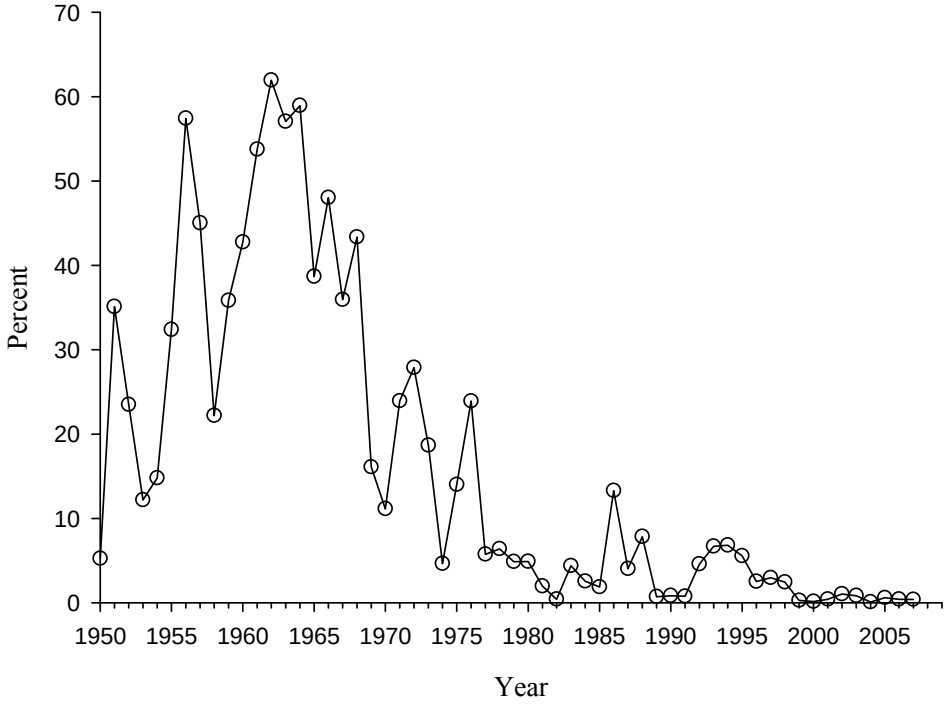


Fig. 2 Annual catch per unit effort (arithmatic mean of number of spot per trip) for spot from South Carolina and the south Atlantic States (MD, VA, NC, SC) from 1981 to 2008. Data source: Marine Recreational Fisheries Statistics Survey (NMFS, 2009).

*Long term mean CPUE was the same (4.37 spot per trip) for South Carolina and all states combined.

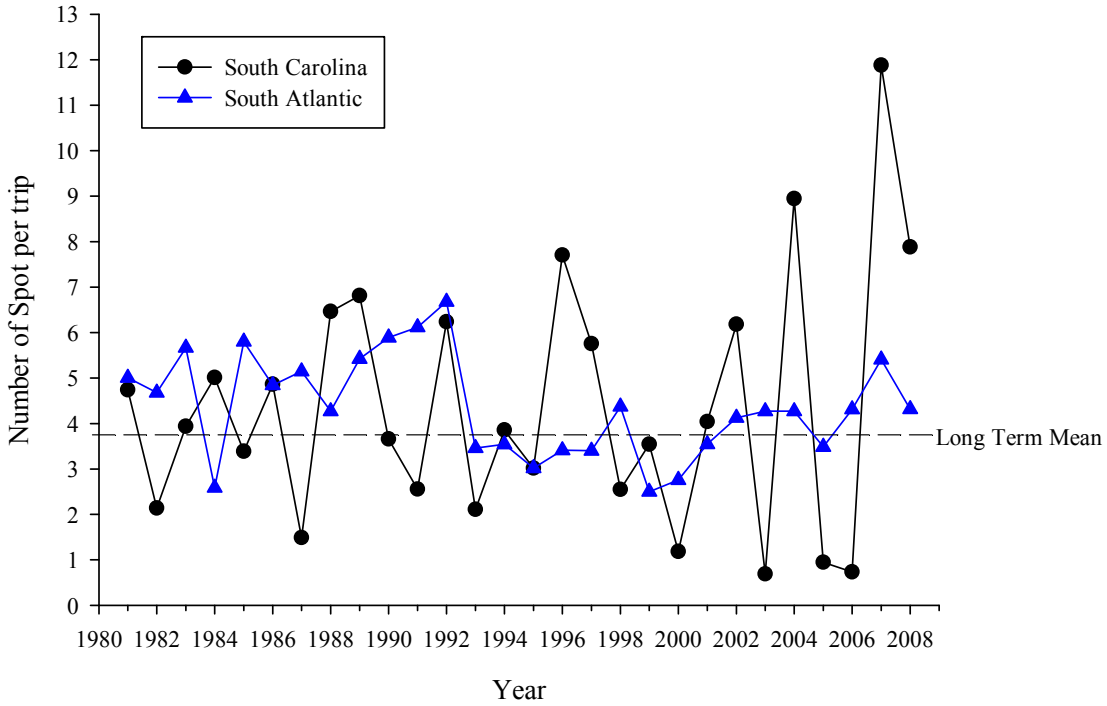


Fig. 3 Number of anglers in South Carolina targeting or catching spot from 1981 to 2008. Data sources MRFSS.

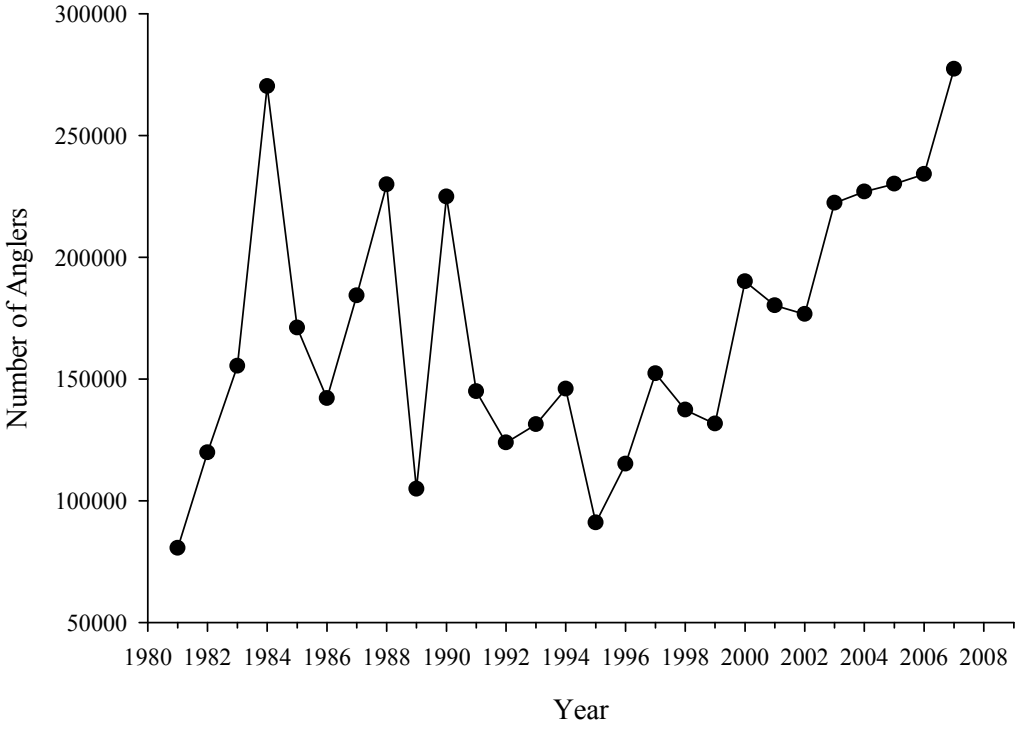


Fig. 4 Length frequency distibution of Spot in South Carolina from the Marine Recreational Fisheries Statistics Survey (NMFS) from 2003 to 2007.

