Atlantic States Marine Fisheries Commission

SPOT STOCK MONITORING REPORT

Report to the South Atlantic State-Federal Fisheries Management Board
May 5, 2010

Overview

At the request of the South Atlantic State-Federal Fisheries Management Board, the Spot Plan Review Team (PRT) prepared this fourth annual report on trends in available fishery-dependent and fishery-independent indices of relative spot abundance through 2009. The PRT consists of representatives from Maryland Department of Natural Resources, Virginia Marine Resources Commission, North Carolina Division of Marine Fisheries, and South Carolina Department of Natural Resources, thus individual monitoring reports were generated for these states only. Another report on the NMFS Bottom Trawl Survey was provided by South Carolina Department of Natural Resources. Additional fishery-independent data were provided by staff from New Jersey Division of Fish and Wildlife and Delaware Division of Fish and Wildlife.

Provided below is a brief overview of the reported indices of relative spot abundance. See the attached reports for more detailed descriptions and discussion. Overall conclusions on the stock's health and recommendations from the PRT to the Management Board are included.

Fishery-Dependent Data Summary

1. Commercial Harvest Per Unit Effort

Commercial harvest and effort data from Maryland, Virginia, and North Carolina from the states' respective commercial monitoring programs were used to create commercial harvest per unit effort (HPUE) indices for seven fisheries. These fisheries generally operate as multi-species fisheries; shifts in target species, because of market prices and/or species availability, lend some uncertainty to the observed trends. All 2009 data are preliminary.

MD Inshore Pound Net Fishery: pounds per trip generally increased from 1980−2005, but have declined three of past four years (2006−2007, 2009) because of low catch despite stable effort.

MD Inshore Gill Net Fishery: pounds per net yard hour were zero 1980−1984, moderate and variable through the 1990s, increased to a peak in 2002, declined to a moderate level 2005−2008, and increased in 2009.

VA Inshore Gill Net Fishery: pounds per trip exhibit limited variability 1994−2009, with the 2009 value being above average.

VA Haul Seine Fishery: pounds per trip were variable around the mean from 1994−2006, exhibited a sharp increase 2007−2008 before returning to average level in 2009.

NC Long Haul Seine Fishery: pounds per trip were variable with slightly increasing trend 1994−2000, but declined nearly consistently 2001−2009, reaching the time series low in 2009.

NC Inshore Gill Net Fishery: pounds per trip exhibit limited variability since 1994, but have been declining slightly since 2000, although the 2009 value is a slight increase from 2008.

NC Ocean Gill Net Fishery: pounds per trip vary widely but declined consistently from 2004 to the time series low in 2008; the 2009 value exhibits a large increase but is still below average.

2. Recreational Harvest Per Unit Effort

Recreational harvest and effort data from the Marine Recreational Fisheries Statistics Survey (MRFSS) for Maryland, Virginia, North Carolina, and South Carolina have been used to estimate harvest per unit effort (HPUE) in past reports; the trends below are through 2008 only as 2009 data were incomplete at the time the state reports were generated. Effort is represented by trips in which anglers reported catching or targeting spot. Trends from additional state recreational programs are also reported below.

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

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

SC MRFSS: HPUE is 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 Charter Boat Logbook: catch per angler generally declined 1993−2001 and generally increased 2002−2009, with the 2009 value above the time series average.

MD Citation Program: distribution of citations for spot > 12” was low 1994–1998, high 1999–2004, and similarly low 2005–2009.

NC Recreational Commercial Gear License: survey suspended in 2009 so no updated trends; pounds harvested 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 2001 maximum, decreased but remained moderate 2002−2006, and has been low or non-existent 2007−2009.

3. Characterization Data

Data from Maryland, Virginia, and North Carolina 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. Because of limited sample sizes for ages 4+ fish, only trends for ages 1−3 fish are discussed. Developing the Maryland matrices required borrowing some data from other states, which could influence the accuracy of the observed trends.

MD Commercial Pound Net Fishery: 1980−2009 CAA include ages 0−6, but are dominated by age 1 and sometimes age 2 fish; age 3 represented all but one year, ages 4-6 fish not present every year and are a small proportion of the catch; no clear trend in the CAA; lighter WAA and shorter LAA for ages 0−3 in recent years.

VA Commercial Fisheries: 1998−2009 CAA for gill net (GN), pound net (PN), and haul seine (HS) caught spot include ages 0−6, but only ages 1−2 always present, and age 1 generally dominates; CAA expanded from ages 0−2 in 1998 to ages 0−6 in 2004−2005 and returned to ages <4 by 2009; WAA for GN ages 1−3 show limited variability or vary without trend, for HS ages 1−3 generally declined, and for PN age 1 was variable but generally declining and ages 2−3 declined 2001−2006/2007; LAA for GN ages 1−2 show no trend and age 3 a slight decline, for HS ages 1−3 show slight decrease, and for PN ages 1−2 have no trend and age 3 declined 2002−2007.

NC Commercial Fisheries: no processing of otoliths collected in 2007−2009; 1998-2006 CAA includes ages 0−6, but only ages 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 available.

Fishery-Independent Data Summary

1. Juvenile Relative Abundance Indices

Young-of-year (YOY) relative abundance indices from eight surveys reported.

DE Delaware Bay 16-ft Trawl Survey: variable throughout the time series but higher peaks 1980−1996 than 1997−2009, although modest peaks in 2005 and 2008; 2009 value decline from 2008.

DE Inland Bays 16-ft Trawl Survey: variable throughout the time series but higher 1986−1996 than 1997−2009; decline in 2009 index value after modest peak in 2008.

MD Chesapeake Bay Trawl and Seine Surveys: seine survey generally declining since peak in 1977; both surveys generally low with a few spikes in abundance since 1989; modest spikes in 2008 are followed by low index values in 2009.

MD Coastal Bays Trawl and Seine Surveys: highly variable; moderate to high peaks in 2008 are followed by 5th lowest values in 2009.

VIMS Juvenile Trawl Survey: generally higher prior to 1992, low since then, except an increase 2006−2008 although the 2009 index returned to pre-2006 level.

NC Estuarine Trawl Survey: wide fluctuations with apparent peaks every 3−4 years; decline in 2009 from above average index in 2008.

NC Pamlico Sound Trawl Survey: variable without trend; decline in 2009 from above average index in 2008.

SC Electroshock Survey: high variability 2001−2009 with no clear trend; 2009 value exhibits large decline to below the time series average.

2. Adult or Aggregate Relative Abundance Indices

Adult or aggregate (mix of YOY and older spot) relative abundance indices from six state survey, plus two multi-state survey, were reported.

NJ Delaware River Seine Survey: variable with high and moderate peaks and over all declining trend 1980−1997, then low 1998−2009 with a small peak in 2005; the 2009 value is the lowest in the time series.

NJ Delaware Bay Trawl Survey: 2009 value not available to update trend; generally low and stable since 1991, with a spike in abundance in 2005, and consecutive increases 2007−2008 to time series high.

NJ Ocean Trawl Survey: high inter-annual variability throughout the time series; decline in 2009 index after time series high in 2008.

DE Delaware Bay 30-ft Trawl Survey: variable during disjoint portion of time series, then generally a decreasing trend 1990−2004, an increasing trend 2005−2008, with the 2009 value exhibiting a return to lower relative abundance.

NC Independent Gill Net Survey: overall decline from 2001−2007, with 2008−2009 values low and stable.

SC Trammel Net Survey: variable 1991−2002 with peaks in 1994 and 1999, before dropping to lowest value in 2003 and slowly increasing to above the time series average in 2008 and 2009.

NMFS, NY-NC combined: increasing from 1972–1975, generally above average 1976–1991, generally below average 1992–2004, and return to at or above average 2005–2009, with an increase in the 2009 value; abundance also increased from north to south, and decreased from midshore to offshore generally.

SEAMAP, NC-FL combined; variable but overall decline from 1989−2002, followed by variable with no trend through 2009; the 2009 value increased to the time series average; similar trends in individual state indices, with SC, GA, and FL increasing in 2009 and NC decreasing in 2009.

Stock Monitoring Conclusions

The Spot PRT remains concerned about the spot population. Coastwide commercial landings have declined since 1950. Commercial harvest-per-unit-effort is generally stable or declining in the two states with the largest landings. Increases in 2009 are not expected to persist due to poor recruitment in 2009. The commercial catch-at-age data, which showed an expansion of the age structure in the early 2000s, has contracted the last several years. Length-at-age and weight-at-age have decreased for ages 1-3 spot. Distribution of citations for recreational catch of spot has decreased the last several years, which supports the trend of reduced availability of older spot. Recruitment indices show great inter-annual variability as expected, but those with longer time series exhibit a decline in the magnitude of peaks over time. All juvenile abundance indices reviewed showed poor production in 2009. Most indices of adult spot in the species core area are also either stable or declining.

Last year, the Spot PRT stated that it would recommend the initiation of a stock assessment if the majority of indices declined in 2009, otherwise it would recommend monitoring on an every 2-3 year basis. Based on the trends through 2009, the PRT would recommend the initiation of a stock assessment but for one complication: the ability to conduct a spot stock assessment that would pass peer review. While the life history data compiled by the PRT this year appears adequate for certain assessment models (e.g., surplus production model, a length-based model), there is a major deficiency in bycatch and discard data for spot. Estimating spot bycatch in the shrimp trawl fishery would be extremely problematic, and there are numerous other fisheries that likely discard a large amount of small spot that have no monitoring (e.g., pound net fishery discards in Maryland, scrap/bait fishery landings in Virginia).

Therefore, the Spot PRT supports the Management Board request for the Omnibus Amendment to include a trigger based on available spot data. Specifically, the Spot PRT recommends a management trigger based on an annual review of spot data, which would thus also serve as a stock monitoring program. The trigger should result in the consideration of management action rather than a stock assessment (like the Atlantic croaker management plan trigger) due to the problems with conducting a stock assessment. Because the trigger would prompt management action, the specifics of what fires the trigger will have to be carefully analyzed and determined. The Spot PRT plans to begin work on this for inclusion in the Draft Omnibus Amendment. In the mean time, it is critical that additional bycatch monitoring programs be established if spot is to be assessed through a benchmark assessment in the future.

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

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Evaluation of the Status of Spot in Maryland - 2009

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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 subsequent years.

Spot commercial CPUEs were updated through 2009 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 through 2008 and updated Maryland charter boat log data through 2009. Juvenile indices (JI) were also updated, through 2009, 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 1993-2009, and catch at age, mean weight at age and mean length at age calculated from 1998-2009.

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 2009. 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.

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 catch per haul from 1959 -2009. 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 catch by hectare. 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 catch per haul. 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 1989-2009 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 - 2009, and consequently are the only years commercial CPUEs were generated. Maryland 2009 commercial effort and catch data are preliminary at this time. The landings data will change, since some 2009 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 – 2009, so the pound net catch per trip was calculated directly from the database 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. 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.

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). Preliminary 2009 data were only available for waves one through four at the time this report was written, so no 2009 index was calculated. Maryland wave six spot harvest estimates are generally very low and often are zero, but wave five catches can be substantial. Directed trips were from anglers that reported catching or targeting spot. Annual CPUE was calculated as the annual harvest divided by the number of trips for each year from 1981 to 2008.

The second recreational index was derived from the Maryland charter boat log database. 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 1993-2009. The 2009 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 2009, excluding 2000, so only 12 inch and greater spot were included for each year. The 2000 data was unavailable for inclusion in this report.

Characterization Data

From 1993- 2009 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). In 2009 seafood dealer sampling was added, all fish were from the pound net fishery. Random boxes of fish were selected and all fish measured to the nearest mm and weight was recorded in grams. Length frequency distributions were constructed for spot, using both data sets 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 1998-2009 using Maryland pound net length frequency data, Maryland commercial landings data, Virginia Marine Recourses Commission (VMRC) and North Carolina Department of Marine Fisheries (NCDMF) age data and VMRC length weight relationships by year. The 2009 catch at age used the same data sets with the exception of the length weight relationship, which

was derived from 2009 Maryland data. 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 2007-2009 was not available to be used to in 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, increased in 2007 and 2008, but then declined sharply in 2009 (Table 1; Figure 1). The 2009 BCS GM of 1.23 fish per tow was the 2nd lowest of the 1989-2009 time series. The 2009 JSS GM of 0.44 fish per haul ranked 37th in the 51 year time series still indicating a low, but more average, year class. The Maryland Coastal Bays JIs indicated a relatively low level of abundance with several peaks, for the 1989 to 2009 time period (Table 1, Figure 2). The 2009 CSI GM of 2.47 fish per haul and the CTI GM of 2.07 fish per hectare were both the 5th lowest of the 1989-2009 time period and a sharp decline from the relatively high 2008 values.

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 2; Figure 3). In 2006 landings dropped sharply to 37,774 pounds, but 2007 landings increased 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 landings were 120,994 pounds and gill nets accounted for 48% of the catch. Preliminary 2009 landings increased to 488,596 pounds, the 5th highest value in the 1929-2009 time series. Maryland's long-term average harvest (1929 – 2008) is 142,750 pounds. Ninety-five percent of the 2009 harvest was from gill nets, and as in 2007 the majority, over 90%, was caught by four fishermen.

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 2, Figure 4). The landings estimates decreased in 2008 and 2009, with the 2009 preliminary estimate of 1,677,659 fish harvested being near the 1981-2008 time series mean of 1,716,025 fish.

When evaluating Commercial CPUEs for Maryland, it is important to consider that neither pound net or gill net, or any other gear, are generally used to target spot in Maryland. The majority of spot landings are by-catch, or are 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, since their dockside value adjusted to 2009 dollars had generally decreased slightly in Maryland until 2006 (Figure 5). The adjusted price per pound increased rapidly in 2006, and continued to increase through 2008, before declining back to the long term mean in 2009 (2009 data is preliminary). The recent above average prices for spot may be responsible for the sudden increase in gill net effort and catch. Because of the shifting nature of Maryland's spot gill net fishery, conclusions concerning relative abundance from the associated CPUE values should be considered tenuous.

Gill net catch has generally followed effort, particularly in more recent years (Figure 6). The gill net CPUE had zero values for 1980-1984, were moderate and variable through the 1990s, and then increased peaking in 2002 (Table 3, Figure7). Since 2002 the gill net index decreased back to a moderate level in 2005, remained stable through 2008, and increased in 2009.

The trend in pound net catch generally followed effort until 2006 and 2007, when effort remained fairly stable while catch declined (Figure 8). In 2008 effort remained similar to the previous 5 years, but catches increased. 2009 preliminary data indicates a decline in both catch and effort. The pound net commercial CPUE index generally increased through 2005 and then declined sharply in 2006 and 2007(Table 3, Figure 7). The 2008 pound net CPUE indicated an increase, but the preliminary 2009 CPUE indicates a sharp decline.

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 Maryland MRFSS CPUE varied widely, with a slight generally decreasing trend through 1999 and a generally increasing trend from 2000 to 2006 (Table 3, Figure 9). The 2008 Maryland MRFSS index decreased for the second straight year to approximately the time series mean. A 2009 CPUE was not generated, since wave 5 data was not yet available.

The charter boat fishery for spot was prosecuted entirely in Chesapeake Bay. The Maryland charter boat CPUE generally declined from 1993 to 2002, and generally increased from 2002 through 2007 (Table 3, Figure 9). The 2009 Charter GM of 9.6 spot per angler was above the long term mean of 8.1 spot per angler. Both the MRFSS and charter boat indices did appear to follow a similar trend, particularly in recent years (Figure 9).

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 3). There were three submissions of 12 inch citation spot in 2008 and two in 2009.

Spot mean length from the onboard sampling decreased in 2009 to 185 mm TL, the third lowest of the16 year time series (Table 4). Spot from seafood dealer sampling had a mean length and weight of 211 mm and 141 g, respectively (Table 5). The length frequency distribution in 2009 was further truncated, with fish between 150 and 199 mm TL accounting for 67% of the catch (Figure 10). Both mean length and length frequency distribution from the onboard sampling in 2009 may have been affected by the small sample size (n = 33). No jumbo spot were present in the 2009 onboard sampling. Jumbo spot in the survey have been declining for the past several years, with less than 1% of the pound net sample comprising spot >254 mm TL in 2007 and 2008, <2% in 2006 and 3% in 2005. This followed good catches in the early part of the decade (10% in 2003, 13% in 2004). The length frequency distribution from the seafood dealer survey indicated the majority of commercially harvested spot were 190 mm or greater (Figure 11), with a more normal distribution. There is no size limit for spot, but it is highly likely fishermen are discarding small spot, or selling them as bait.

Catch at age estimates for Maryland's commercial spot harvest in pounds and numbers were dominated by age one spot (Table 6, Figures 12 and 13). 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 and 2009, but since VA age sample sizes for the 15 and 16 cm length groups were very low, 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 were present in low numbers all years except 1998. Age four 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 (Figures 12 and 13). However, the estimated number at age was derived solely from pound net length frequencies and utilized VMRC length weight relationships (except 2009, which uses MD DNR data) 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 14). 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 15). 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.

References

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Table 1. Maryland juvenile spot indices, 1959-2009.

	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			
1973	3.26			
1974	2.30			
1975	4.42			
1976	3.19			
1977	6.89			
1978	3.36			
1979	2.71			
1980	2.53			
1981	1.65			
1982	2.25			
1983	1.07			
1984	3.43			
1985	1.50			
1986	1.77			
1987	1.17			
1988	4.50			
1989	0.70	41.61	24.31	15.26
1990	1.05	46.33	18.73	16.90
1991	0.81	19.52	13.30	8.36
1992	0.44	1.72	0.90	1.33
1993	1.42	10.53	4.10	5.06
1994	1.49	53.00	145.74	96.33
1995	0.10	0.36	2.01	3.33
1996	0.28	2.71	1.20	1.91
1997	1.34	15.32	57.61	46.51
1998	0.44	2.43	2.86	2.39
1999	0.61	2.86	7.13	8.05
2000	0.83	7.21	26.90	14.08
2001	0.37	2.02	1.84	1.71
2002	0.36	1.35	58.19	19.69
2003	0.31	1.77	2.39	2.99
2004	0.80	4.03	4.20	4.60
2005	3.49	52.96	35.00	16.90
2006	0.34	7.50	5.29	4.17
2007	0.61	14.09	19.37	12.98
2008	0.87	25.27	140.36	33.38
2009	0.44	1.23	2.07	2.47

Table 2. Maryland spot commercial landings in pounds, 1929-2009, and recreational numbers harvested and released, 1981-2009. 2009 values are preliminary and MRFSS estimates do not include waves 5 or 6.

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	2,296,888	2,049,388	120,994
2009	1,677,659	695,597	488,596

Table 3. Maryland spot CPUE indices and number of citation submissions, 1980-2009. Shaded 2009 values are preliminary.

Year	Pound Net	Gill Net	MRFSS	Charter	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	8.13	
1994	14.05	0.019	3.77	10.48	0
1995	12.94	0.025	4.12	11.43	3
1996	6.69	0.011	5.19	5.28	2
1997	4.72	0.013	2.02	7.23	3
1998	7.92	0.022	3.31	8.22	1
1999	8.89	0.016	2.24	6.27	35
2000	7.66	0.024	2.58	6.22	
2001	13.00	0.040	3.07	5.90	101
2002	10.50	0.055	3.50	6.23	141
2003	19.79	0.031	7.27	7.68	129
2004	9.89	0.050	3.49	7.34	70
2005	17.17	0.025	3.73	8.42	10
2006	7.90	0.026	4.93	9.82	4
2007	3.46	0.023	4.85	10.28	0
2008	16.72	0.028	3.95	8.96	3
2009	4.85	0.051		9.55	2

Index	Units
Pound Net	Pounds per Trip
Gill Net	Pounds per Yard Hour of Net
MRFSS	Fish per Trip
Charter Boat	Geometric Mean Catch per Angler
Citations	Number of citations submissions greater than 12 inches in length

Table 4. Mean total length (mm), standard deviation, and sample size of spot from Maryland Chesapeake Bay onboard sampling of pound nets, 1993-2009.

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	1354
2004	208	36	882
2005	197	37	2818
2006	191	29	2195
2007	208	23	519
2008	198	21	1195
2009	185	21	33

Table 5. Mean total length (mm), mean weight (g), standard deviations, and sample sizes of spot from Maryland Chesapeake Bay dealer sampling of the pound net fishery, 2009.

Year	Number of Lengths	Mean Length (mm)	Standard Deviation	Number of Weights	Mean Weight (g)	Standard Deviation
2009	581	211	22	572	141	50

Table 6. Catch at age for the Maryland commercial spot fishery in Numbers and pounds, 1989-2009.

Catch numbers

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 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	902,358	518,551	26,085	1,366	0	0
2008	39,809	429,304	17,581	3,081	10	0	0
2009	0	1,282,880	320,921	1,847	0	0	0

Catch Pounds

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 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	212,060	158,216	8,888	1,470	0	0
2008	5,340	108,091	6,418	1,139	6	0	0
2009	0	366,123	121,569	904	0	0	0

Table 7. Mean weight at age, in grams, of spot from Maryland commercial pound nets, 1989-2009.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1998	162.9	195.9	252.4				
1999	100.9	144.1	208.4	628.7			
2000	81.8	178.2	218.8	318.8			
2001	133.1	199.6	327.3	501.6	474.8		
2002	71.2	97.7	254.6	375.0	367.4	448.0	
2003	63.4	145.9	257.5	388.8	460.2	529.6	
2004	62.8	110.2	192.3	294.7	545.7	520.1	
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		
2007		106.6	138.4	154.5	488.0		
2008	60.8	114.2	165.6	167.7	266.5		
2009		129.5	171.8	222.1			

Table 8. Mean length at age in, centimeters, of spot from Maryland commercial pound nets, 1989-2009.

	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
1998	21.6	23.2	25.2				
1999	19.0	21.4	24.0	34.5			
2000	18.2	23.2	24.6	27.8			
2001	21.2	23.9	28.0	31.7	31.5		
2002	17.4	18.8	26.0	29.7	29.5	31.5	
2003	16.5	21.5	26.3	29.9	31.8	33.5	
2004	16.0	19.4	23.7	27.8	34.7	34.1	
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		
2007		19.9	21.8	22.7	32.5		
2008	16.5	20.0	22.7	22.8	26.5		
2009		20.6	22.6	24.5	0.0		

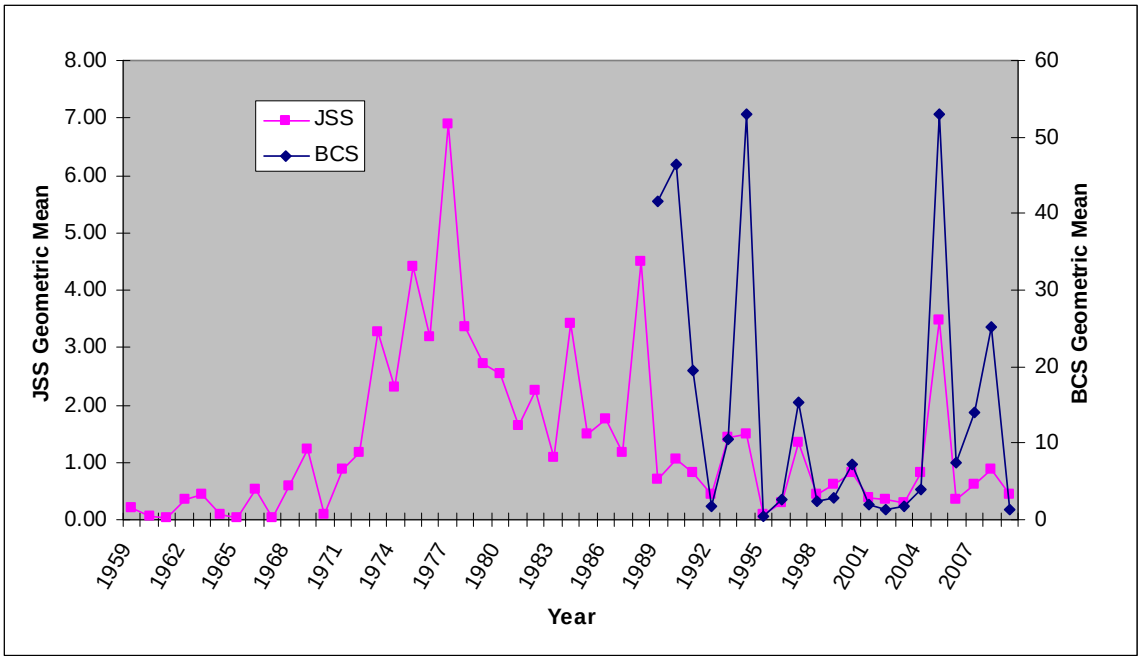


Figure 1. Comparison of Maryland Chesapeake Bay juvenile spot geometric mean indices, 1980-2009.

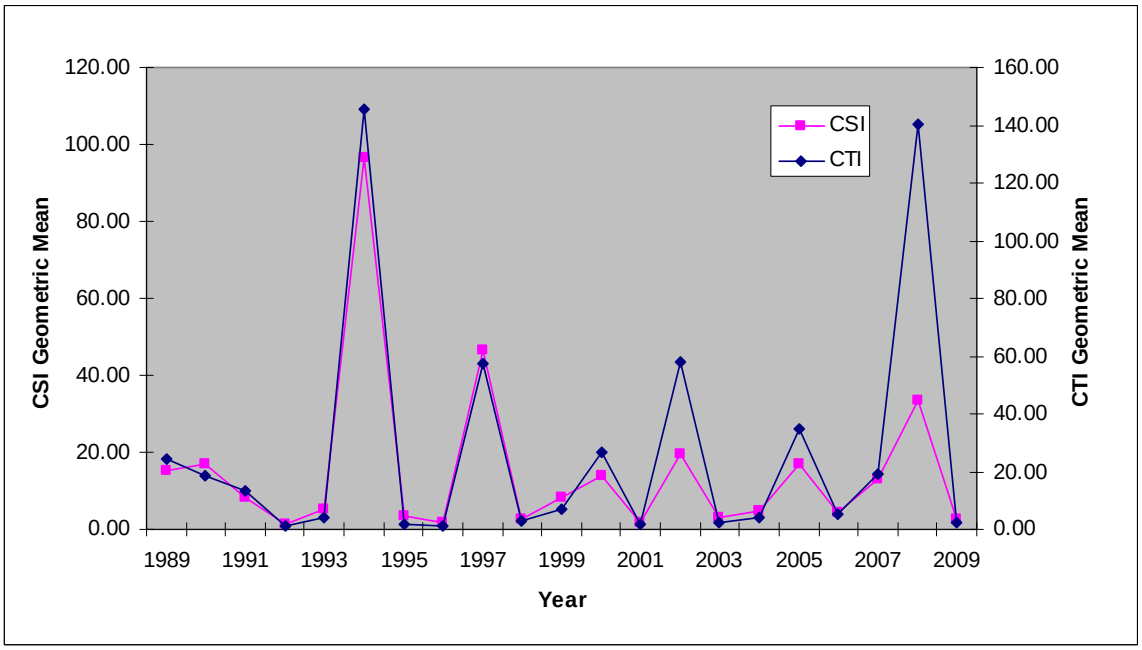


Figure 2. Comparison of Maryland Coastal Bay geometric mean juvenile spot indices, 1989-2009.

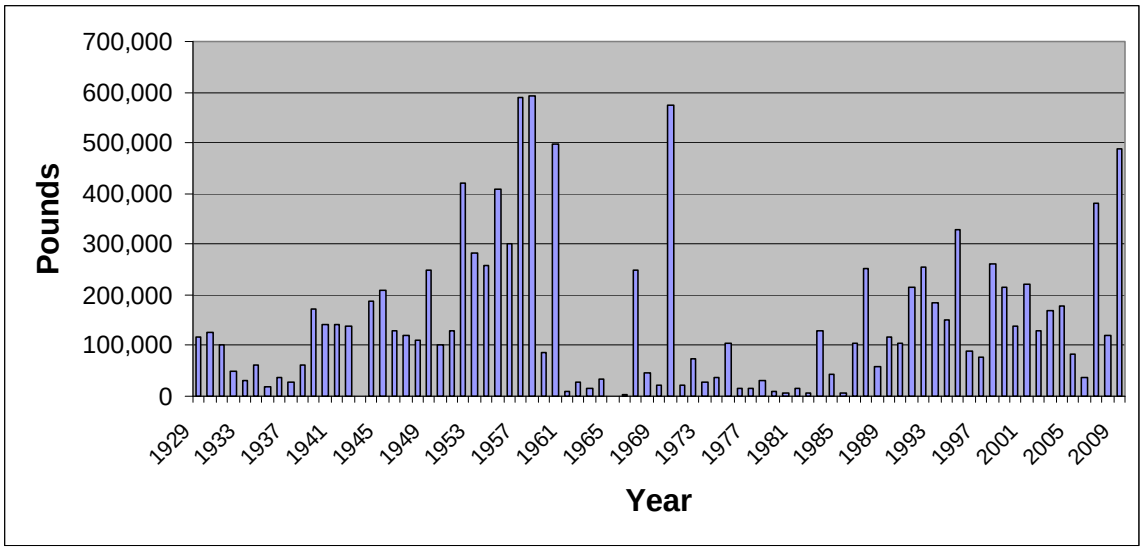


Figure 3. Maryland's spot commercial landings in pounds, 1929-2009**.** 2009 data are preliminary.

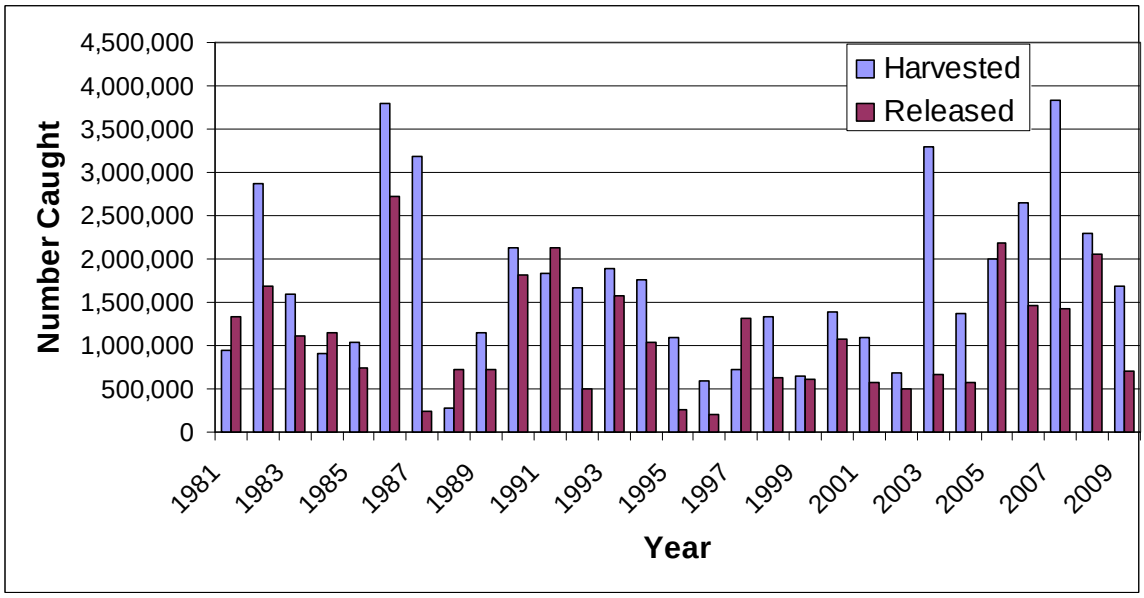


Figure 4. MRFSS estimates of Maryland spot harvest and releases, 1981-2009. 2009 data is preliminary and does not include waves 5 or 6.

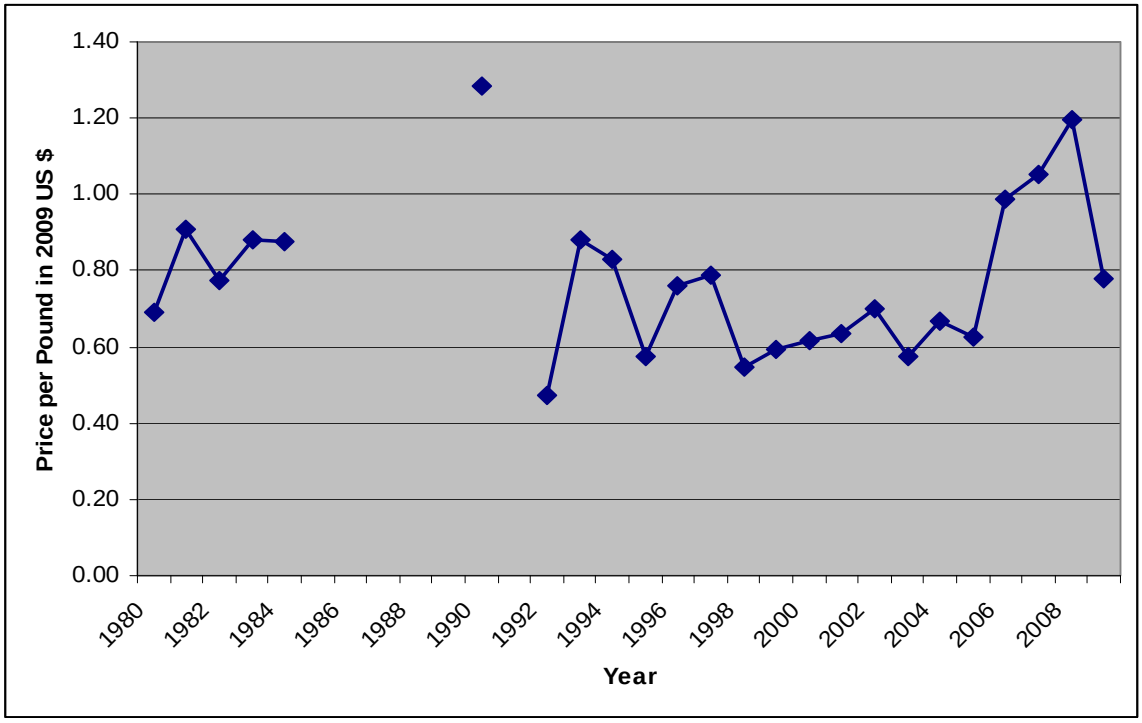


Figure 5. Price per pound, in 2009 dollars, for spot sold in Maryland, 1980-2009 for years with available data.

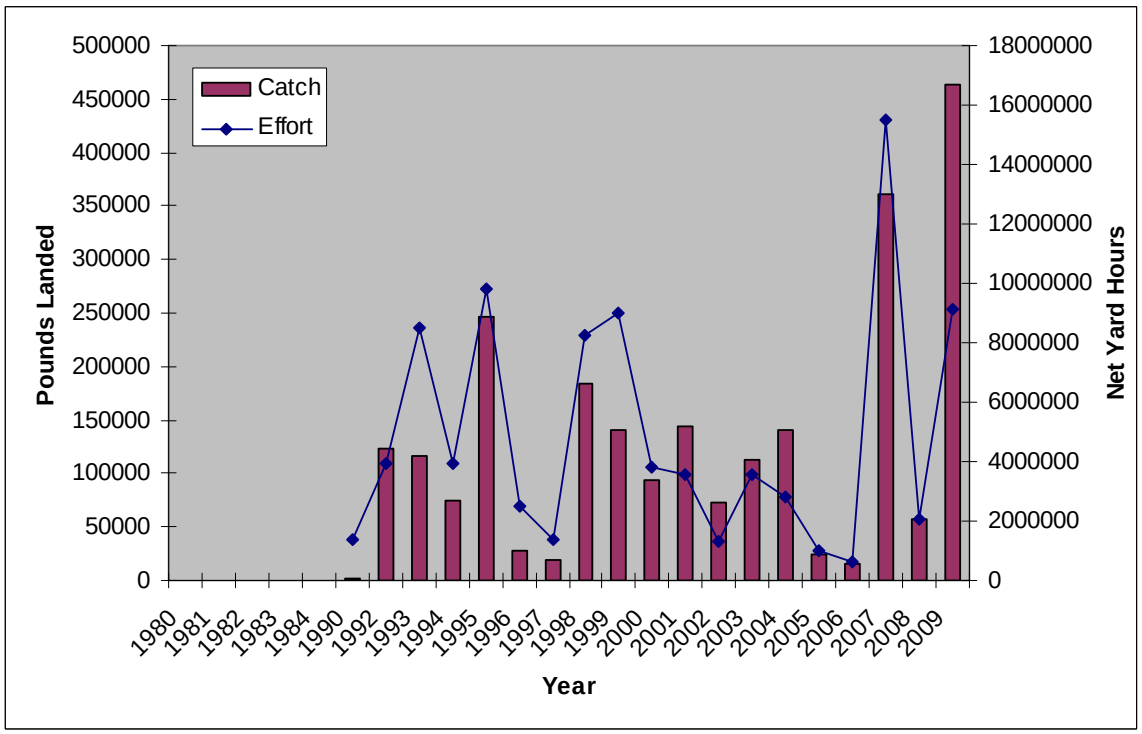


Figure 6. Maryland gill net catch and effort used in the derivation of the commercial gill net CPUE, 1980 – 2009, excluding 1985-1989 and 1991.