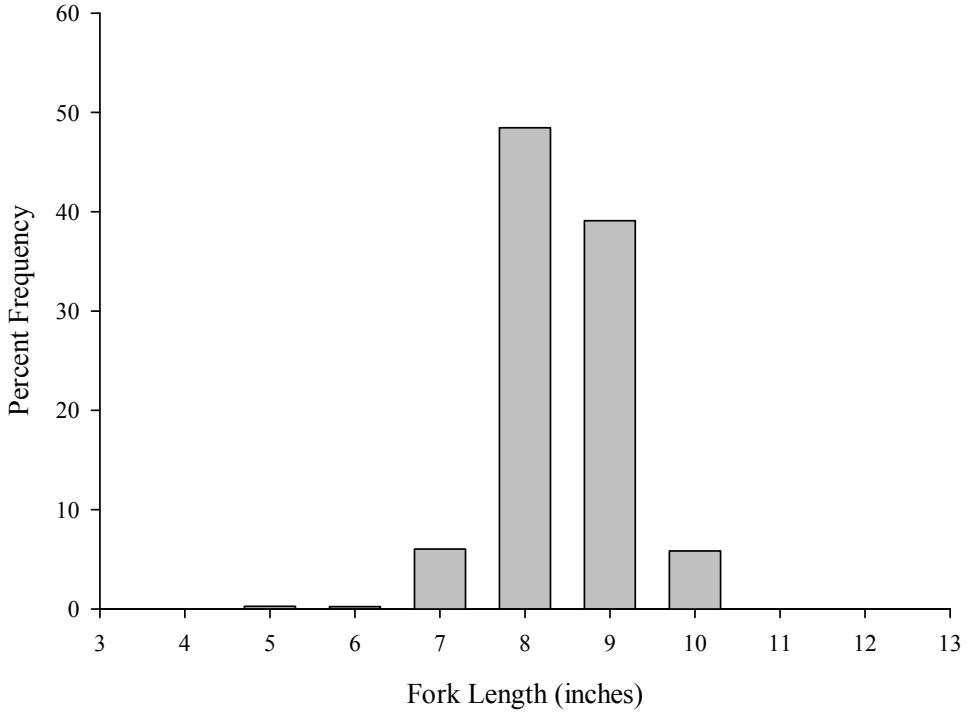


Fig. 5 Length frequency distribution of Spot in South Carolina from the State Finfish Survey 1991 to 2007. n = 2867

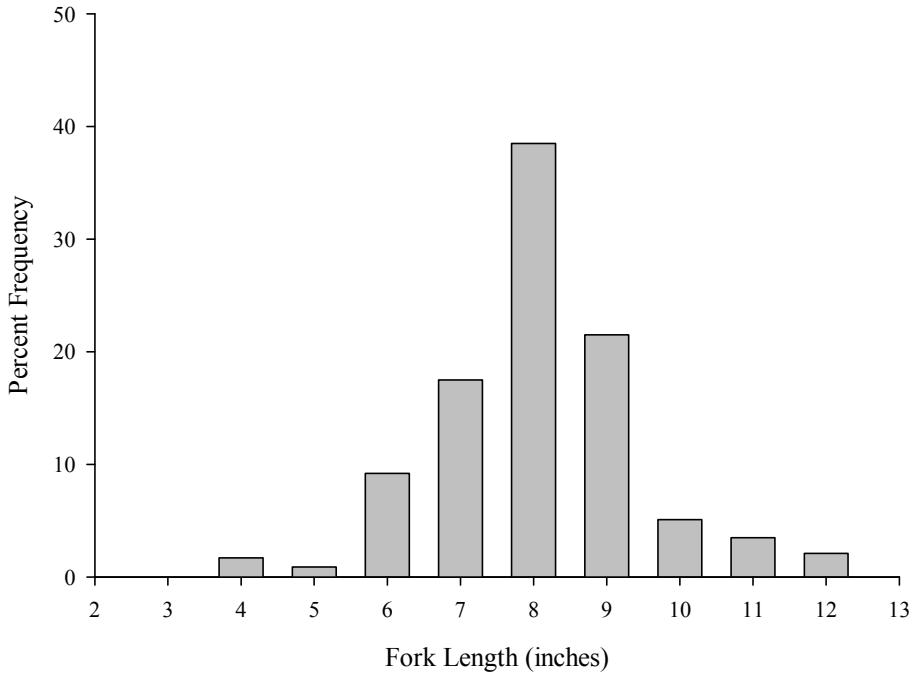


Fig. 6 Mean annual fork length for Spot in South Carolina waters from the South Carolina State Finfish Suvey and the Marine Recreational Finfish Statistics Survey 1991 to 2008.

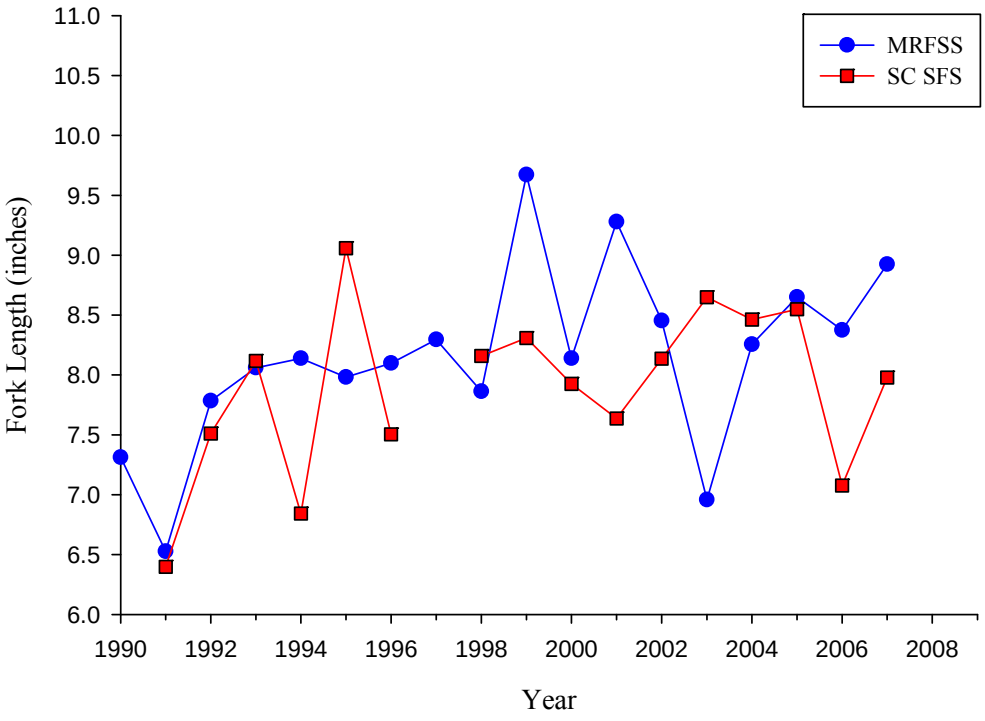


Fig. 7 Length frequency distribution for spot in South Carolina estuaries from trammel net surveys from 1991 to 2008. n = 28,165

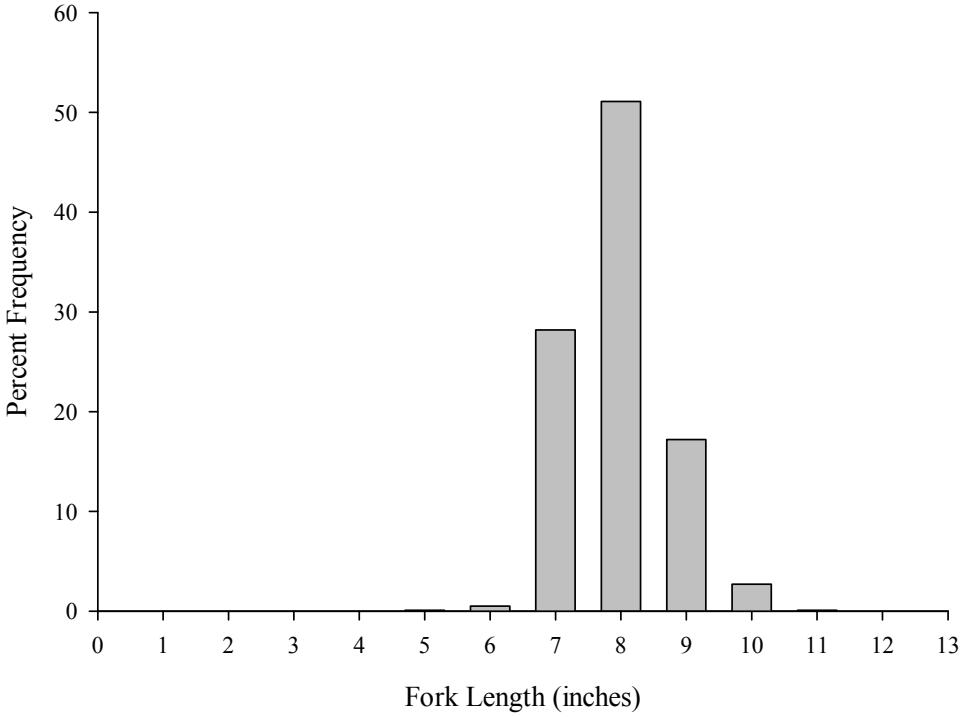


Fig. 8. Length frequency distribution for Spot from South Carolina estuarine electroshock boat surveys 2001 to 2008. n = 13,693

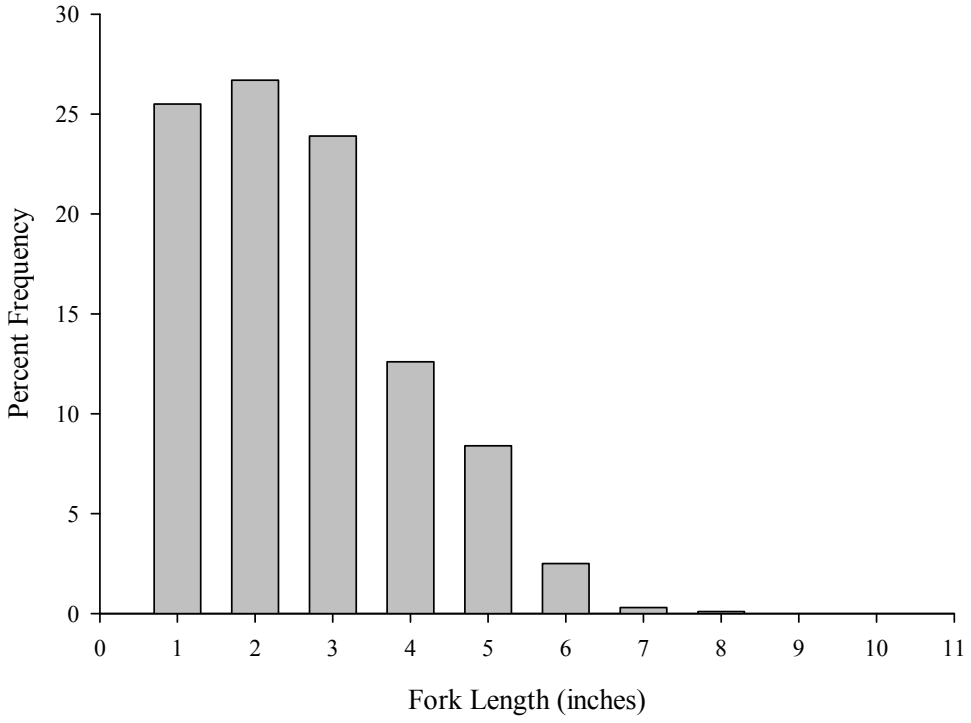


Fig. 9 Monthly size frequency distributions for Spot in South Carolina estuaries from the electroshock boat survey from 2001 to 2008

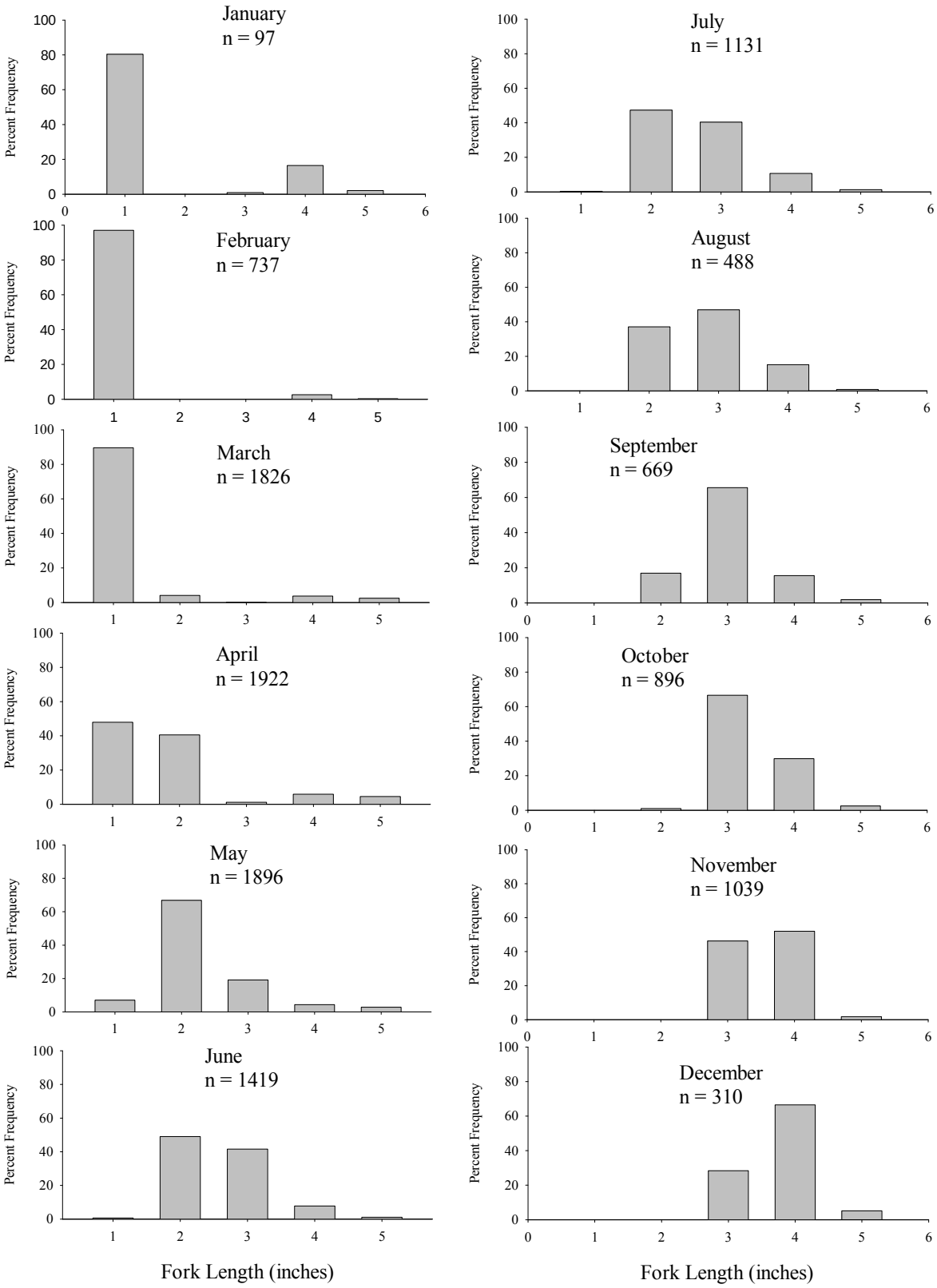


Fig. 10 Fork length frequency distribution of Spot by state for SEAMAP trawl surveys in the southeastern United States from 1989 to 2008. n = 16,989

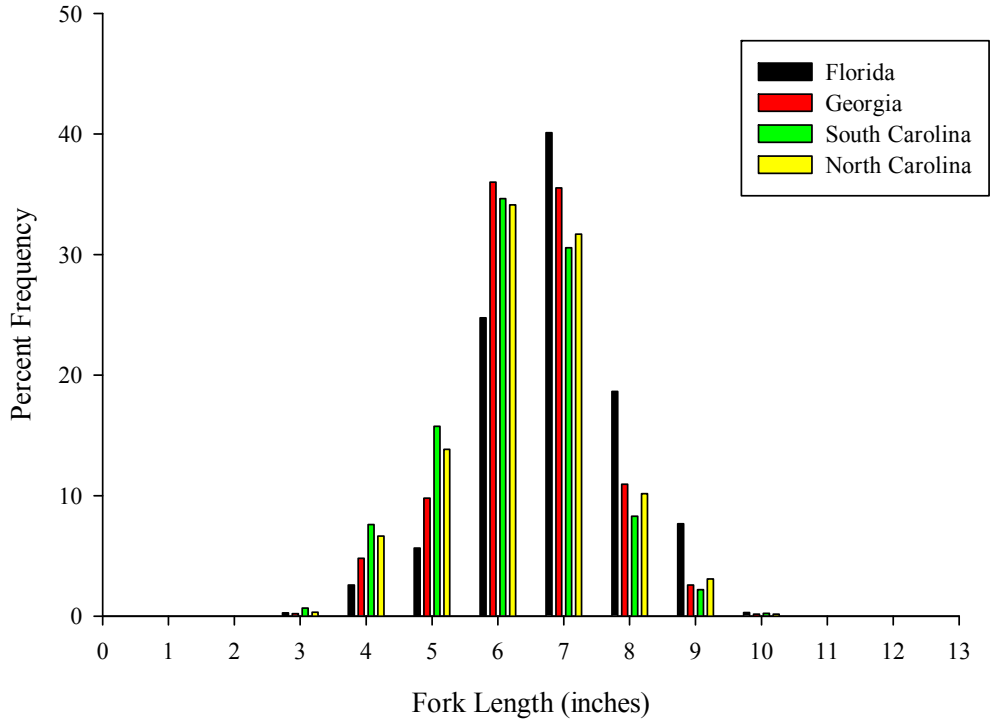


Fig. 11 Size distribution using number of spot by state for SEAMAP trawl surveys from 1989 to 2008. n = 16,989