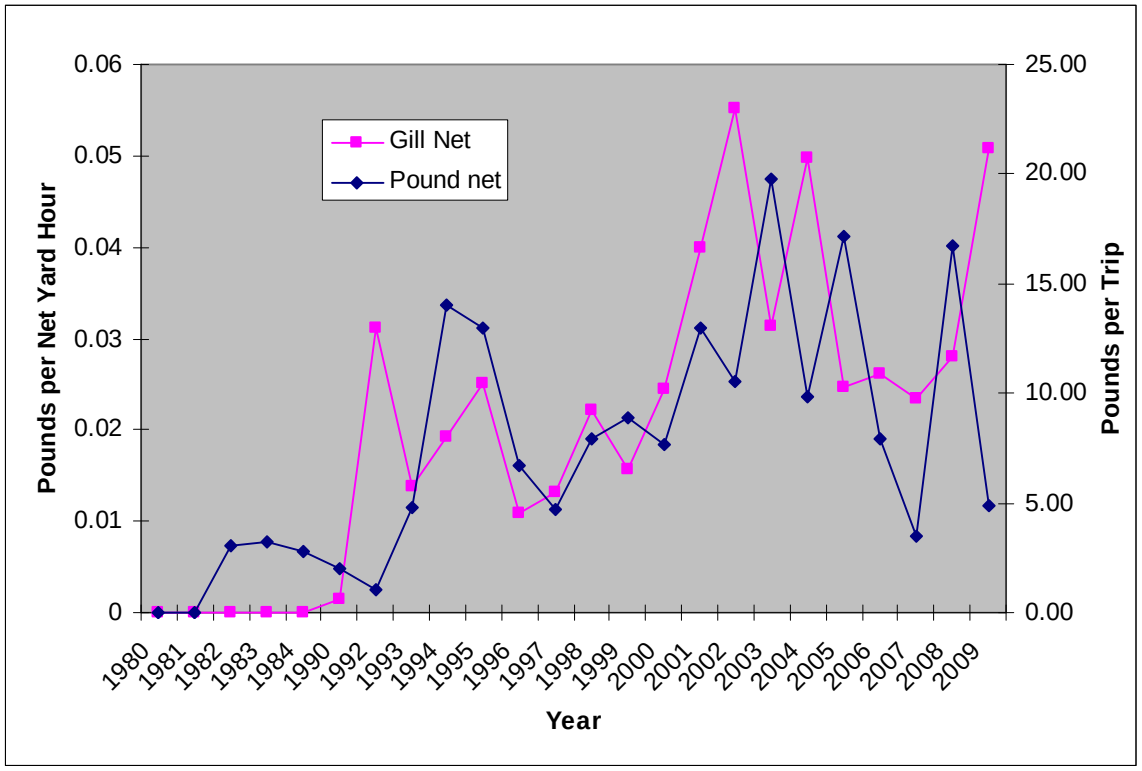


Figure 7. Maryland commercial spot gill net and pound net CPUE indices, 1980-2009, excluding years were effort was unavailable. 2009 data is preliminary.

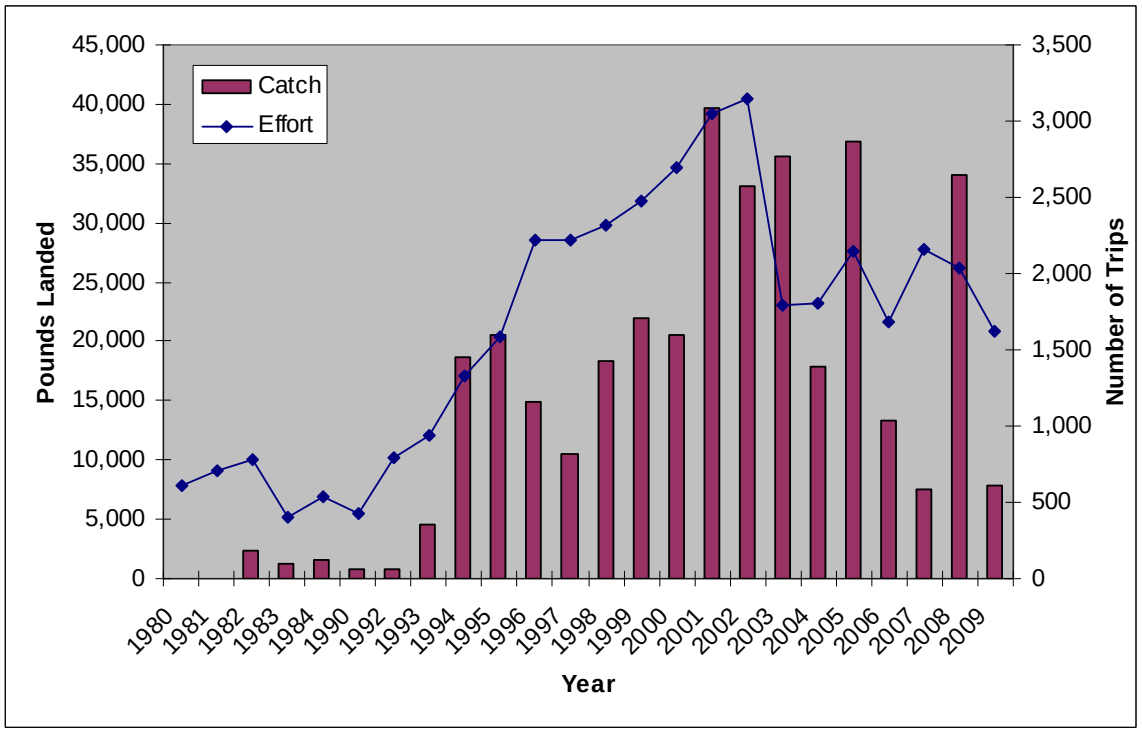


Figure 8. Maryland pound net catch and effort used in the derivation of the commercial pound net CPUE, 1980 – 2009, excluding 1985-1989 and 1991.

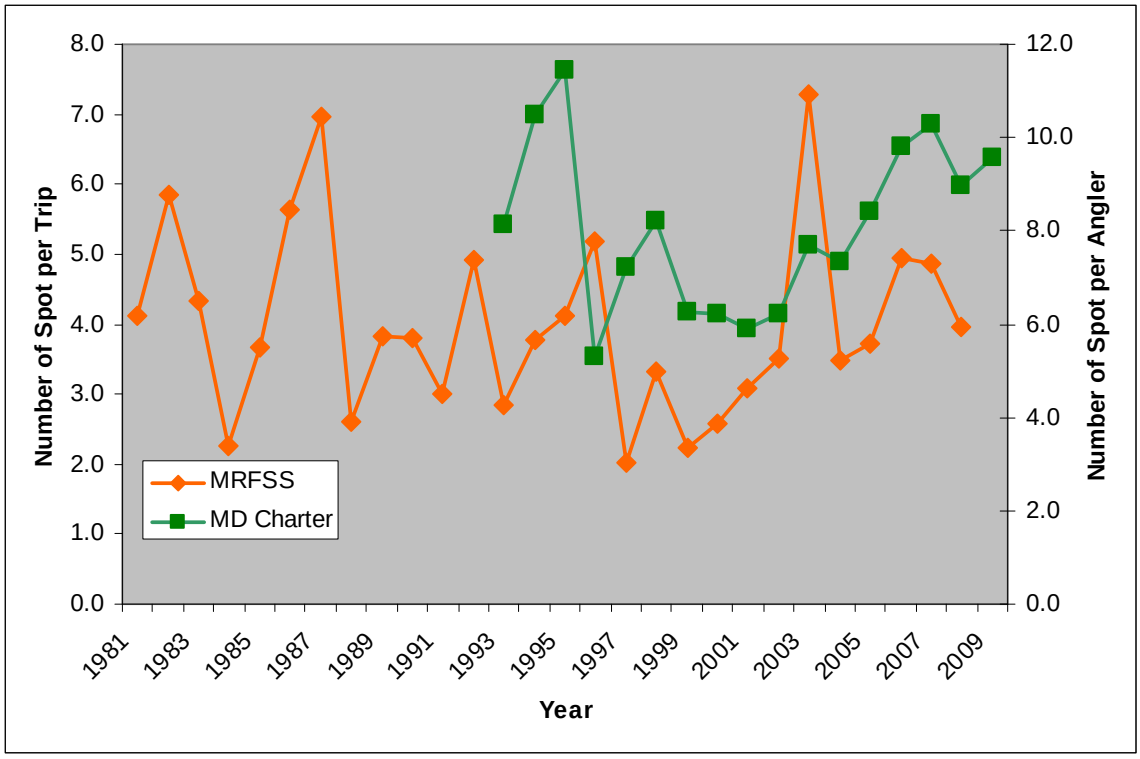


Figure 9. Maryland charter boat CPUE, 1993-2009 and inland MRFSS CPUE, 1981-2008.

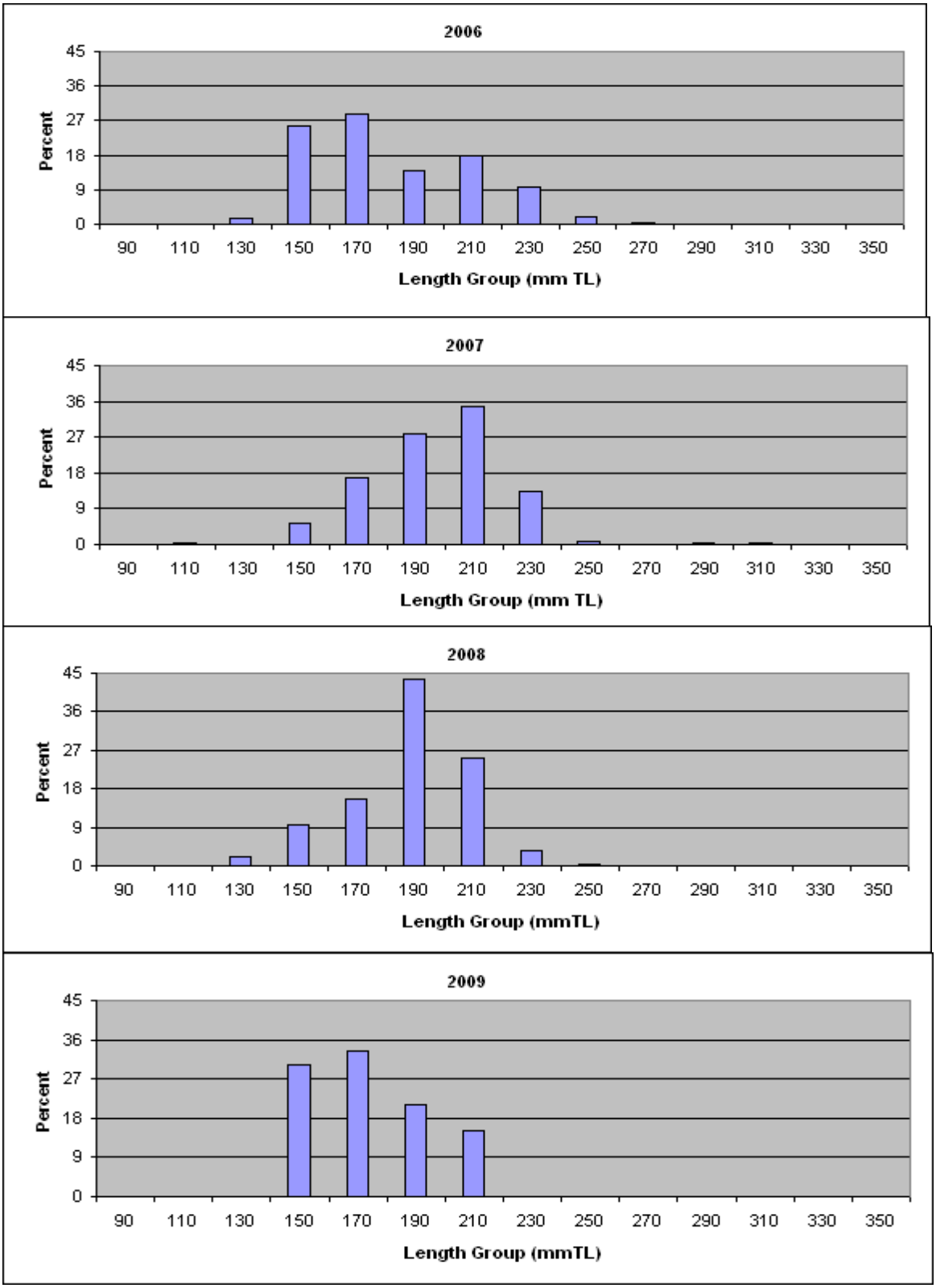


Figure 10. Spot length frequency distributions from onboard pound net sampling, 2006-2009.

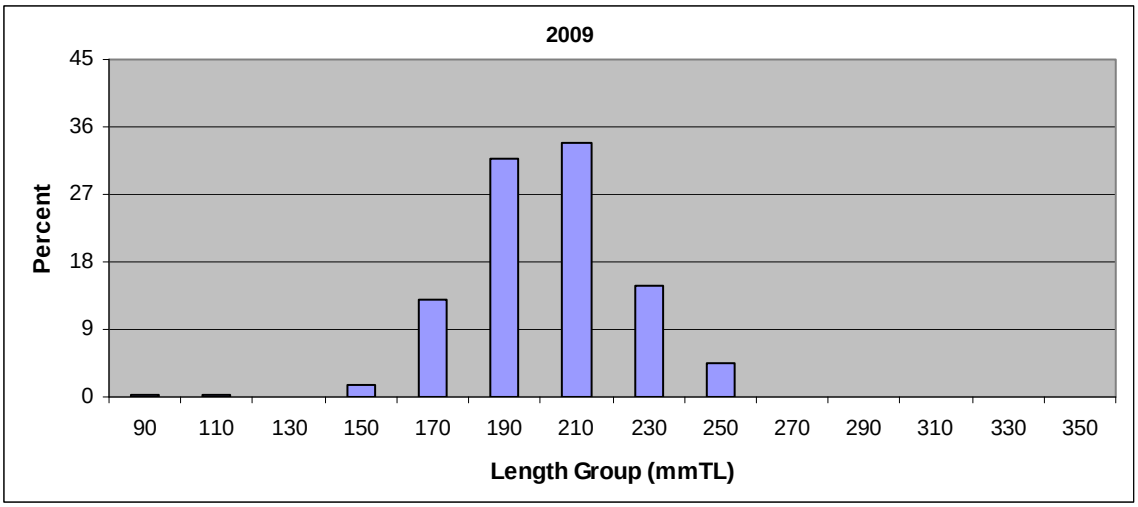


Figure 11. Spot 2009 length frequency distribution from seafood dealer sampling.

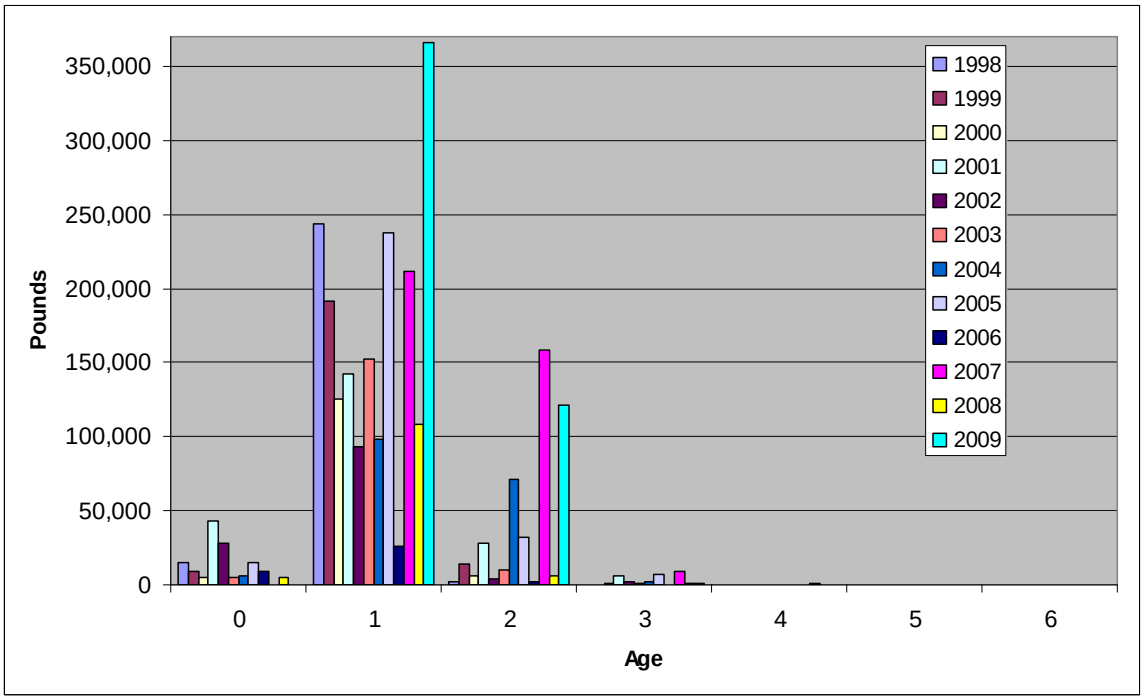


Figure 12. Spot catch at age in pounds for Maryland's commercial fishery, 1998-2009.

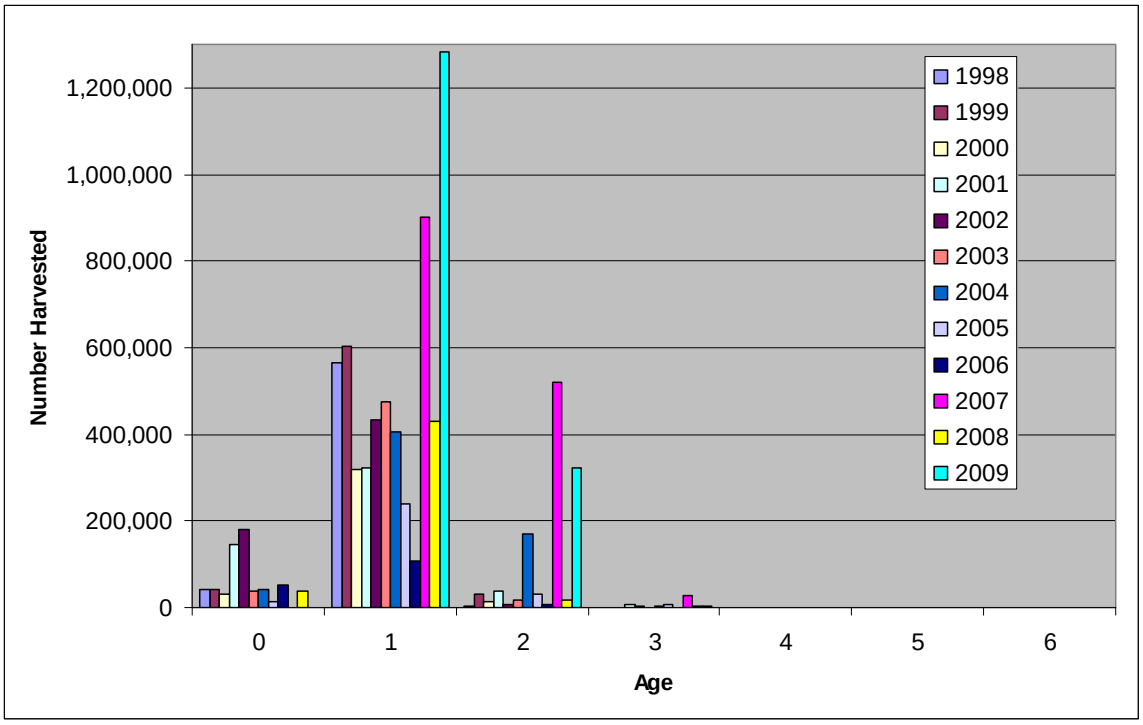


Figure 13. Spot catch at age in numbers for Maryland's commercial fishery, 1998-2009.