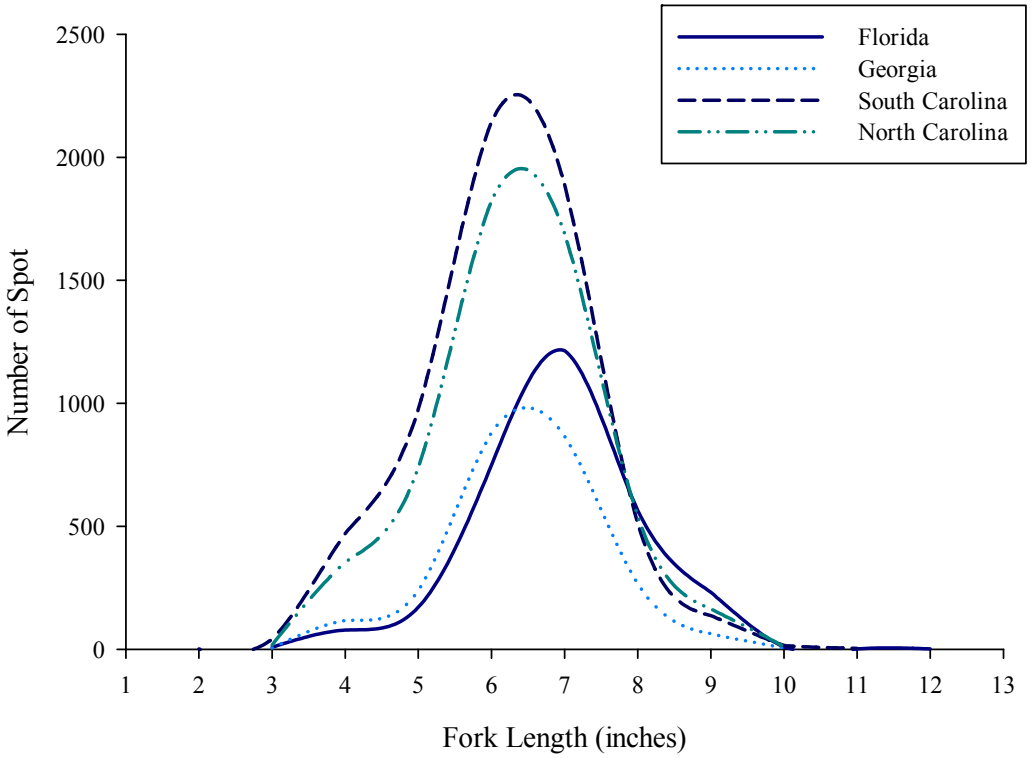


Fig. 12. Age frequency distribution for Spot from SEAMAP trawl surveys off the southeastern coast of the United States in 2001. n = 746

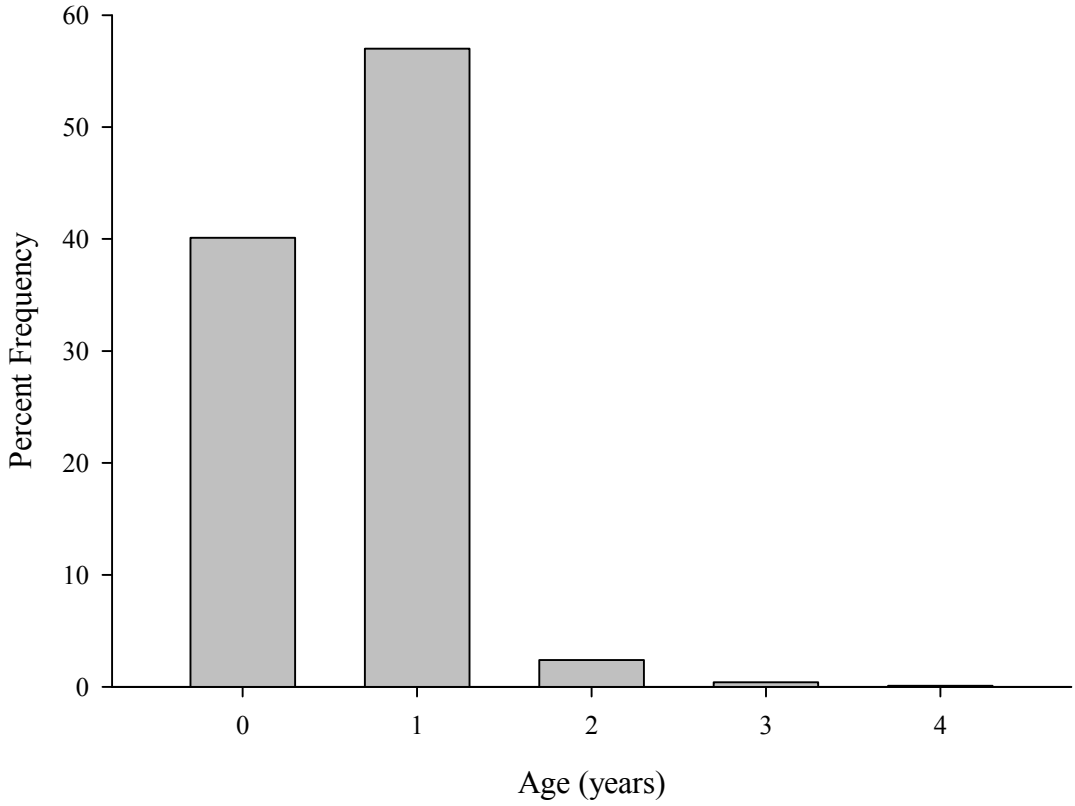


Fig. 13A Percent maturity by sex and fork length for spot from SEAMAP trawls surveys in South Carolina in 2001. Dotted line indicates size at 100% maturity.

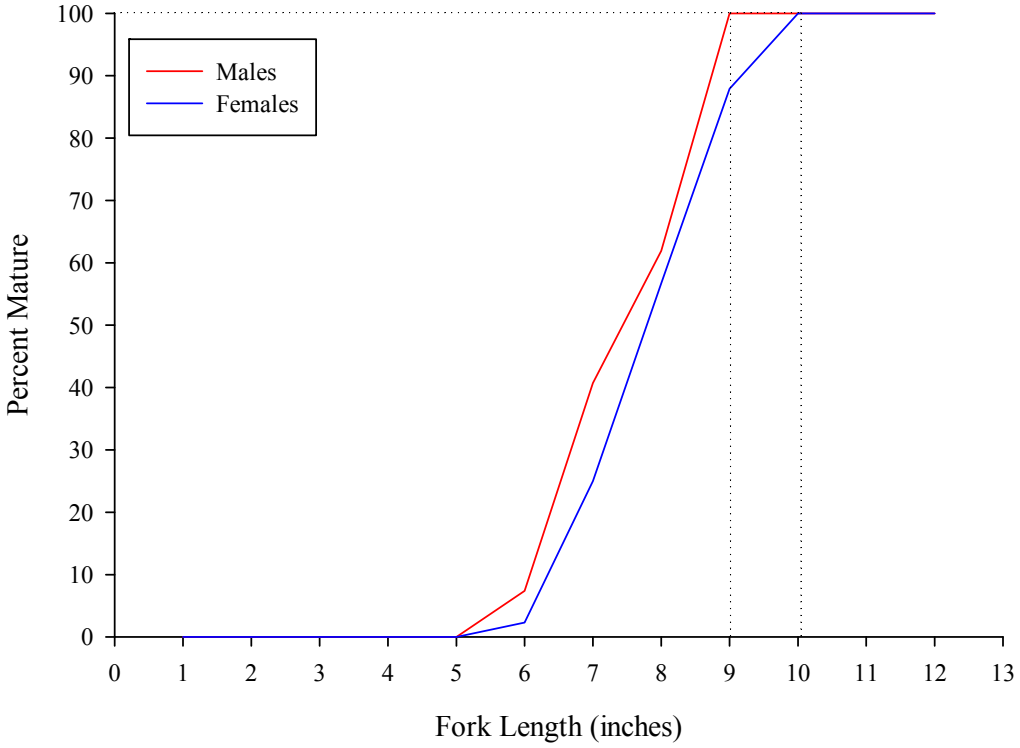


Fig. 13B Percent maturity by sex and age for spot from SEAMAP trawl surveys in South Carolina in 2001. Dotted line indicates age at 100% maturity

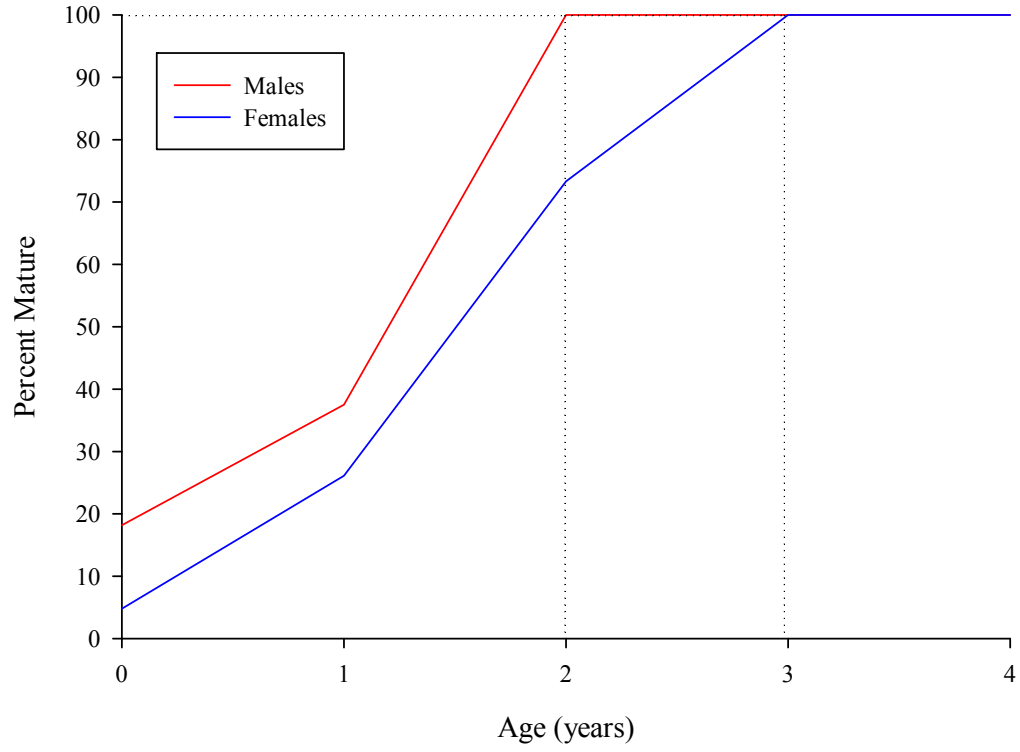


Fig. 14 Fork length vs. specimen weight with regression line for Spot from the SEAMAP survey 1989 to 2008. N = 3103

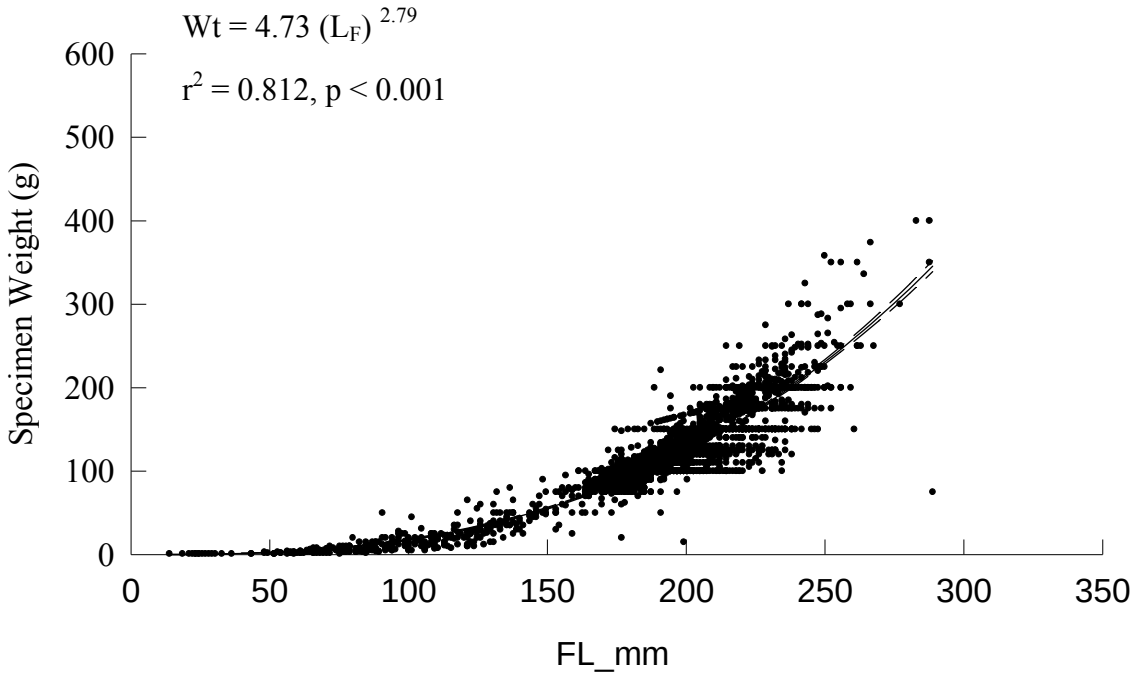


Fig. 15 Fork length at age for spot from SEAMAP suveys 2001 with von Bertalanffy growth curve for group. Dashed lines represent 95% confidence limits. n = 746

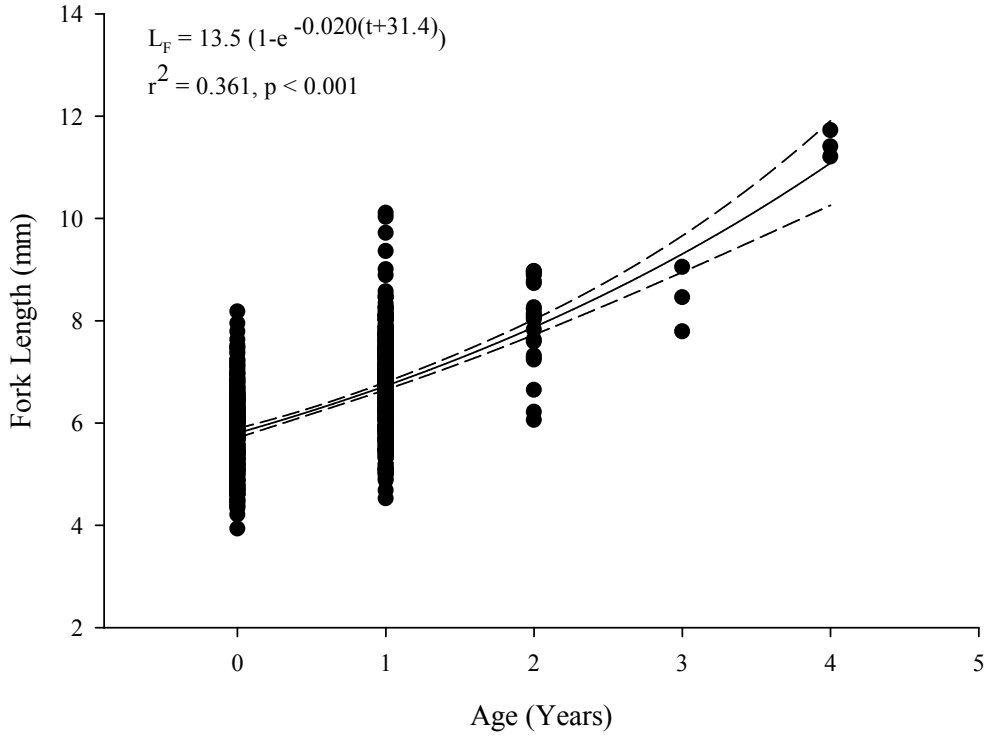


Fig. 16 Trammel net mean annual catch per unit effort for spot in South Carolina with mean annual salinity from 1991 to 2008.