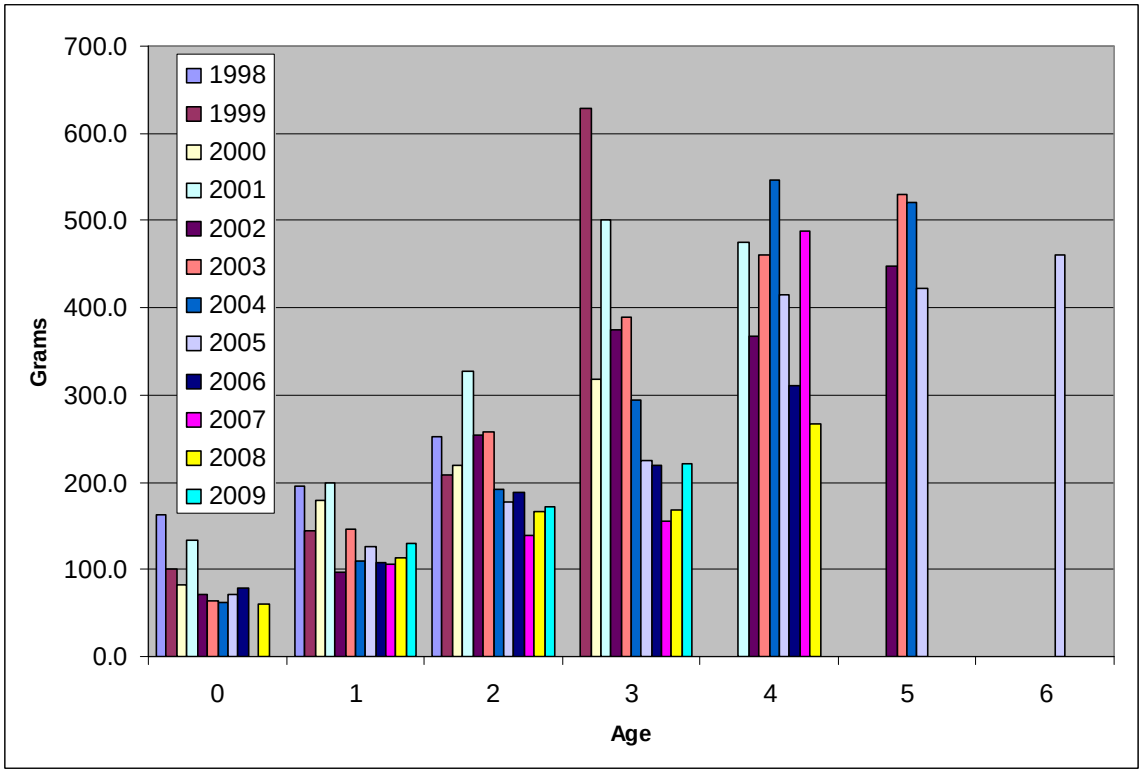


Figure 14. Spot mean weight at age in grams for Maryland's commercial pound net fishery, 1998-2009.

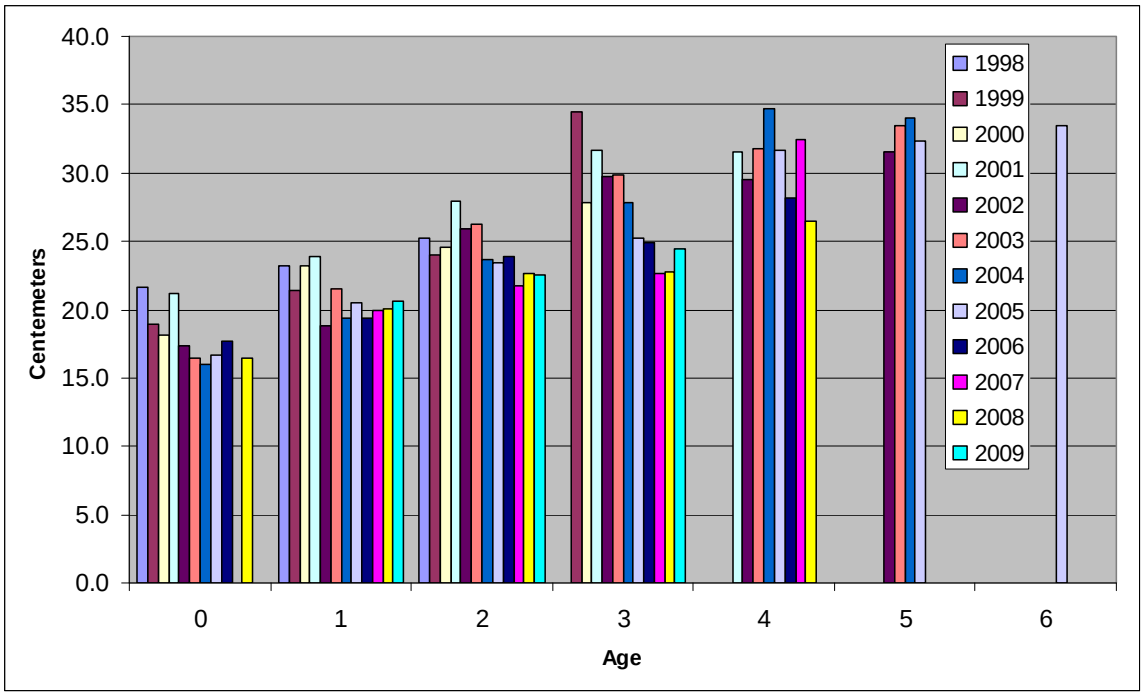
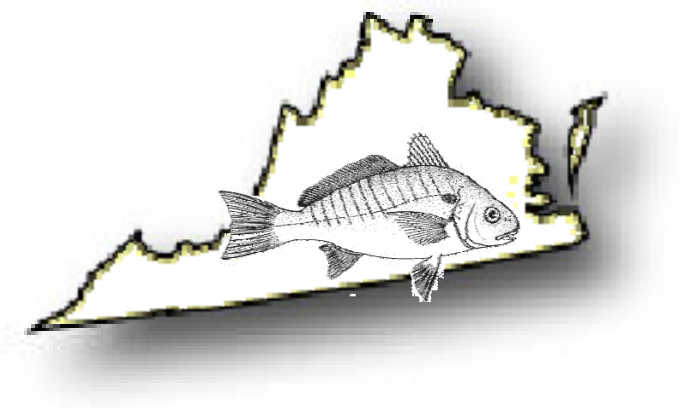


Figure 15. Spot mean length at age in centimeters for Maryland's commercial pound net fishery, 1998-2009.

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



Report to the Atlantic States Marine Fisheries Commission

April 2010

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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 2009 where possible.

Management

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

Fisheries-Dependent Monitoring

Commercial Fishery

Commercial fisheries data were obtained from the VMRC mandatory reporting database. Note that 2009 commercial data are considered preliminary and should be interpreted with caution.

Commercial fisheries have landed an average of 3.18 million pounds of spot per year in Virginia from 1994 through 2009 (Table 1; Figure 1). During this time period, Virginia's commercial landings of spot have ranged from a low of 1.89 million pounds in 2006 to a high of 4.35 million pounds in 1998. The majority of commercial landings of spot have been taken by gill nets (including anchor, drift, and staked), accounting for 79.2% of the harvest between 1994 and 2009. Haul seines and pound nets have accounted for most of the remaining landings, accounting for 10.4% and 9.86% of Virginia's commercial landings, respectively.

The VMRC Biological Sampling Program collects biological data from Virginia's fisheries. Fish samples are measured and weighed and selected species are further processed for ageing. Age data are available from 1998 to 2009, though 2009 data are considered preliminary. The biological sampling data were used to estimate the total weight at age of spot in Virginia's commercial landings. Spot ranging in age from 0 to 6 have been observed in Virginia's commercial landings during the available time series (Table 2). The commercial landings have been dominated by age-1 spot in most years of the available time series. Note that no age-0 spot were observed in 2003, 2004, or 2009.

Gear-specific estimates of average individual weight at age and average individual length at age were calculated using data collected from commercial gill nets, haul seines, and pound nets. 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. The average weight of age-1 spot sampled from the commercial gill-net fishery showed little variation over the time series (Table 3). The average weight of age-2 and -3 spot harvested by gill nets varied over the time series. The average weight of spot aged 1 through 3 sampled from commercial haul seines exhibited a general decrease over the time series (Table 4). Spot samples collected from commercial pound nets showed a decline in the average weight of age-2 and -3 fish from 2001 through 2006/2007 (Table 5). The average weight of age-1 spot sampled from pound nets was variable, but generally decreasing, 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 6). 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 7). Age-3 spot sampled from the commercial pound-net fishery exhibited a declining trend in average length from 2002 through 2007 (Table 8). No clear trend in average length was evident for age-1 or age-2 spot sampled from the pound nets.

Fishery-dependent indices of commercial harvest-per-unit-effort (HPUE) 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 HPUE exhibited limited variability between 1994 and 2009 (Figure 2). The series ranged from a low of 581 pounds per directed trip in 2006 to a high of 1,005 pounds per directed trip in 1998. The haul-seine HPUE has been slightly more variable, ranging from a low of 570 pounds per trip in 2001 to a high of 1,835 pounds in 2007. The haul-seine HPUE for spot has declined since the peak observed in 2007.

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.). Recreational statistics estimates for 2009 include waves 1–4 and 6 only and are considered preliminary; the 2009 estimates should be interpreted with caution.

Recreational fisheries have accounted for about 25% of the total landings (commercial landings plus recreational harvest—Type A + B1) in weight of spot in Virginia during 1994 to 2009 (Figure 1). From 1981 to 2009, annual recreational harvest (Type A+B1) of spot averaged approximately 1.41 million pounds in weight and 3.87 million fish in number (Table 9). The lowest annual recreational harvest on record in terms of weight during these years occurred in 1999, at just over 244 thousand pounds of spot. Since then, Virginia's recreational harvest of spot in weight increased to nearly 2.50 million pounds in 2007. Estimated recreational harvest weight of spot in 2008 was just over 2.0 million pounds. The number of spot harvested by recreational anglers in Virginia ranged from a low of 527 thousand fish in 2000 to a high of 12.1 million fish in 1983, from 1981 to 2009. The 2009 estimates of recreational harvest weight and number are low relative to the previous five years; however, the 2009 estimates are incomplete as they do not yet include data from wave 5. During 2001 through 2008, the majority of Virginia recreational harvest of spot in terms of both weight and numbers occurred in wave 5. It is expected that the final estimates of recreational harvest weight and number for 2009 will be within the range of values observed between 2004 and 2008.

The number of spot released alive by Virginia's recreational anglers has averaged over 2.0 million fish a year from 1981 to 2009 (Table 9). The annual number of recreational live releases has been below the time-series average since 1992, with the exception of 1994 (2.14 million fish) and 2007 (2.31 million fish). The largest number of live releases was observed in 1981, when an estimated 8.91 million spot were released by recreational anglers in Virginia. The number of spot released alive in Virginia exceeded recreational harvest in only one year between 1981 and 2009.

Recreational indices of harvest-per-unit-effort (HPUE) were developed by H. Rickabaugh (Maryland Department of Natural Resources, pers. comm.). The Virginia recreational HPUE

series was calculated by dividing the number of spot harvested (Type A+B1) by the number of trips that targeted spot and/or caught spot (Type A, B1, or B2). Since estimates of recreational harvest and recreational effort for 2009 are incomplete, a 2009 index was not calculated; an index for 2009 will be computed when the 2009 data are finalized. Recreational HPUE was variable from 1981 through 2008, ranging from a low of 1.42 spot harvested per trip in 2000 to a high of 16.6 spot harvested per trip in 1983 (Figure 3). Annual recreational HPUE has demonstrated an increasing trend in 2003 through 2008.

Fisheries-Independent Surveys

VIMS Juvenile Fish and Blue Crab Trawl Survey

The Virginia Institute of Marine Science (VIMS) Juvenile Fish and Blue Crab Trawl Survey was implemented in 1955 to monitor the seasonal distribution and abundance of important finfish and invertebrate species occurring in the Chesapeake Bay and its tributaries.

The VIMS develops annual indices of abundance for age-0 spot to provide a measure of relative year-class strength. The Random-Stratified Index (RSI) is a weighted geometric average based on data collected from stations in the tributaries (fixed and random) and in the bay (random) and so is considered the most comprehensive spatially (M. Fabrizio, VIMS, pers. comm.). The following months and length cut-offs were used to restrict the index to age-0 spot: July (0–160 mm total length); August (0–180 mm total length); September (0–200 mm); and October (0–200 mm total length).

The RSI index has been highly variable throughout much of the time series (Figure 4). The largest index values were observed during 1988–1990, the earliest years for the RSI time series. Since then, the index suggests spot year-class strength has been relatively weak. A slight increase occurred from 2006 to 2008, but decreased in 2009.

Table 1. Commercial landings (pounds) of spot in Virginia by major gear type, 1994–2009. Note: 2009 data are preliminary.

Year	Gill Net [1]	Haul Seine	Pound Net	Other	Total
1994	3,496,046	299,903	416,708	3,898	4,216,555
1995	2,806,046	176,098	584,644	5,273	3,572,061
1996	2,320,009	339,417	294,640	758	2,954,824
1997	2,891,966	271,308	336,165	11,997	3,511,436
1998	3,452,137	463,791	391,241	39,486	4,346,655
1999	2,391,810	327,497	221,102	33,035	2,973,444
2000	3,159,762	337,626	252,563	9,036	3,758,987
2001	2,824,799	222,431	363,698	8,708	3,419,636
2002	2,431,135	227,978	354,392	4,072	3,017,577
2003	2,506,453	350,586	525,254	6,953	3,389,246
2004	2,723,539	246,491	324,514	6,773	3,301,317
2005	1,889,000	248,244	237,879	9,257	2,384,380
2006	1,509,580	275,794	98,664	4,622	1,888,660
2007	2,900,368	799,396	305,991	58,821	4,064,576
2008	1,256,679	444,323	164,848	33,381	1,899,231
2009	1,818,385	266,908	151,222	21,225	2,257,740

Table 2. Catch-at-age (pounds) of spot landed by Virginia's commercial fisheries, 1998–2009. Note: 2009 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	212,819	4,040,210	93,626	0	0	0	0
1999	53,946	2,466,937	452,561	0	0	0	0
2000	3,151	3,139,449	458,627	137,016	20,743	0	0
2001	122,619	1,348,043	1,452,390	438,655	57,930	0	0
2002	41,001	1,744,407	582,297	446,107	190,646	13,120	0
2003	0	1,960,883	841,165	335,727	231,666	19,804	0
2004	0	367,763	2,661,560	230,034	19,556	21,256	1,148
2005	718	636,226	809,608	879,792	36,885	11,519	9,633
2006	17,831	1,110,306	537,342	144,505	78,676	0	0
2007	915	1,708,092	2,157,396	183,414	7,662	7,097	0
2008	1,469	1,103,260	686,053	102,082	6,365	0	0
2009	0	1,298,909	929,799	29,032	0	0	0

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

Table 3. Average weight (pounds) at age of spot samples collected from commercial gill-net landings in Virginia, 1998–2009. Note: 2009 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	0.300	0.518	0.618				
1999		0.498	0.664				
2000		0.449	0.729	0.777	0.810		
2001	0.410	0.535	0.912	1.20			
2002	0.370	0.486	0.600	0.722	0.818	0.850	
2003		0.447	0.645	0.823	0.850		
2004		0.459	0.519	0.581		1.02	1.00
2005		0.520	0.664	0.673	0.754	0.980	0.930
2006		0.458	0.683	1.02	1.07		
2007		0.478	0.430	0.589		1.21	
2008		0.500	0.517	0.558	0.600		
2009		0.558	0.551	0.767			

Table 4. Average weight (pounds) at age of spot samples collected from commercial haul-seine landings in Virginia, 1998–2009. Note: 2009 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	0.360	0.453					
1999	0.380	0.499	0.735				
2000		0.473	0.499				
2001		0.523	0.843	0.985			
2002	0.230	0.307	0.655	0.747	0.880		
2003		0.349	0.480	0.660	0.690		
2004		0.253	0.503	0.662			
2005		0.279	0.414	0.550			
2006	0.140	0.338	0.390	0.495			
2007	0.0500	0.252	0.307		0.760		
2008		0.285	0.363	0.460			
2009		0.291	0.375	0.419			

Table 5. Average weight (pounds) at age of spot samples collected from commercial pound-net landings in Virginia, 1998–2009. Note: 2009 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	0.210	0.437	0.608	0.460			
2001	0.287	0.477	0.839	1.08	1.07		
2002	0.207	0.371	0.647	1.02	0.88		
2003		0.331	0.534	0.818	0.743	0.940	
2004		0.375	0.516	0.886	1.14	0.850	
2005	0.270	0.268	0.532	0.744	0.925		
2006	0.207	0.270	0.386	0.498	0.612		
2007	0.100	0.418	0.428	0.398		1.04	
2008	0.120	0.206	0.545	0.613			
2009		0.288	0.362				

Table 6. Average length (inches) at age of spot samples collected from commercial gill-net landings in Virginia, 1998–2009. Note: 2009 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	8.27	9.63	9.87				
1999	8.86	9.64	10.5				
2000		9.52	11.2	11.8	11.8		
2001	9.09	9.81	11.7	11.6			
2002	8.66	9.87	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	10.2	10.3		
2009		10.1	10.2	11.4			

Table 7. Average length (inches) at age of spot samples collected from commercial haul-seine landings in Virginia, 1998–2009. Note: 2009 data are preliminary.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
1998	8.83	9.26					
1999	6.82	9.73	10.8				
2000	6.84	9.63	10.33	11.7			
2001		10.0	11.4	12.1			
2002	7.78	8.86	11.3	11.8	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			
2009		8.33	9.04	9.45			

Table 8. Average length (inches) at age of spot samples collected from commercial pound-net landings in Virginia, 1998–2009. Note: 2009 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	9.68	11.4	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	13.1	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	7.47	10.3	10.6			
2009		8.82	9.25				

Table 9. Estimated amount of spot harvested (Type A+B1) and released alive (Type B2) by recreational anglers in Virginia, 1994–2009. Note: 2009 estimates include waves 1–4 and 6 only and are considered preliminary.

	Harvest (Type A + B1)				Released Alive (Type B2)	
Year	**Number**	**PSE[Number]**	**Weight (lb)**	**PSE[Weight]**	**Number**	**PSE[Number]**
1981	11,662,684	17.6	4,625,985	16	8,905,412	35.9
1982	4,526,847	18.3	1,563,396	22.9	1,618,065	27.3
1983	12,059,247	23.1	2,520,125	24.2	2,715,522	41
1984	1,489,795	13.6	404,533	13.5	2,607,693	18.4
1985	5,491,918	10	1,955,039	10.2	2,051,793	12.9
1986	4,229,191	8.6	1,205,158	8.9	2,250,794	10.7
1987	3,864,151	8	1,336,387	8.3	1,736,228	11
1988	2,028,768	12.4	720,609	12.9	762,504	22.7
1989	3,714,855	7.5	1,400,728	7.6	2,519,034	8.1
1990	5,354,294	11.1	2,103,751	11.1	4,441,195	10.8
1991	8,820,075	10	2,729,698	10.2	7,041,156	9.9
1992	6,317,539	13.5	2,278,309	14.5	2,091,001	13.1
1993	2,836,534	15.6	951,766	15.5	1,374,950	13.7
1994	3,395,503	8	1,217,036	7.6	2,142,198	8.3
1995	2,731,242	12.7	1,067,637	12.1	1,166,428	13.5
1996	1,109,237	14.1	492,982	15.2	577,847	14.9
1997	3,328,144	17.6	1,263,447	15.8	1,365,809	14.8
1998	2,023,756	11.6	866,619	12.2	900,352	11.3
1999	569,250	18.3	244,499	18.1	339,988	16.1
2000	527,259	15.3	252,885	15.5	502,923	15.5
2001	1,056,365	11.6	523,202	12.9	968,976	9.3
2002	1,601,837	14.5	829,972	16	481,765	13.8
2003	1,441,002	11.5	875,729	13.2	933,842	20
2004	2,323,007	10.5	1,447,697	11.1	975,455	12
2005	2,993,635	16.5	1,434,965	16.6	1,799,399	15.5
2006	3,510,289	18.2	1,463,070	19.9	921,133	17
2007	6,608,680	9.6	2,467,311	9.8	2,310,874	9.3
2008	5,060,572	16.4	2,055,159	17.8	1,721,412	11.1
2009	1,539,972	20.5	514,748	20.1	1,100,283	15.8

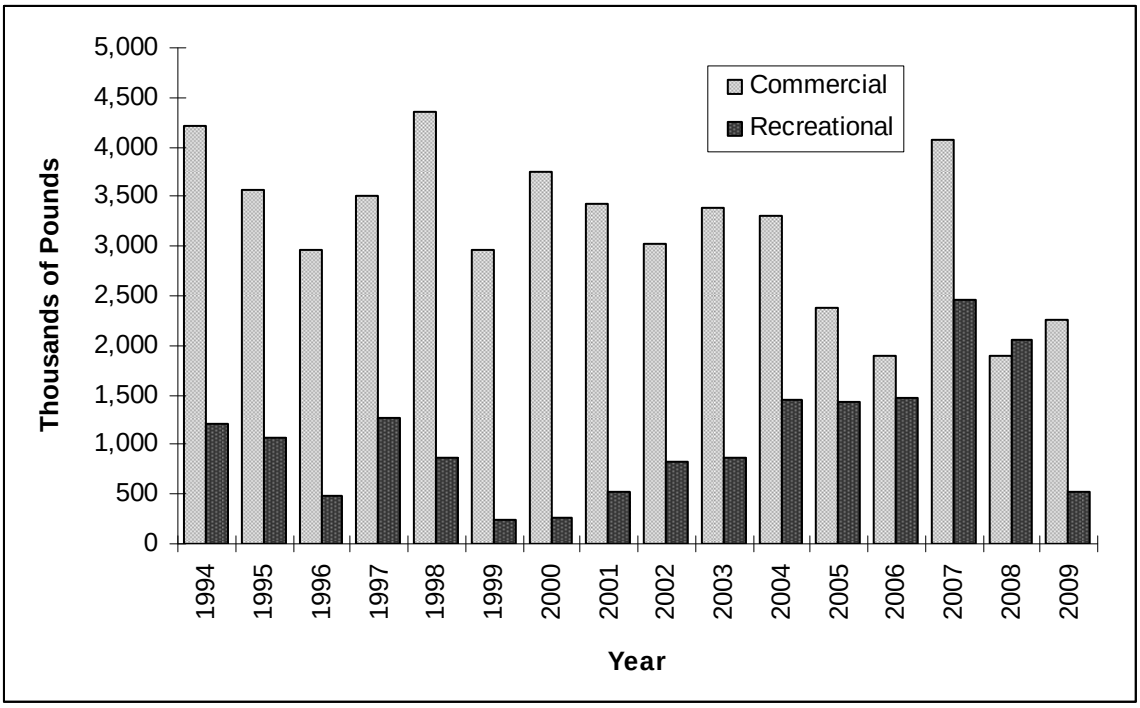

Figure 1. Annual commercial landings and recreational harvest of spot in Virginia, 1994–2009. Note: 2009 data are preliminary.

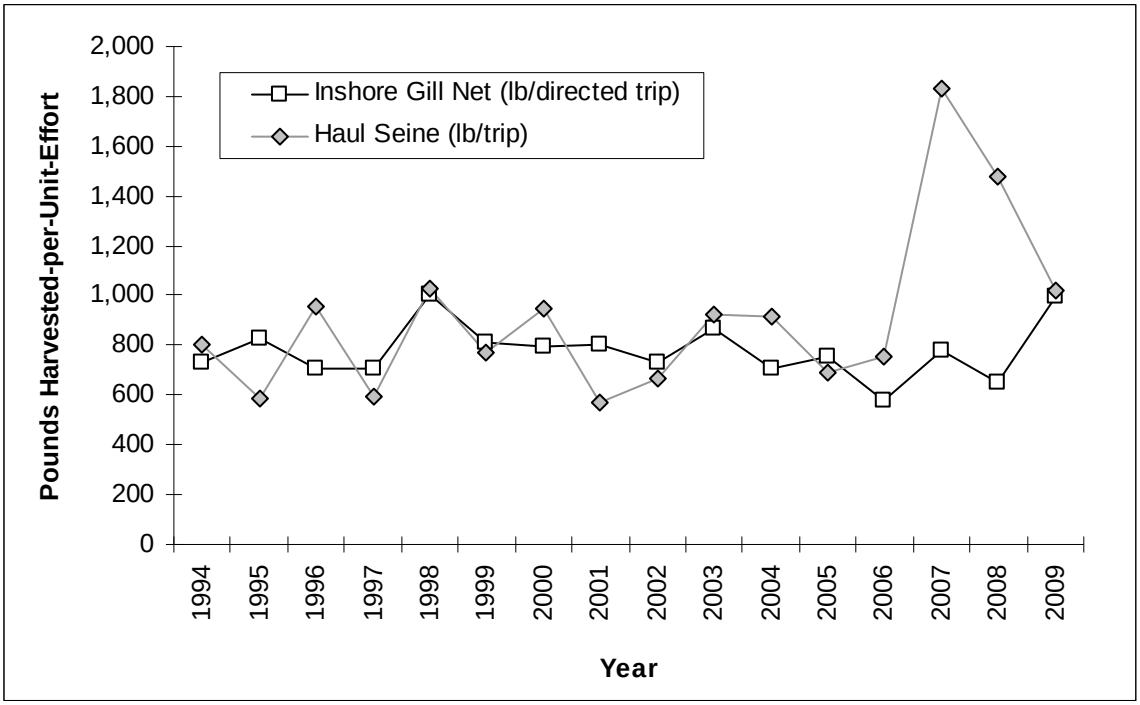

Figure 2. Harvest-per-unit-effort (HPUE) of spot in Virginia's commercial inshore gill-net and haul-seine fisheries, 1994–2009. Note: 2009 data are preliminary.

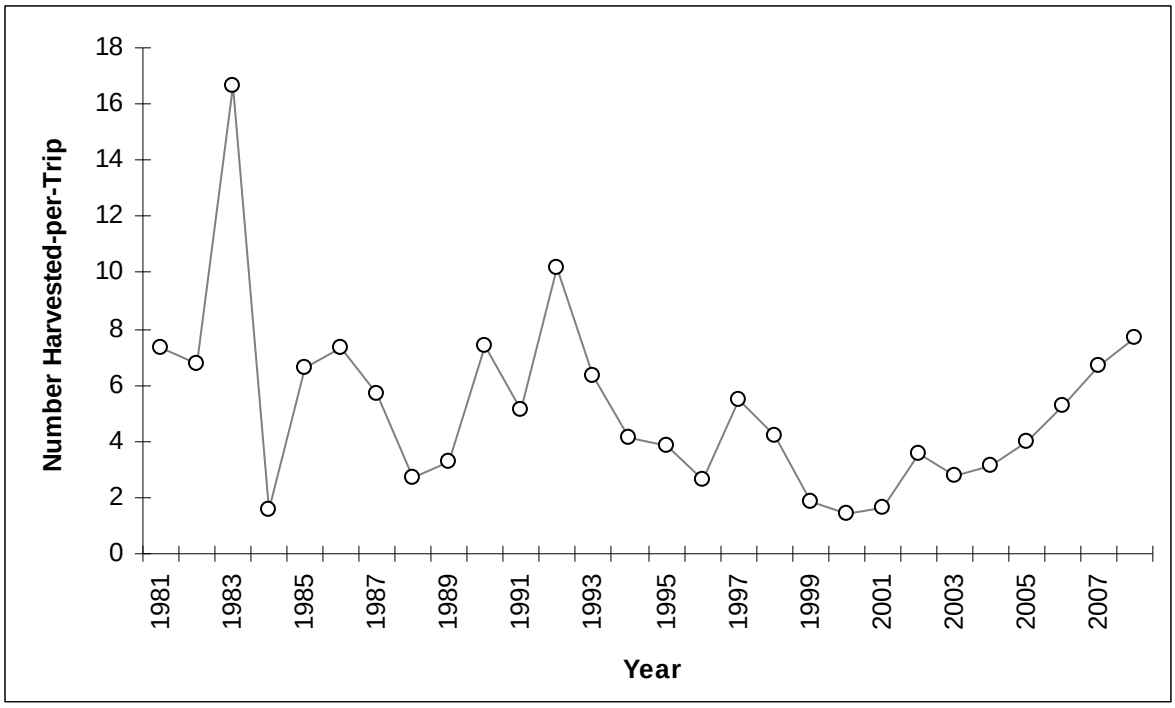

Figure 3. Harvest-per-unit-effort (HPUE) of spot in Virginia's recreational fishery, 1981–2009.

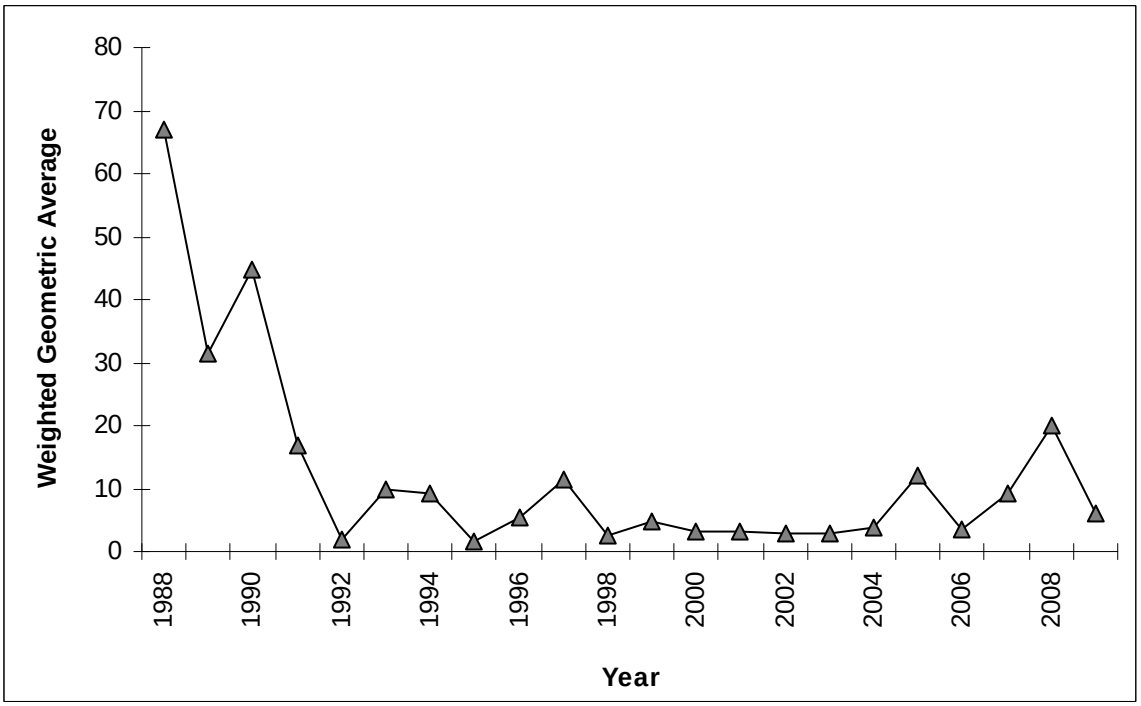

Figure 4. Random-Stratified Index of age-0 spot relative abundance based on the VIMS Juvenile Fish and Blue Crab Trawl Survey, 1988–2009.

DRAFT SPOT HARVEST AND INDEX REPORT FOR NORTH CAROLINA

A Report to the Atlantic States Marine Fisheries Commission

April 09, 2010
North Carolina Division of Marine Fisheries

Recent (1994-2009) Trends in North Carolina Commercial and Recreational Spot Fisheries

Introduction:

The following represents North Carolina's commercial and recreational harvest and biological information for 2010. No changes in management are proposed for the upcoming year.

Dependent Data:

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

Data shown for 2009 are preliminary and will not be verified and finalized until mid May 2010.

- Commercial landings since 1994 have averaged 2.1 million pounds (Figure 1).
- Three major fisheries accounted for an average of 89.0% of landings, inshore gill net, ocean gill net and long haul (Figure 2) since 1994, and 92.9% 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 36.5% increase in 2009.
- Since 1994, effort had been decreasing in the ocean gill net fishery, however there was a 79% increase from 2008 to 2009. Effort also increased by 17% in the inshore gill net fishery and by 7% in the long haul fishery (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. However there was a 79% increase from 215 trips in 2008 to 385 trips in 2009 (Figure 3).
- 2009 inshore gill net trips increased 17.5% year to year, long haul trips increase 7.1% year to year, and ocean gill net trips increased 79.1% while total commercial landings increased 36.5% from the 15-year historical low.
- CPUEs in the long haul fishery were the lowest of the 15-year period and have decreased for 5 consecutive years. The CPUEs for the inshore gill net fishery increased from the lowest of the 15-year period. The ocean gill

net CPUEs have fluctuated the most, with CPUE values in 2009 increasing significantly from 2008, which is 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 (2009 effort data unavailable). It was calculated by summing Type A and Type B1 catch and dividing by the number of contributing fishermen at the interview/trip level. Landings data shown for 2009 are preliminary, do not include the wave 5 data, and will not be verified and finalized until later in 2010.

- Landings in the recreational fishery have averaged 1.2 million lb (Figure 1).
- Landings in 2009 were 86.4% below the 1994-2009 mean and decreased 81.2% year to year. However this does not include the wave 5 data from the 2009 MRFSS survey, and is likely not representative.
- 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.

- NCDMF began to gather data in 2002 on RCGL license holders and spot landings have averaged 203,383 lb since 2002.
- Due to budget constraints the RCGL surveys were suspended in 2009.
- 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 or 2009 (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 2009 (Figure 10).
- CPUEs have been extremely variable with no clear trend.
- Most recent year (2009) showed a significant decrease from 2008.

Estuarine Trawl Survey - Program 120:

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 2009 (Figure 11).
- These data also show wide fluctuations with no clear trend.

Independent Gill Net Survey: Pamlico Sound – Program 915:

This study that began in 2001 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 from 2004 to 2007 and leveled off in 2008 (Figure 12).
- CPUE highest in 2001, lowest in 2007 and 2008 and increased slightly in 2009.

Aging Data:

Data has not been completed for 2007 to 2009 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. Commercial landings increased in 2009 from the historical lows of 2008, but remain less than half of 2004 landings. Effort, measured by trips has increased in the ocean gill net, inshore gill net, and long haul fisheries (79.1, 17.5, and 7.1% respectively). CPUEs in the ocean gill net and inshore gill net fisheries increased in 2009 from historical lows in 2008. CPUEs in the long haul fishery decreased slightly but pounds landed increased from historical lows in 2008, due in part to increased effort. 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.

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 2008 and again decreasing in 2009.

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, increasing only slightly in 2009 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.

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 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 decreasing CPUEs in the juvenile indices for 2009 are discouraging (although fluctuation in recruitment indices is expected). These decreases were partially offset by a slight increase in the adult abundance index and increased commercial landings in 2009.

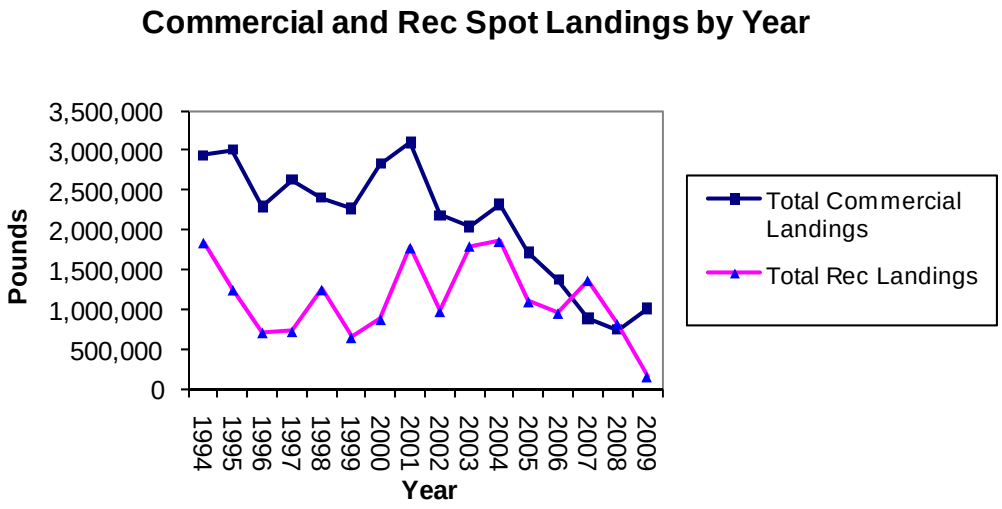

Figure 1. North Carolina commercial and recreational landings, 1994-2009.
* Recreational does not include Wave 5 (September and October of 2009)

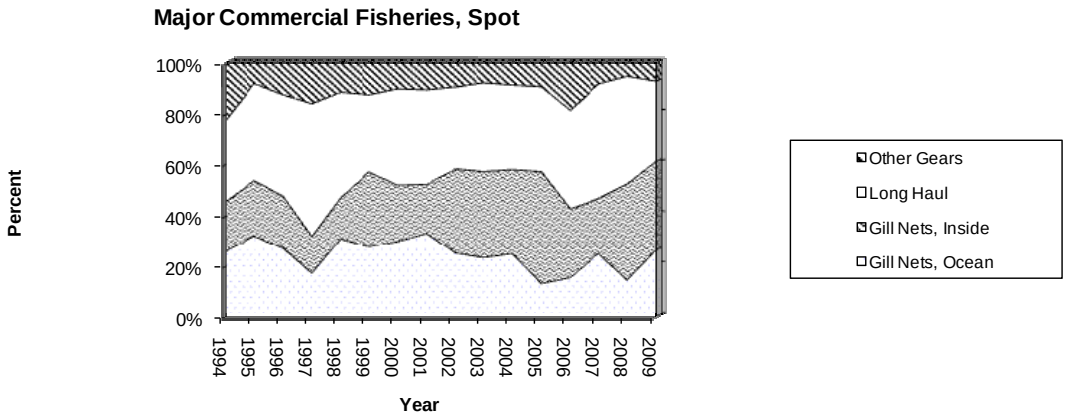

Figure 2. Major commercial gears capturing spot, 1994-2009.

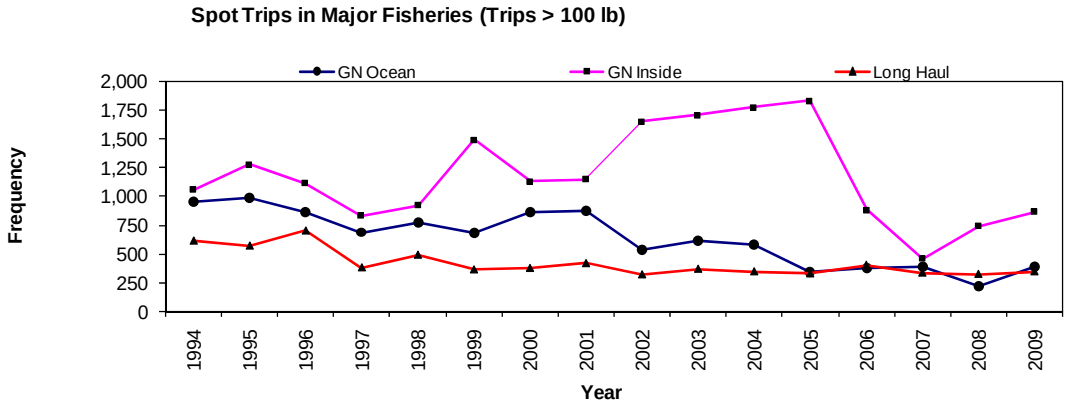

Figure 3. Spot trips in major North Carolina commercial fisheries, 1994-2008.