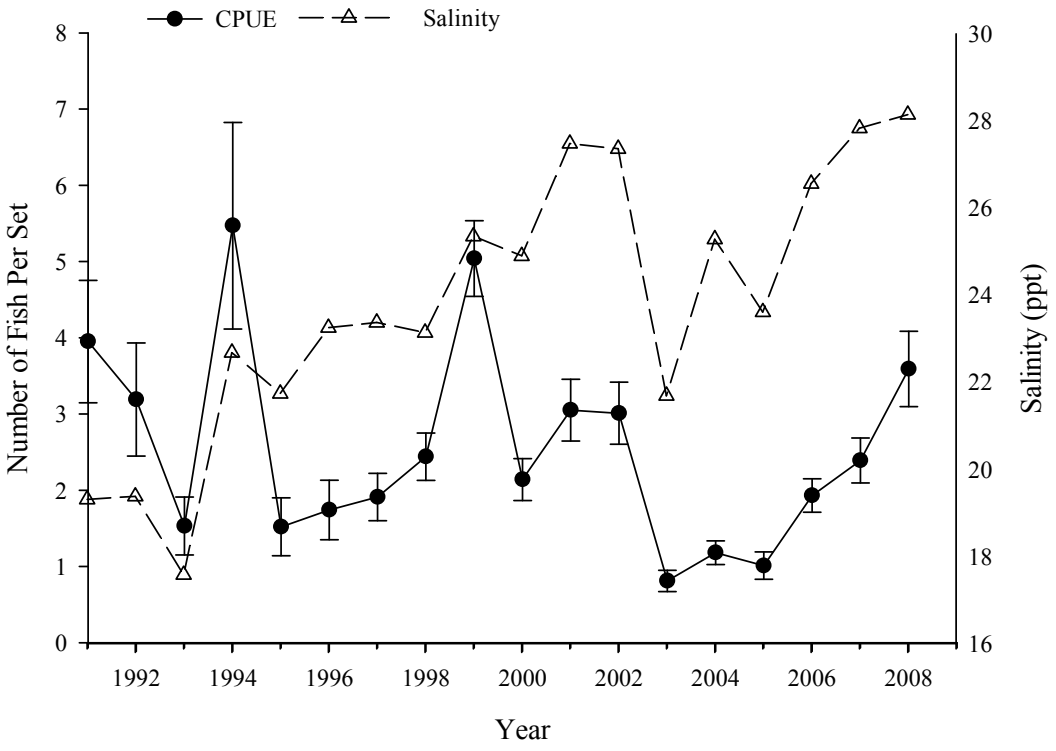


Fig. 17 Mean annual catch per unit effort for spot young-of-the-year (Jan. - Apr., <4 inches L_F) and all specimens from electroshock surveys of South Carolina estuarys 2001 to 2008.

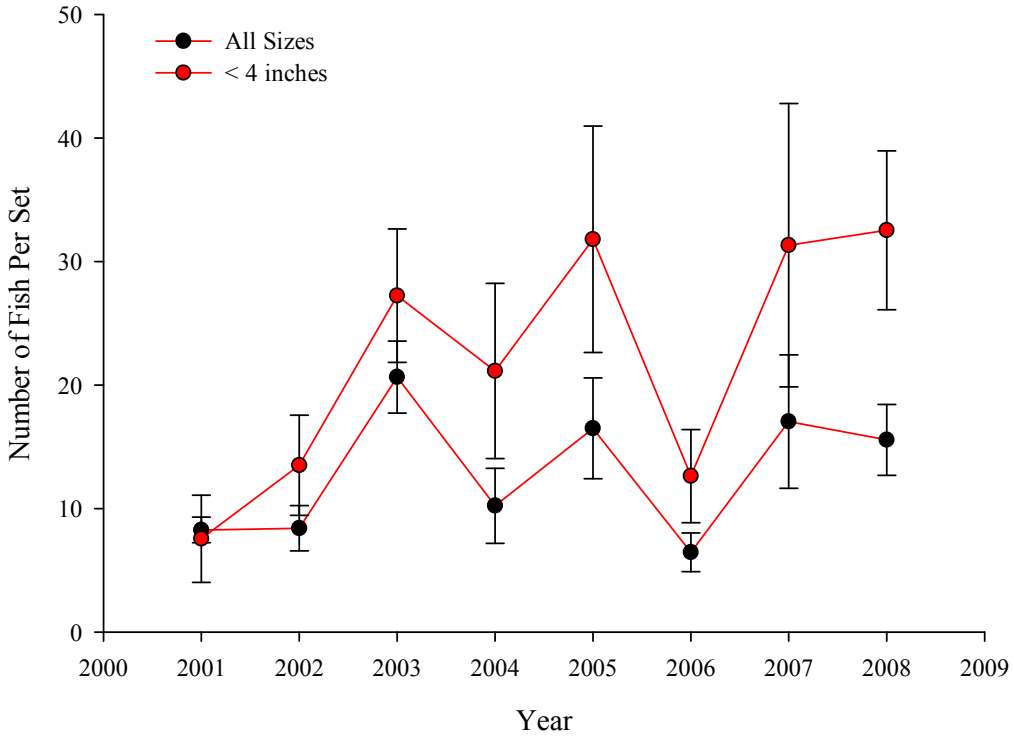


Fig. 18 Mean annual catch per unit effort for young-of-the-year spot in South Carolina estuaries from electrofishing surveys with mean annual water temperature from 2001 to 2008.

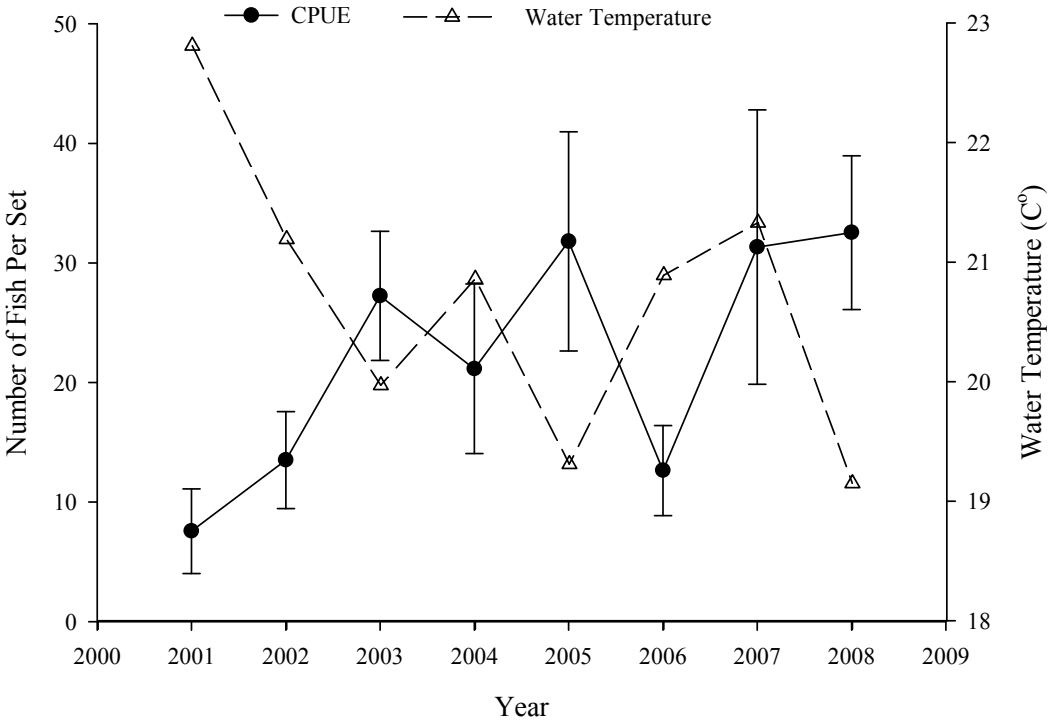


Fig. 19 Mean stratified catch per unit effort (mean kg per tow) for spot for SEAMAP trawl surveys off the South Carolina coast 1989 to 2008. Error bars represent standard error of the mean.

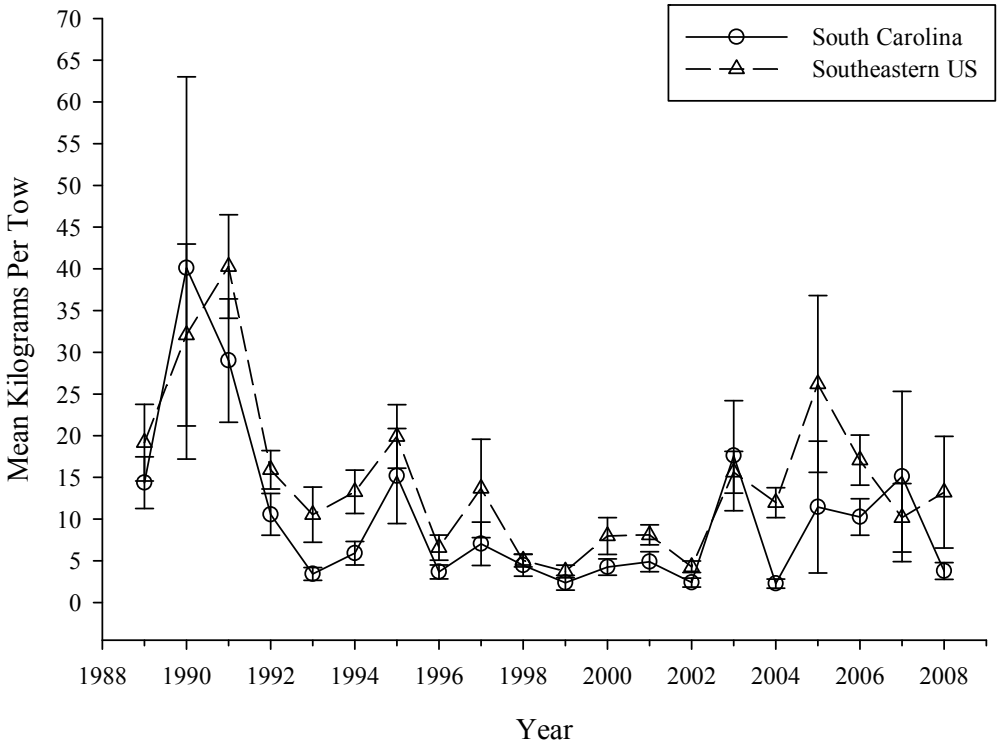


Fig. 20 Mean stratified catch per unit effort (mean kg per tow) for Spot for SEAMAP trawl surveys by state for the southeastern United States from 1989 to 2008. Error bars represent standard error of the mean.

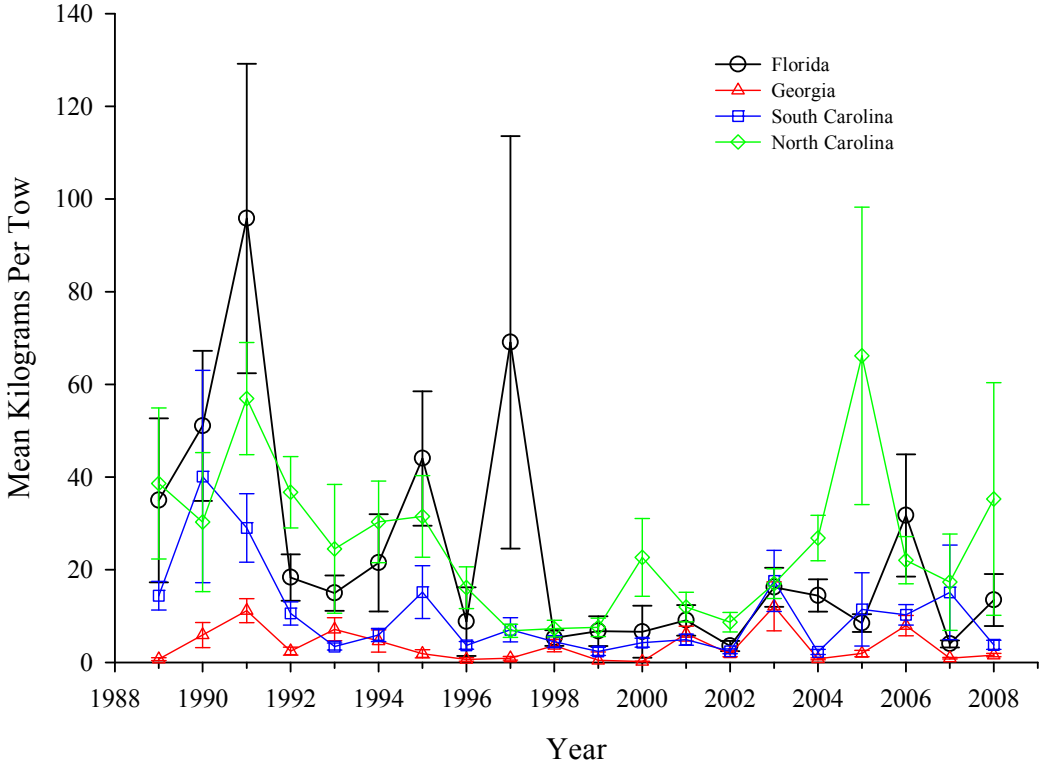
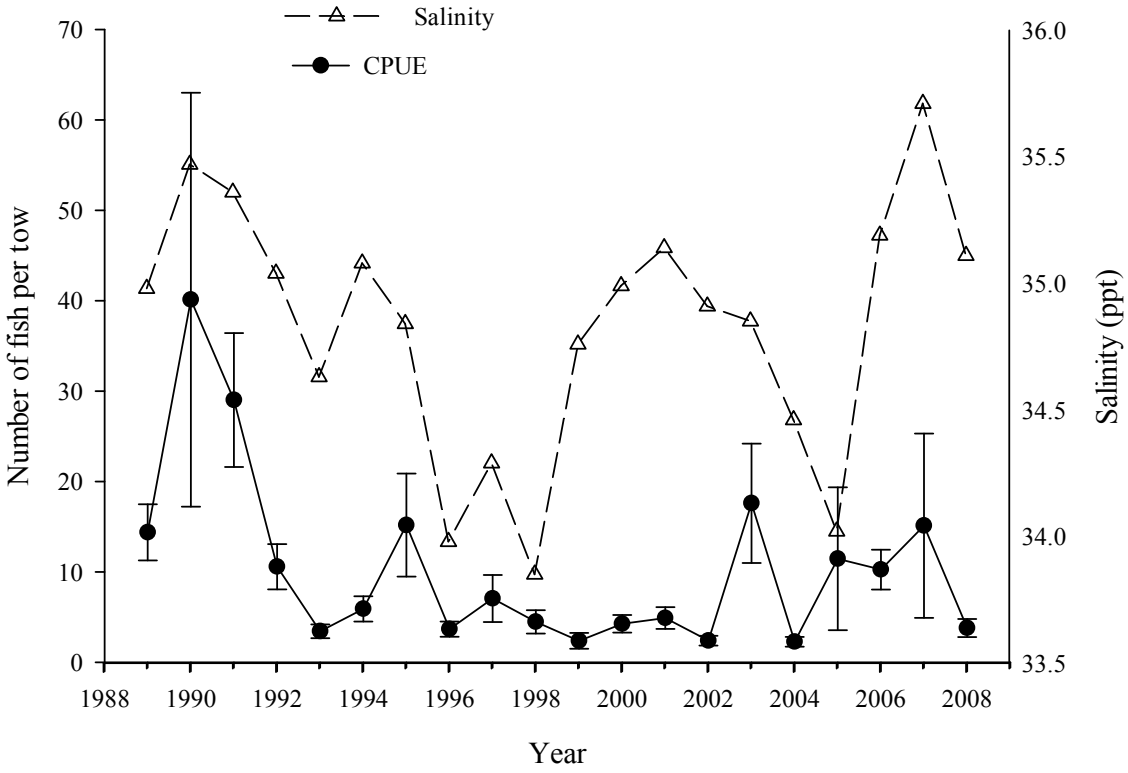


Fig. 21 SEAMAP mean annual catch per unit effort in South Carolina with mean annual salinity from 1989 to 2008.



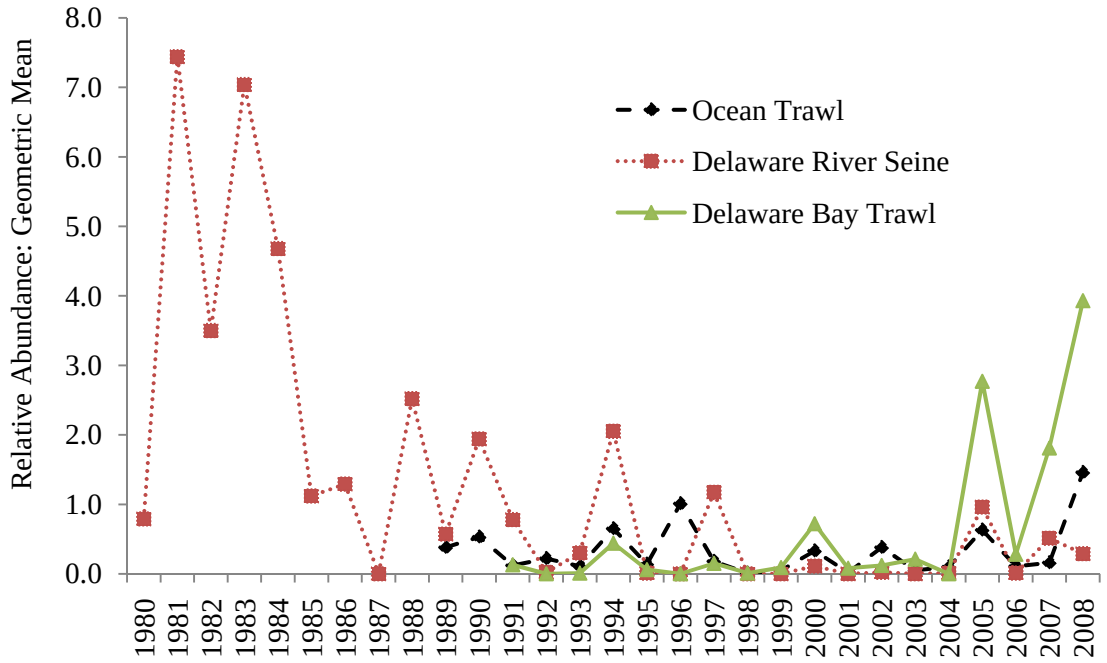
Spot Relative Abundance Indices Provided by the New Jersey Division of Fish and Wildlife

Aggregate indices of spot abundance are available from three NJ DFW surveys.