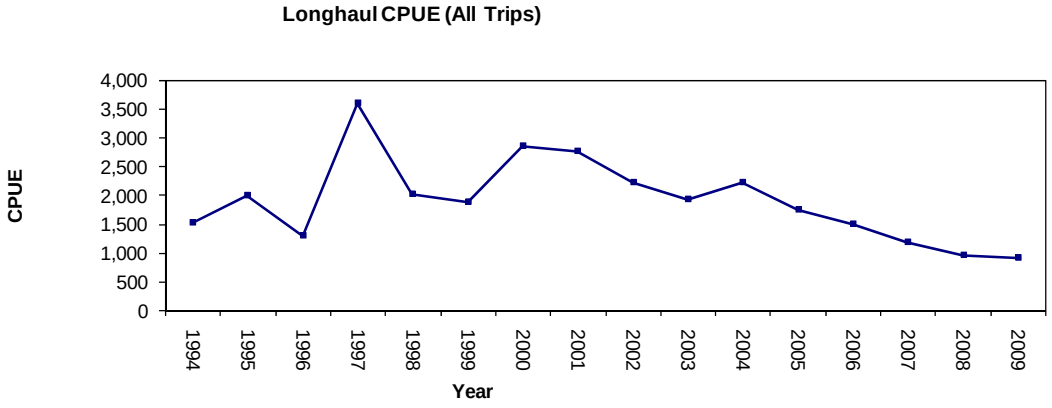

Figure 4. CPUE of long haul fishery based on NCTTP trips and landings, 1994-2008.

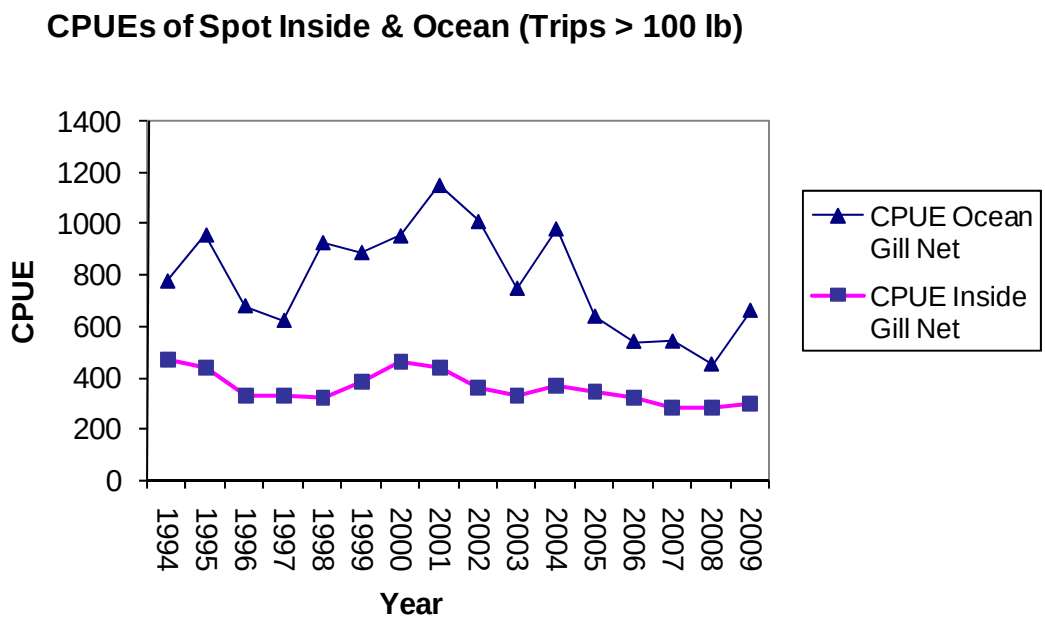

Figure 5. North Carolina ocean and inshore gill net spot CPUEs based on NCTTP, 1994–2008.

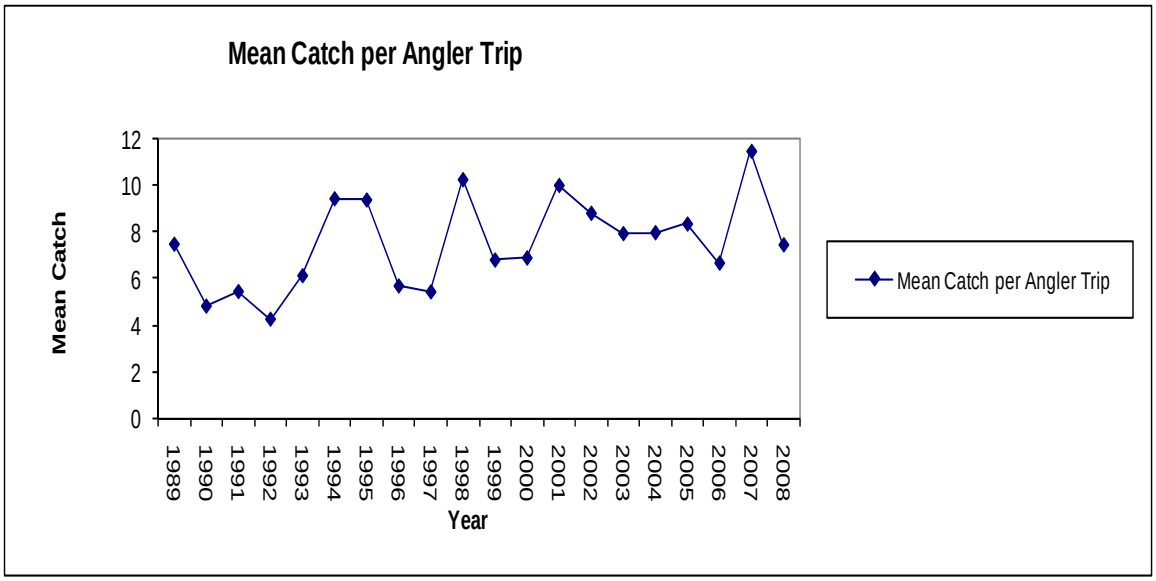

Figure 6. Spot mean catch per angler trip, 1989–2008 (from MRFSS).

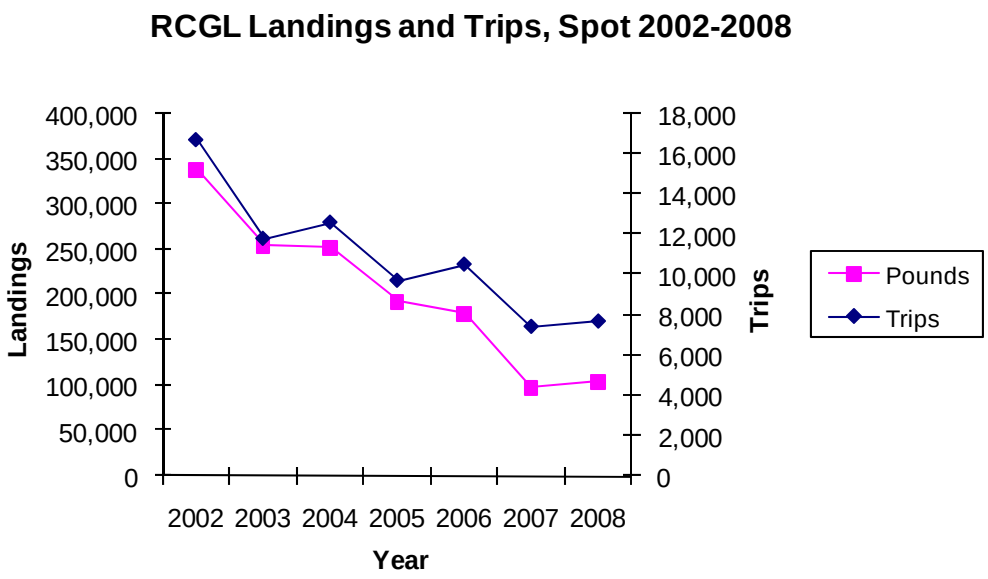

Figure 7. North Carolina spot landings and trips from RCGL license holders, 2002-2008.

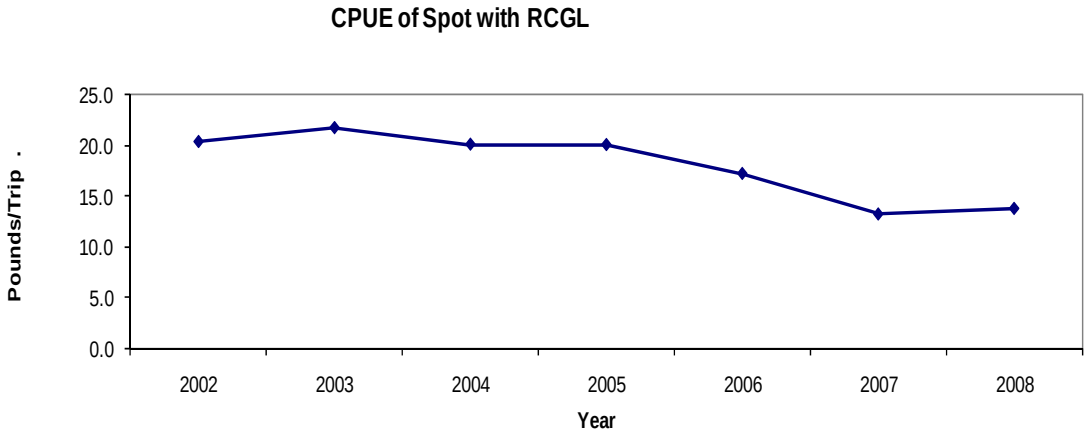

Figure 8. North Carolina spot CPUEs from RCGL license holders, 2002-2008.

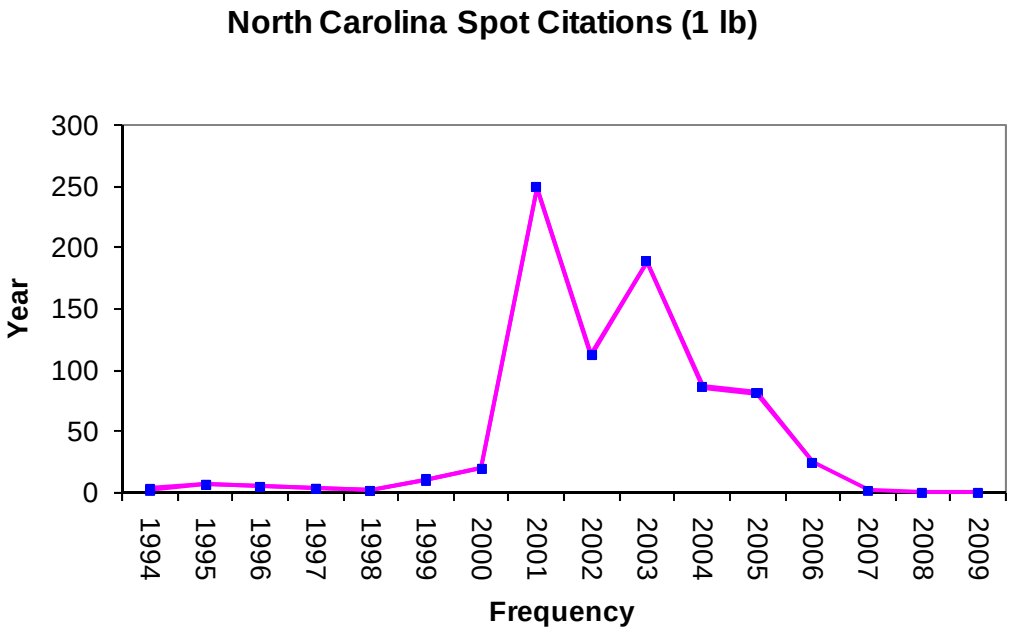

Figure 9. Number of spot citations (issued for hook and line catches > 1 lb) issued 1994-2008.

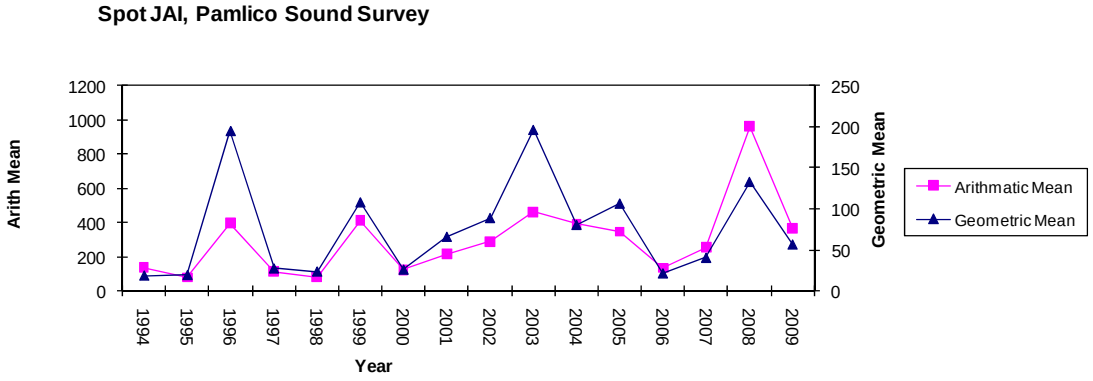

Figure 10. North Carolina Pamlico Sound Survey juvenile indices for spot 1994-2008.

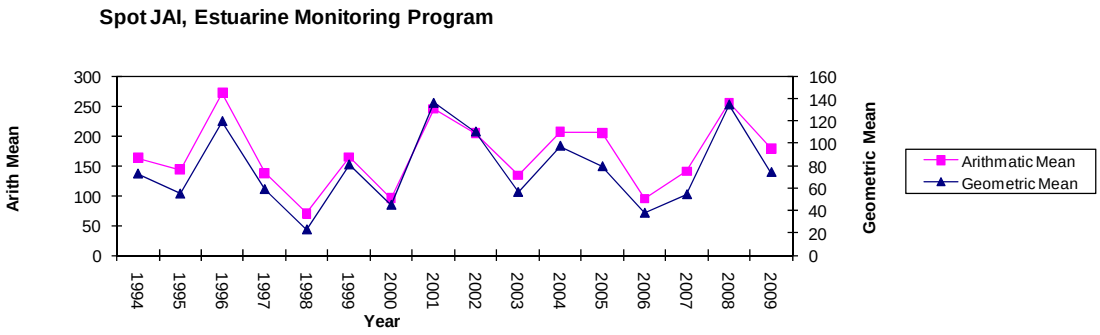

Figure 11. North Carolina Estuarine Trawl Survey juvenile indices for spot, 1994-2007.

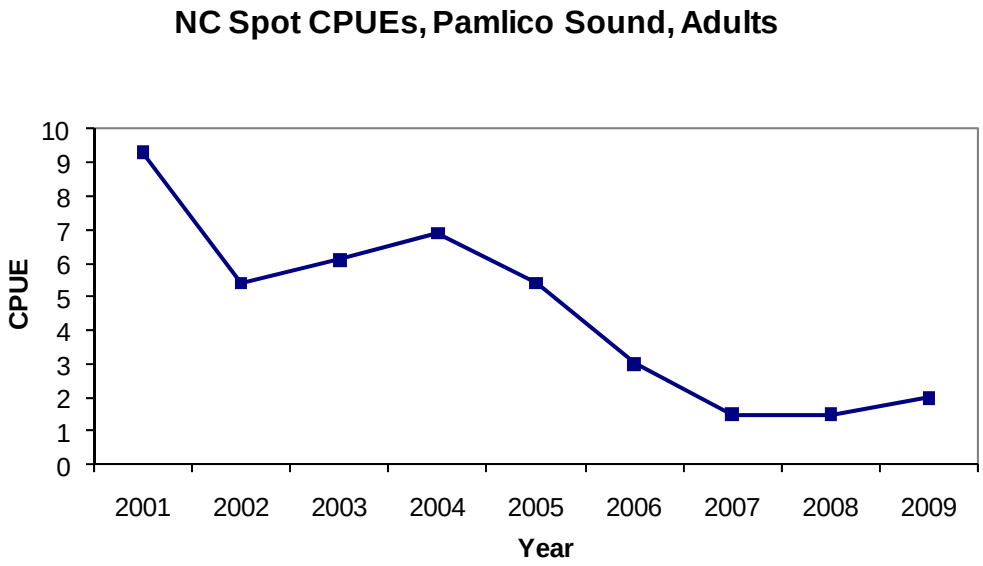

Figure 12. North Carolina spot annual weighted CPUE from Pamlico Sound Independent Gill Net Survey, 2001-2008.

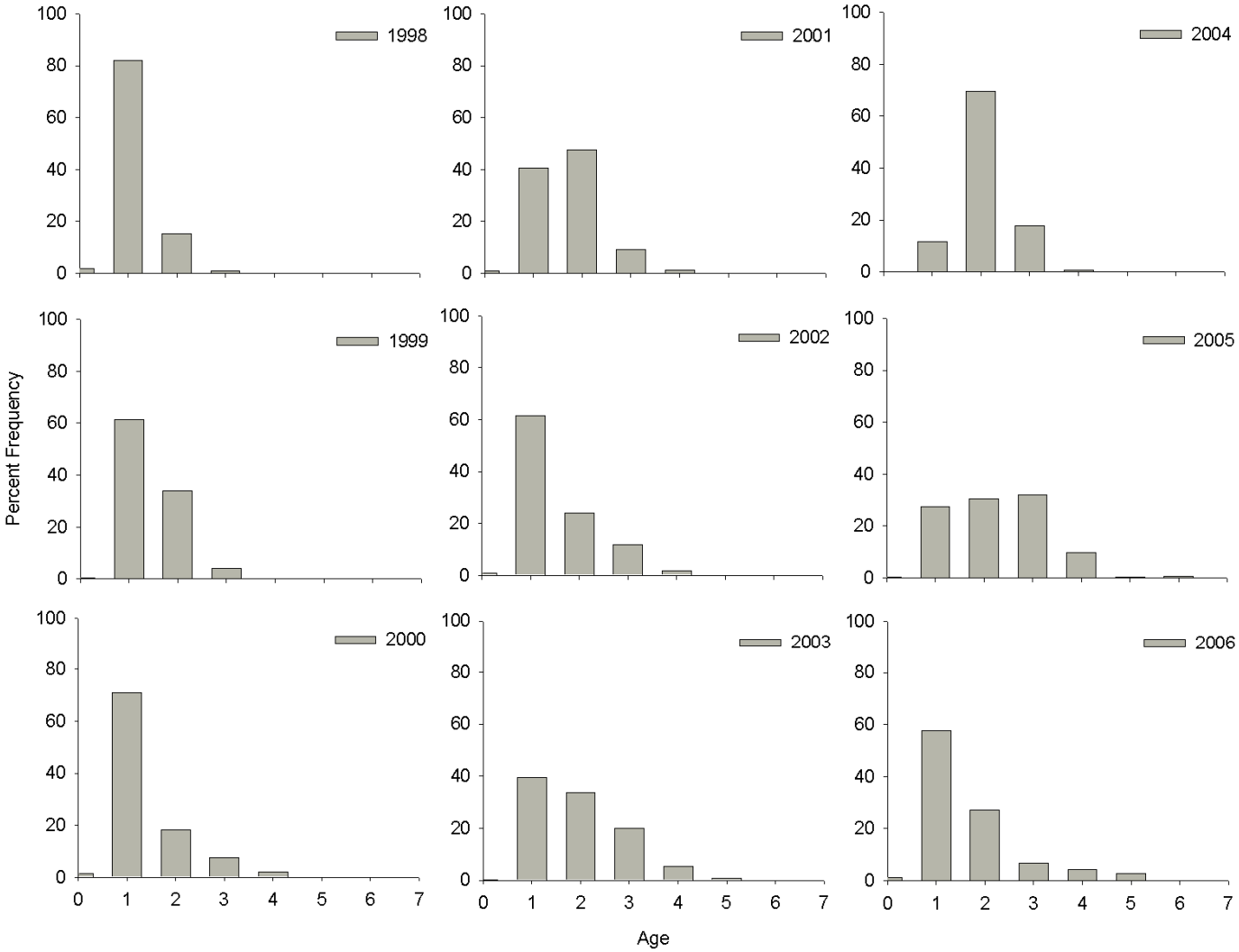

Figure 13. Age distribution of spot landed and sold in North Carolina inshore gill net fishery, 1998-2006.

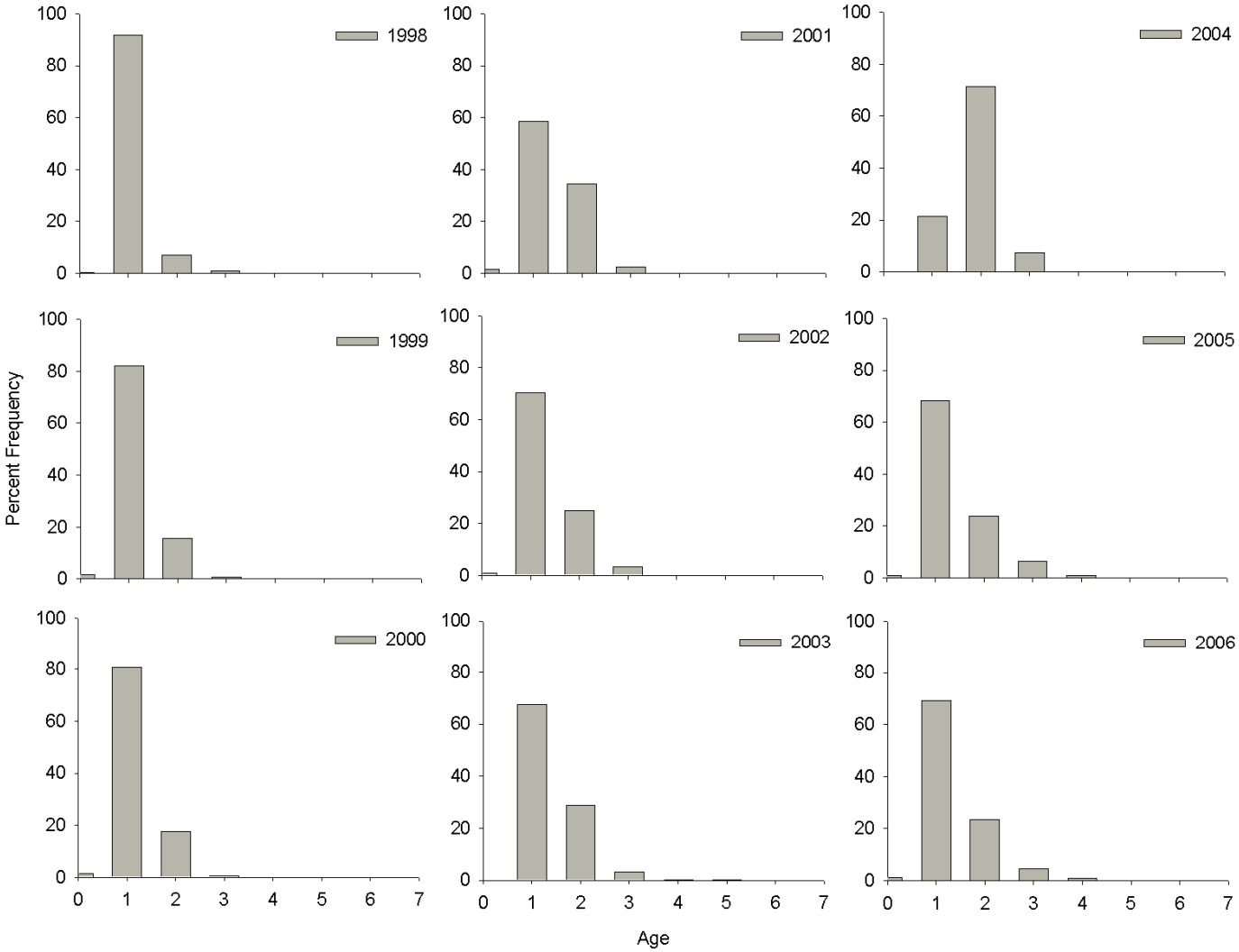

Figure 14. Age distribution of spot landed and sold in the North Carolina ocean gill net fishery, 1998-2006.

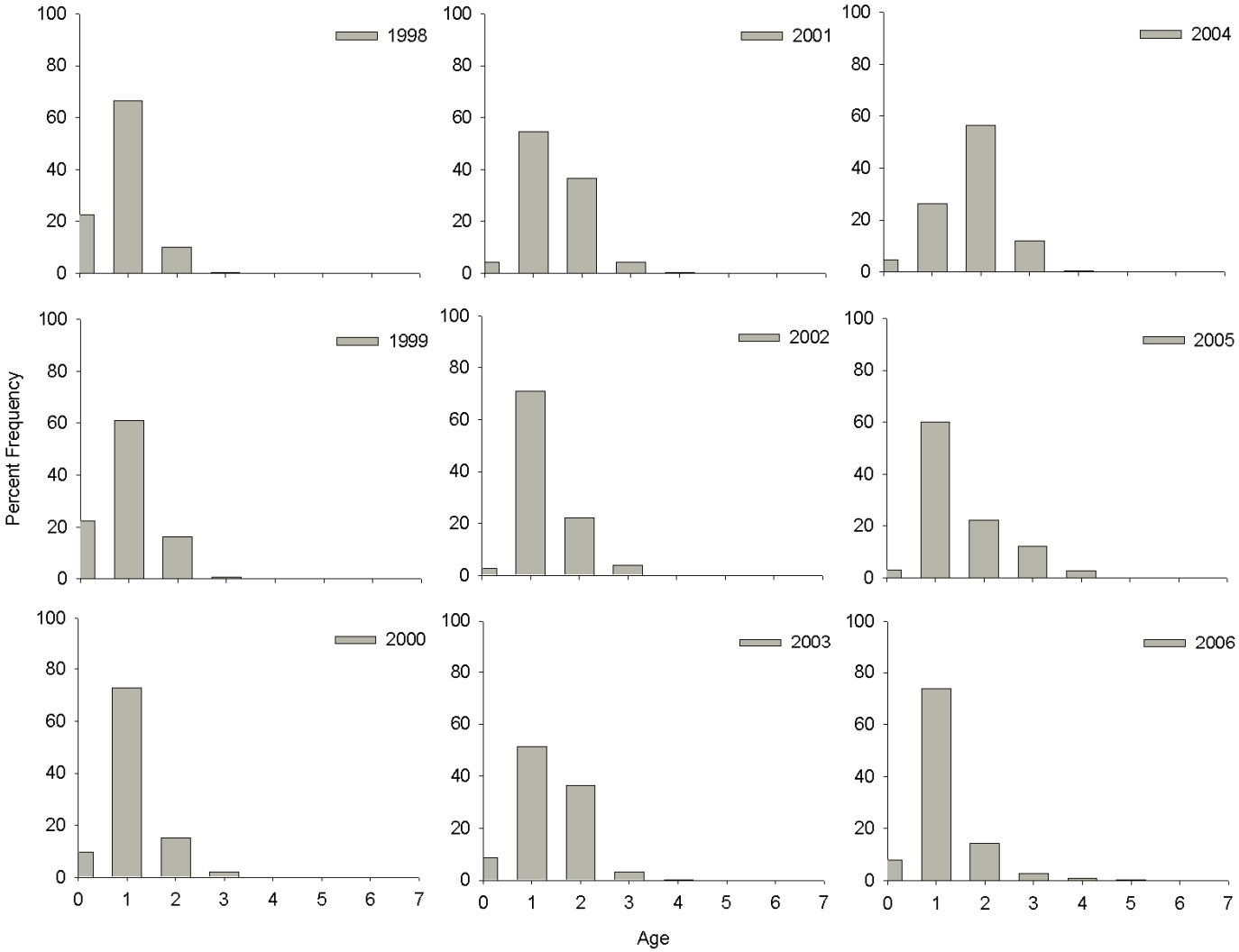

Figure 15. Age distribution of spot landed and sold in the North Carolina long haul fishery, 1998-2006.

Evaluation of Spot, *Leiostomus xanthurus*, in South Carolina: 2009

Report to the Atlantic States Marine Fisheries Commission
April 2010

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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 annual data relevant for Spot (*Leiostomus xanthurus*) as a resource.

The historical fishery dependent data of commercial catch records covered the period from 1950 through 2009 (NMFS, 2010). 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 primarily 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 2009, and from the South Carolina State Finfish Survey (SCSFS) for the period 1991 to 2009. The 2009 recreational data received from the MRFSS was preliminary because not all sampling waves were available at the time of this analysis. 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 specifically 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 2009. 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 (including spot) 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 & Discussion

Commercial Landings

Commercial landings in South Carolina showed a substantial increase in 2009 to 22,557 lbs over 2008 landings (Table 1). While commercial landings have not been seen at this level since 1997, by historical standards spot landings were typically in the hundreds of thousands of pounds prior to the 1990s. So, while the increase in landings was a marked increase from the previous ten years, it does not necessarily represent the historical landing levels of this fishery. The majority of the landings were captured by the shrimp trawl fishery (presumably as utilized by-catch), with a small portion attributable to the gill net fishery (Table 2).

Recreational Landings

Recreational landings in 2009 decreased from 2008 levels, ending an increasing trend that had been occurring since 2003 (Fig. 1). In addition to a decrease in landings there was a decrease in the number of angler trips and, as a result, a corresponding drop in recreational catch to the lowest level seen in the time series since it began in 1981 (Fig. 2). The only other year with a catch that was comparable occurred in 1990. However, since the 2009 data was preliminary and only sampling waves 1-4 were available at the time of this analysis, the recreational data is subject to re-interpretation when the full data set becomes available. Historically, the majority of South Carolina's harvest (A + B1) and total catch (A + B1 + B2) occurs in the fall during waves 5 & 6, so this number will have to be revised when the new data become available.

The South Carolina state finfish survey (SFS) reported a total of 5,878 spot caught from the following sources: creel census reported 4,957 spot kept (harvest) and 286 released, and the charter vessel landings reported 635 spot kept. Of the spot that were kept, 678 were measured by the creel census clerks for a mean total length of 233 mm and a range of 180-323 mm.

Trammel Net Survey

There were 2,990 Spot captured in the trammel net survey 2009. Total length (L_T) ranged from 145 to 345 mm with an overall mean of 206.9 ± 13.6 mm. Specimens were collected every month of the year. The majority of specimens seen (84.7%) occurred in the 190-220 mm range (Fig. 3), which was a function of gear selectivity due to mesh size. Spot generally recruited to the trammel gear at 180 mm L_T, so there was a limited number of specimens caught below this size. Monthly size frequency distributions were similar across all months during all years. Beginning in 2009, preliminary age, sex, and maturity data were collected from the trammel net survey. There were 183 sex determinations, with 64 males and 119 females, which resulted in an approximate 2:1 female to male sex ratio. The majority of specimens was either immature (42.9%), or mature but reproductively inactive (30.9%), with remaining specimens undergoing reproductive development (22.1%) and only 7 specimens (4.1%) (all males) reproductively active. Ages ranged from 0 to 2 years, with most of the specimens (96.2%) being age 0 or 1. It must be noted that these data are very preliminary and only represent a limited time period, and at this time should not be taken as characteristic of the estuarine spot population in South Carolina.

Electroshock Survey

The electroshock survey captured 1,570 Spot in 2009. Spot were collected every month of the year throughout the entire time period. Sizes ranged from 27 to 230 mm L_T (Fig. 4) with a mean size of 96.8 ± 30.4 mm L_T. The majority of electroshock samples (78.7%) were young-of-the-year juveniles (≤ 120 mm L_T). The presence of the smaller juveniles was a function of the ability of the electroshock boat to capture all size classes (compared to the trammel net) and the greater utilization of low salinity zones of the estuary by juvenile Spot. There were only 13 specimens greater than 180 mm L_T captured by the electroshock boat. Monthly size frequency distributions were variable and indicated that the bulk of recruitment for juvenile Spot occurred from January through April. As with the trammel net survey, preliminary collections of specimens were made for age, sex, and maturity data in 2009. However, due to the small sizes of spot generally seen in the electroshock survey, all of the specimens were sexually immature with only 10 identified males and 22 identifiable females. All spot collected with the electroshock boat were considered age zero due to their small size.

SEAMAP Survey

The SEAMAP survey captured 70,596 Spot in 2009. Fork lengths ranged from 70 to 230 mm L_F with a mean of 145.6 ± 2.83 mm L_F. While the size distributions were similar between states (Fig. 5), Florida had a significantly larger mean L_F (162.6 ± 2.32 mm, $p<0.001$), with North Carolina having the smallest mean L_F (146.8 ± 2.99 mm) and both South Carolina and Georgia not varying significantly from the overall mean (SC: $p = 0.356$, GA: $p = 0.085$). North and South Carolina had approximately the same number of fish (25,928 and 25,852 respectively) and significantly more than either Florida (16,133) or Georgia (2,683). Although small juveniles (< 110 mm L_F) were seen in the SEAMAP trawls, these specimens represented a small fraction (2.9%) of the overall samples in 2009. 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. There were no spot taken for age, sex, and maturity samples in 2009.

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 (≥ 170 mm L_T for the trammel surveys, ≥ 150 mm L_F 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 (25-120 mm L_T) 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.

Mean annual CPUE in the trammel net survey for 2009 increased slightly (3.74) from 2008 staying well within the 0.81 to 5.47 range for all years (Table 3). The CPUE for 2009 did stay above the long term mean (2.60), the first time two years in a row have been above the long term mean since 2001-2003. Peak catches occurred in 1994 and 1999 with catches exceeding the long term mean in 8 of the 19 years. Overall the CPUE trend continues the increasing trend that began in 2001 (Fig. 6).

In contrast, the mean annual CPUE in the electrofishing survey decreased in 2009 (6.8 spot per set) by more than half from 2007-2008 to almost the same level as 2006 (Table 3). Overall the mean annual CPUE has demonstrated a high degree of year to year variability for the entire time series (Fig. 7).

The mean annual CPUE for the SEAMAP data ranged from 79.8 to 599.4 Spot per trawl with a long term mean of 240.2 ± 12.1 spot per trawl (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 minimum CPUE for both South Carolina and the entire data set occurring in 1999. However, the years of the maximum annual CPUE differed in that South Carolina had its highest annual CPUE in 1990 (680.2 spot per trawl) where the maximum for the entire data set occurred in 1991. The mean annual CPUE in South Carolina did increase by over 300% from 2008 to 2009 (Table 3), but such year to year variability was not uncommon. 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. 8).

Table 1. Commercial landings for spot in South Carolina and the south Atlantic from 1951 to 2009. N/A = not available

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	1492	N/A	
2009	22557	N/A	

Table 2. Commercial landings by gear type for spot in from 1951 to 2009.

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		75	1266
2009	1826		20731

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	-	-	250.6	325.1
1990	-	-	680.2	538.5
1991	3.95	-	432.8	599.4
1992	3.19	-	167.8	243.4
1993	1.53	-	73.2	129.7
1994	5.47	-	92.3	218.4
1995	1.52	-	284.7	364.7
1996	1.74	-	83.5	141.6
1997	1.91	-	140.5	203.5
1998	2.44	-	103.1	105.2
1999	5.04	-	47.6	79.8
2000	2.14	-	89.1	124.5
2001	3.05	8.27	112.2	177.6
2002	3.01	8.41	58.0	76.3
2003	0.81	20.65	425.8	345.0
2004	1.18	10.24	50.2	226.2
2005	1.01	16.50	139.6	439.0
2006	1.93	6.50	208.8	277.0
2007	2.40	17.01	80.0	75.7
2008	3.43	15.6	72.0	183.9
2009	3.74	6.8	246.9	216.7

Figure 1. Annual recreational landings for spot in South Carolina from the Marine Recreational Fisheries Statistics Survey (MRFSS) from the National Marine Fisheries Service. Landings are given for harvest (A = landings brought back, B1= spot kept) and total catch (A + B1 + B2 = fish released).

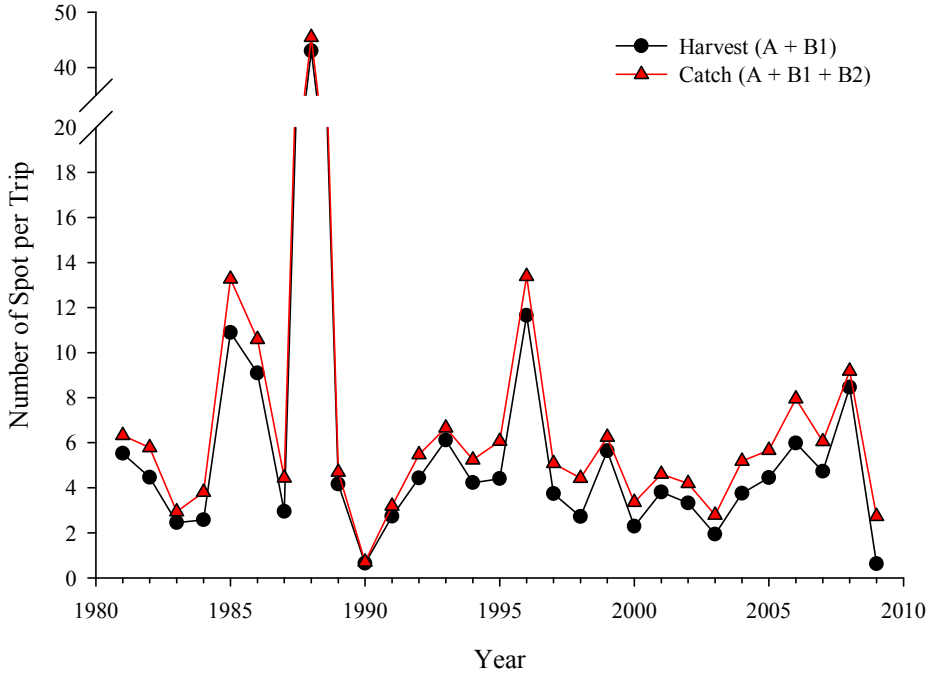


Figure 2. Total landings (A + B1 + B2) for spot in South Carolina from 1981 to 2009. Data from the Marine Recrational Fisheries Statistics Survey (NMFS).