A Delaware River Recruitment Survey, a seine survey utilizing a bagged, 100-foot long by 6-foot deep by ¼-inch mesh beach seine, has been conducted for striped bass young-of-year since 1980. The survey consists of seining 32 stations twice a month from August through October. Both juvenile and adult spot are caught. For spot, the CPUE is calculated for the lower 24 stations within the Delaware River.

An Ocean Trawl Survey, consisting of five nearshore (within 12 nautical miles) surveys, has been conducted each year since 1989. These surveys occur in January/February, April, June, August, and October. The gear used is a two-seam trawl with a 25 m headrope and 0.25" bar mesh codend liner. All species taken during these surveys are weighed and measured. Catch per unit effort in number of fish per tow is calculated for each year. Both juvenile and adult spot are caught. Indices of abundance for spot were calculated for the August and October trawls only, when spot recruit to the gear and abundance is most consistent.

A Delaware Bay Trawl Survey has been conducted since 1991. A 16 foot otter trawl is used at eleven nearshore fixed stations from April to November. Both juvenile and adult spot are caught, and an aggregate relative index of abundance is generated.

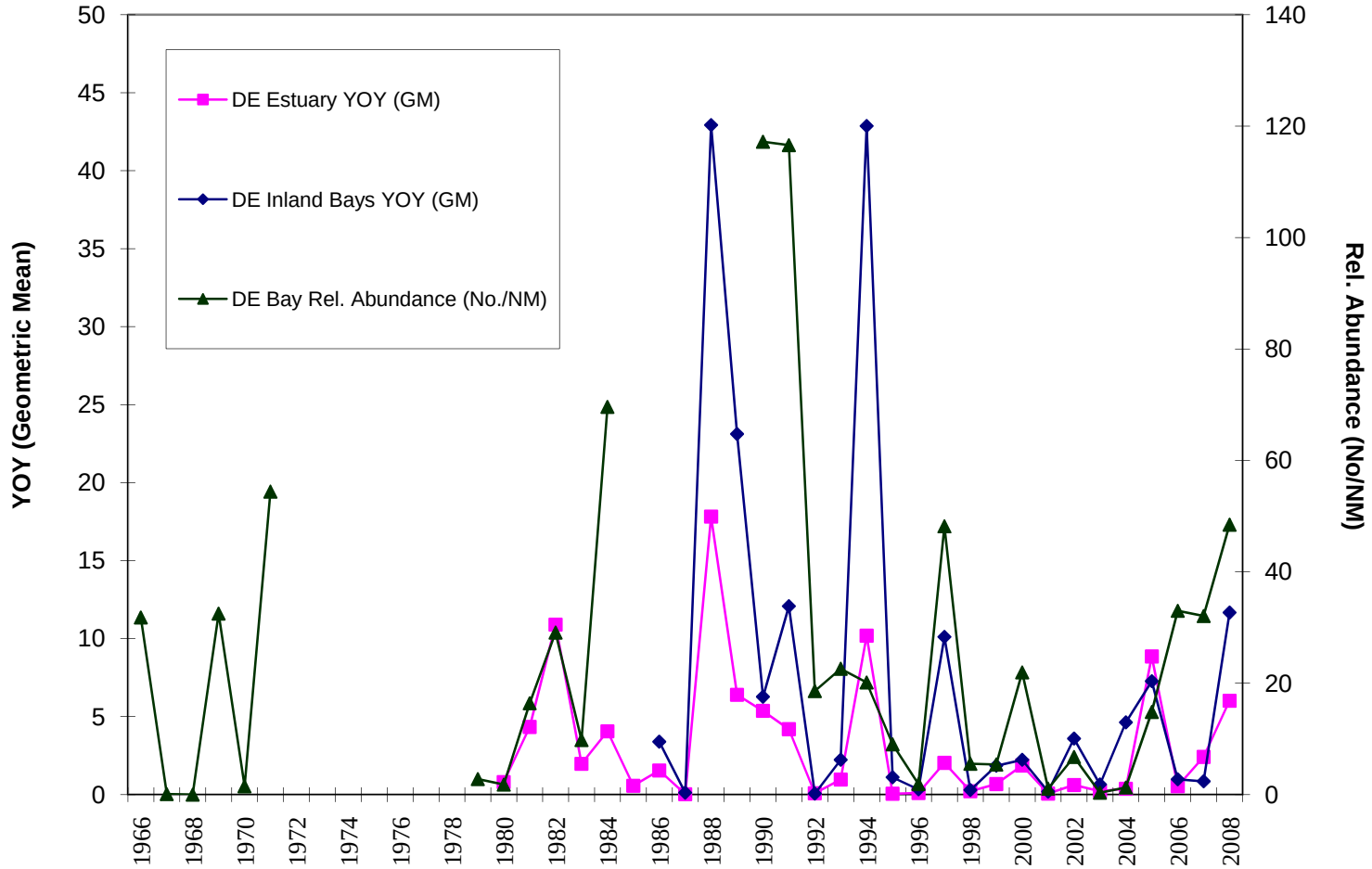


NJ Spot Indices - Geometric Means

	Ocean Trawl	Delaware River Seine	Delaware Bay Trawl
1980	x	0.79	x
1981	x	7.44	x
1982	x	3.50	x
1983	x	7.04	x
1984	x	4.68	x
1985	x	1.12	x
1986	x	1.29	x
1987	x	0.00	x
1988	x	2.52	x
1989	0.38	0.57	x
1990	0.53	1.94	x
1991	0.12	0.78	0.13
1992	0.22	0.02	0.00
1993	0.11	0.30	0.01
1994	0.65	2.05	0.44
1995	0.14	0.01	0.06
1996	1.01	0.00	0.00
1997	0.18	1.17	0.15
1998	0.01	0.00	0.01
1999	0.05	0.00	0.09
2000	0.33	0.11	0.72
2001	0.02	0.00	0.08
2002	0.38	0.02	0.12
2003	0.05	0.00	0.21
2004	0.10	0.01	0.00
2005	0.63	0.96	2.77
2006	0.11	0.01	0.28
2007	0.16	0.51	1.81
2008	1.46	0.29	3.93

Spot Relative Abundance Indices Provided by the Delaware Division of Fish and Wildlife

Year	DE Estuary YOY (GM) Annual young-of-the-year index values, expressed as the geometric mean catch per tow, for spot collected during 16-foot trawl sampling in the Delaware Estuary.	DE Inland Bays YOY (GM) Annual young-of-the-year index values, expressed as geometric mean catch per tow, for various species collected during 16-foot trawl sampling in Delaware's Inland Bays	DE Bay Rel. Abundance (No./NM) Spot relative abundance (No./Naut. Mile) from 30-foot trawl sampling in the Delaware Bay
1966			31.8
1967			0.1
1968			0
1969			32.5
1970			1.5
1971			54.4
1972			
1973			
1974			
1975			
1976			
1977			
1978			
1979			2.8
1980	0.81		1.8
1981	4.34		16.4
1982	10.9		29.1
1983	1.98		9.8
1984	4.06		69.6
1985	0.57		
1986	1.55	3.39	
1987	0.03	0.12	
1988	17.82	42.93	
1989	6.4	23.12	
1990	5.37	6.27	117.2
1991	4.2	12.08	116.6
1992	0.09	0.06	18.6
1993	0.97	2.23	22.6
1994	10.19	42.87	20.14
1995	0.06	1.11	9.04
1996	0.11	0.34	1.9
1997	2.04	10.11	48.18
1998	0.22	0.29	5.55
1999	0.68	1.85	5.42
2000	1.87	2.23	21.95
2001	0.07	0.19	1.07
2002	0.62	3.59	6.76
2003	0.22	0.65	0.34
2004	0.38	4.63	1.27
2005	8.86	7.27	14.85
2006	0.54	0.98	33
2007	2.42	0.85	32.06
2008	6.02	11.67	48.46


DE Estuary YOY (GM)
DE Inland Bays YOY (GM)
DE Bay Rel. Abundance (No./NM)
YOY (Geometric Mean)
Rel. Abundance (No/NM)
0
5
10
15
20
25
30
35
40
45
50
0
20
40
60
80
100
120
140
1966
1968
1970
1972
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2002
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