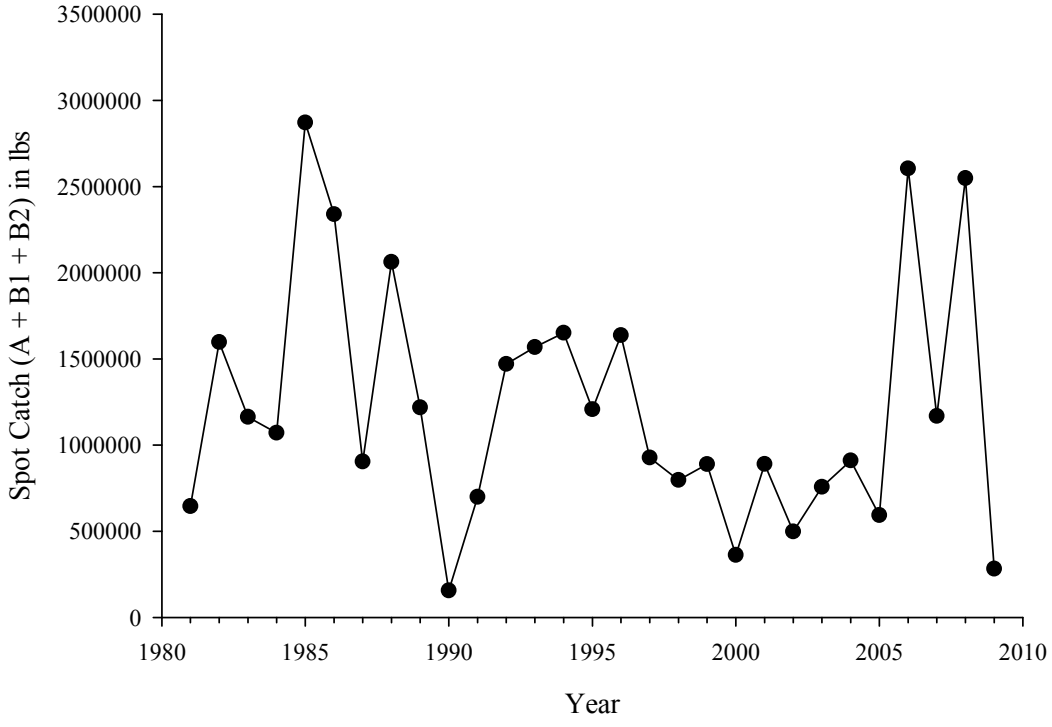


Figure 3. Length frequency distribution of Spot in South Carolina in 1 cm length bins from fishery independent trammel net survey in 2009.

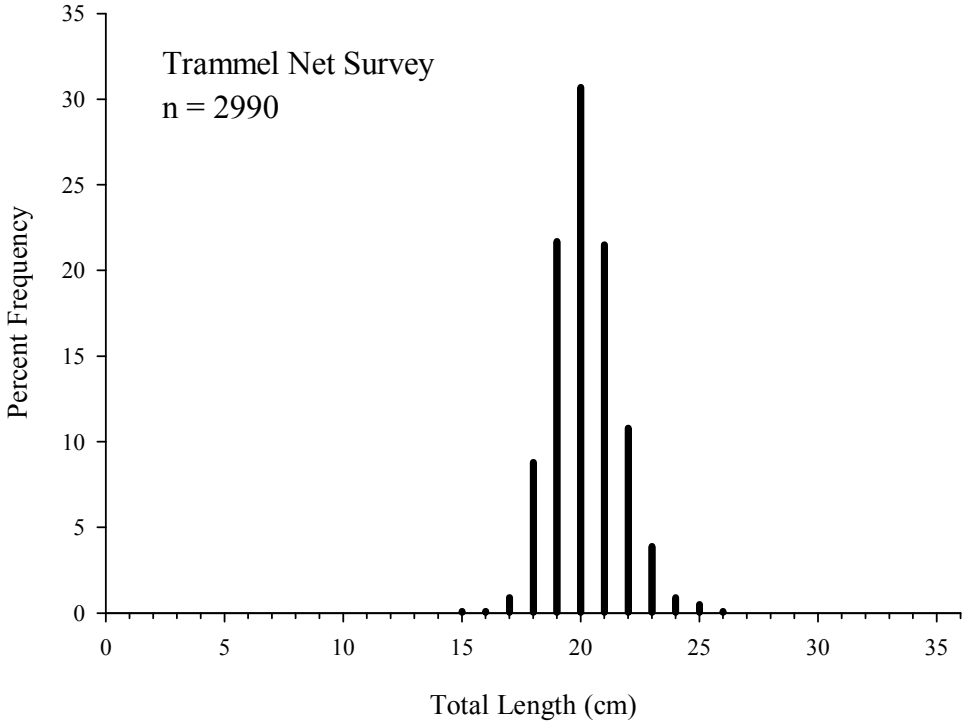


Figure 4. Length frequency distribution of Spot in South Carolina in 1 cm length bins from fishery independent electroshock boat survey in 2009.

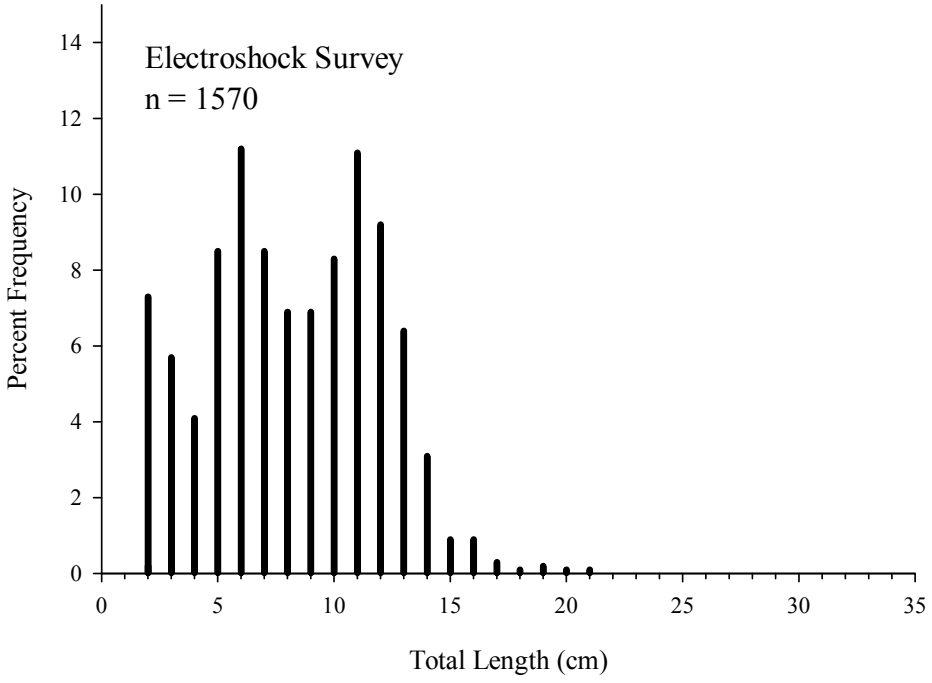


Figure 5. Length frequency distribution of spot from SEAMAP survey in 2009 using 1 cm length bins.

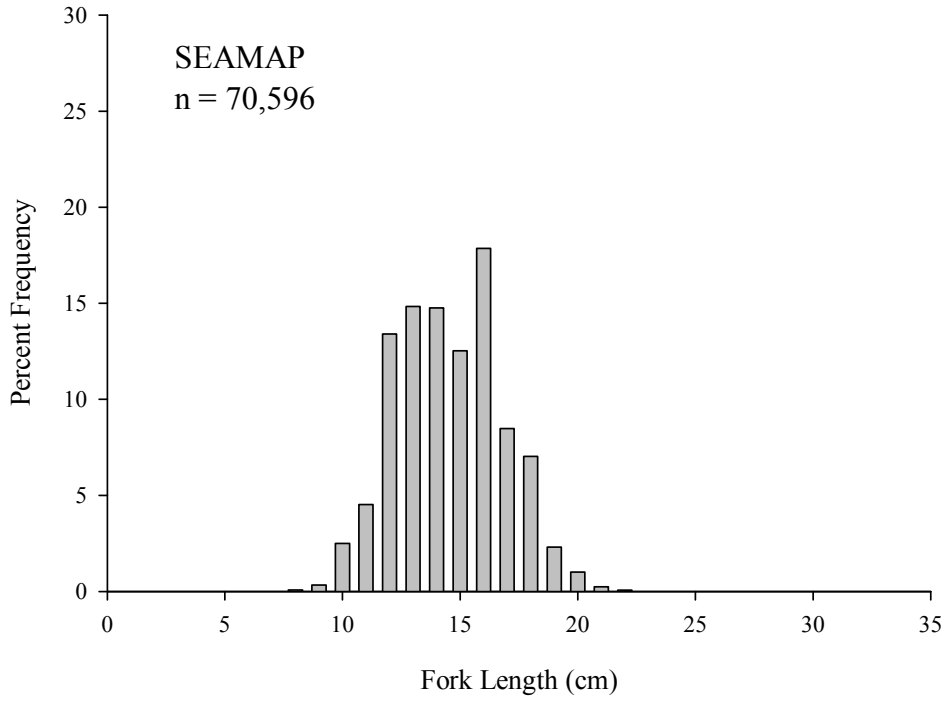


Figure 6. Length frequency distribution of spot by state from the SEAMAP survey in 2009 using 1 cm length bins.

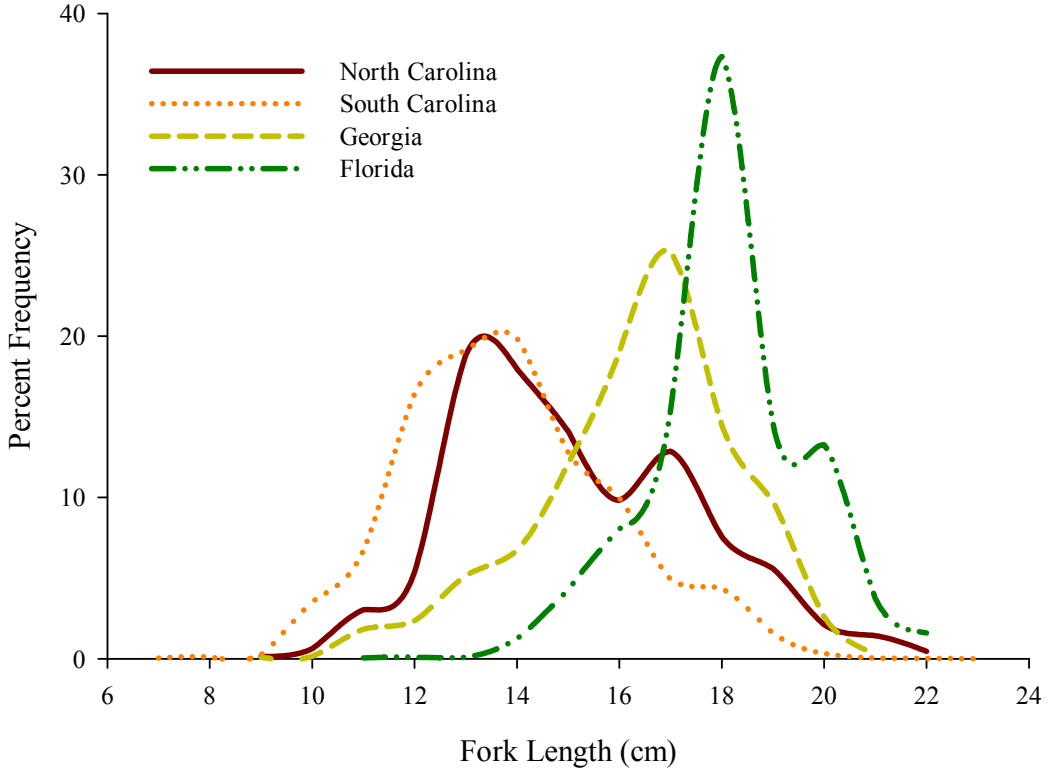


Figure 7. Mean annual catch per unit effort of spot from South Carolina trammel net survey 1991 to 2009. LTM = long term mean.

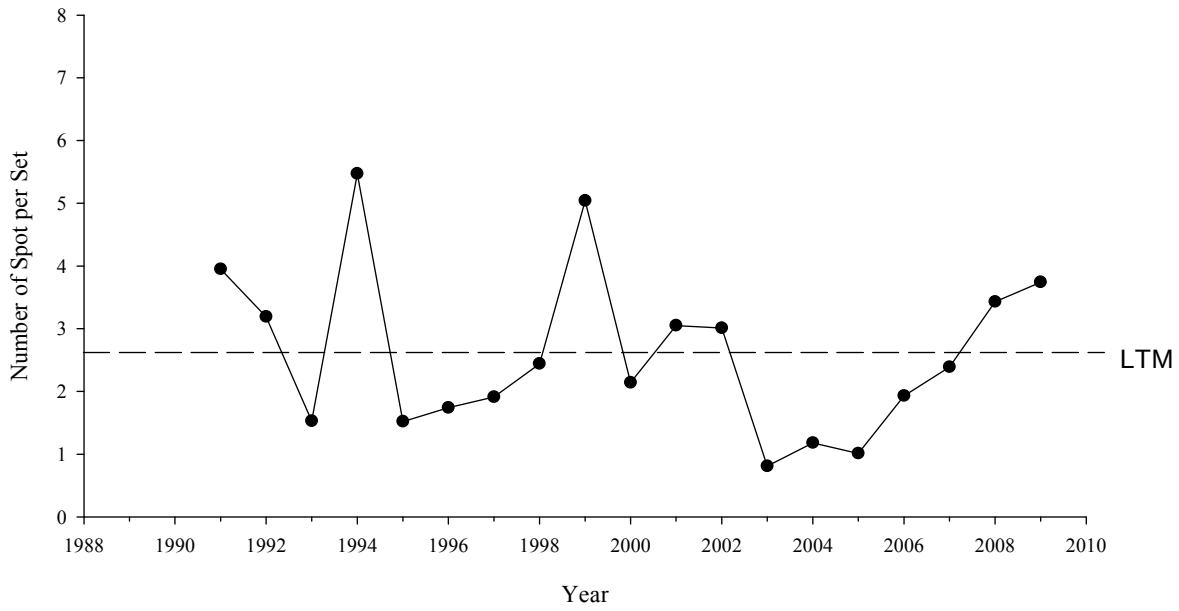


Figure 8. Mean annual catch per unit effort of spot from South Carolina electroshock boat survey 2001 to 2009. LTM = long term mean.

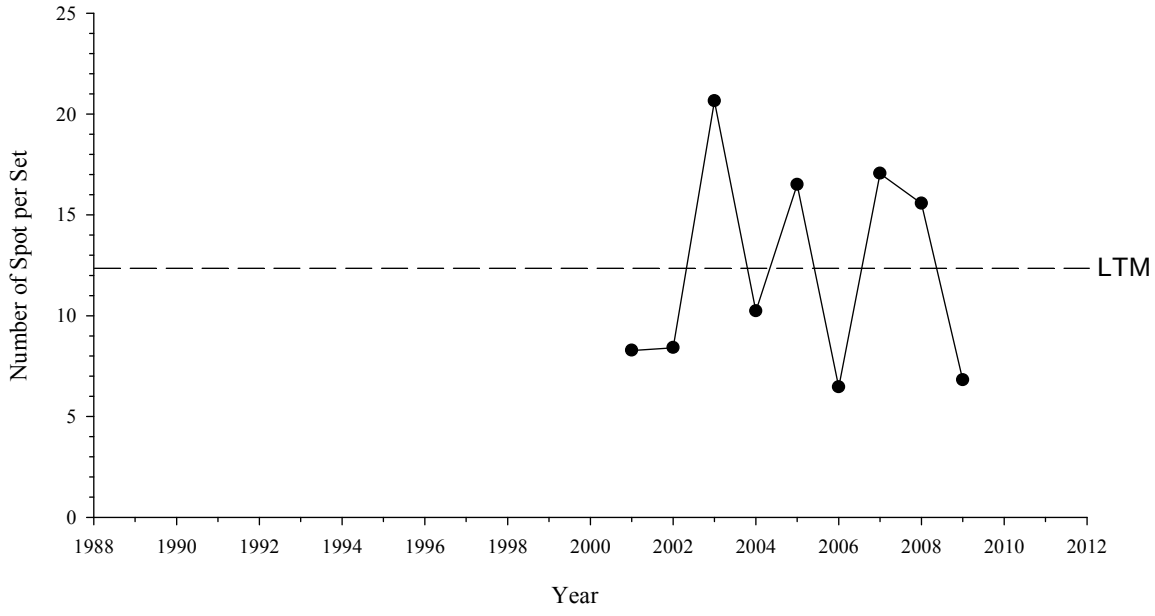


Figure 9. Mean annual catch per unit effort of spot from the SEAMAP survey (NC to FL) from 1989 to 2009. LTM = long term mean.

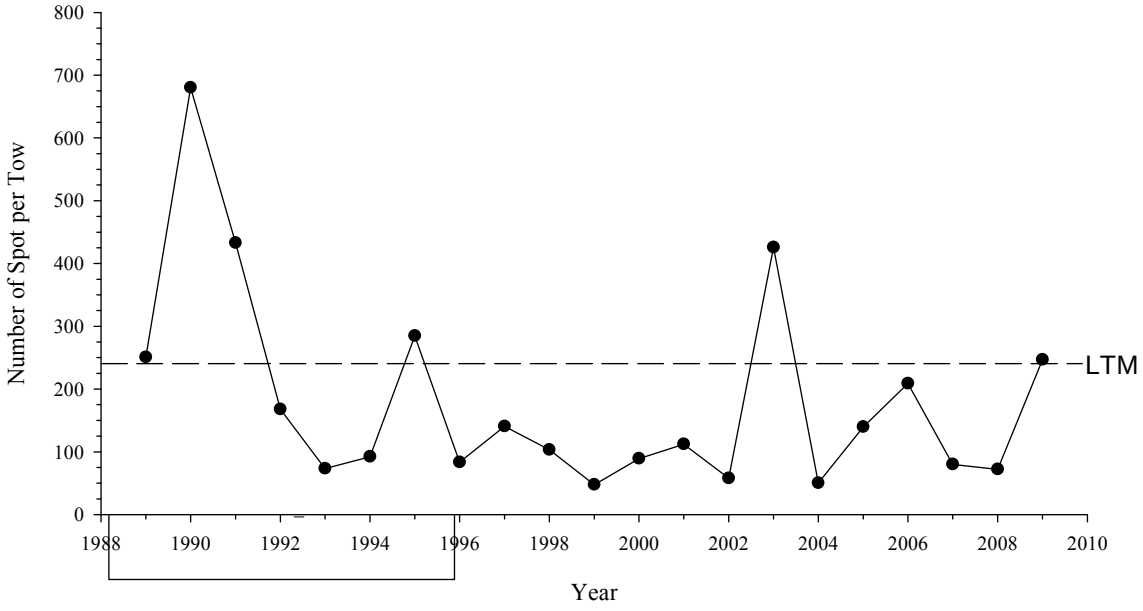
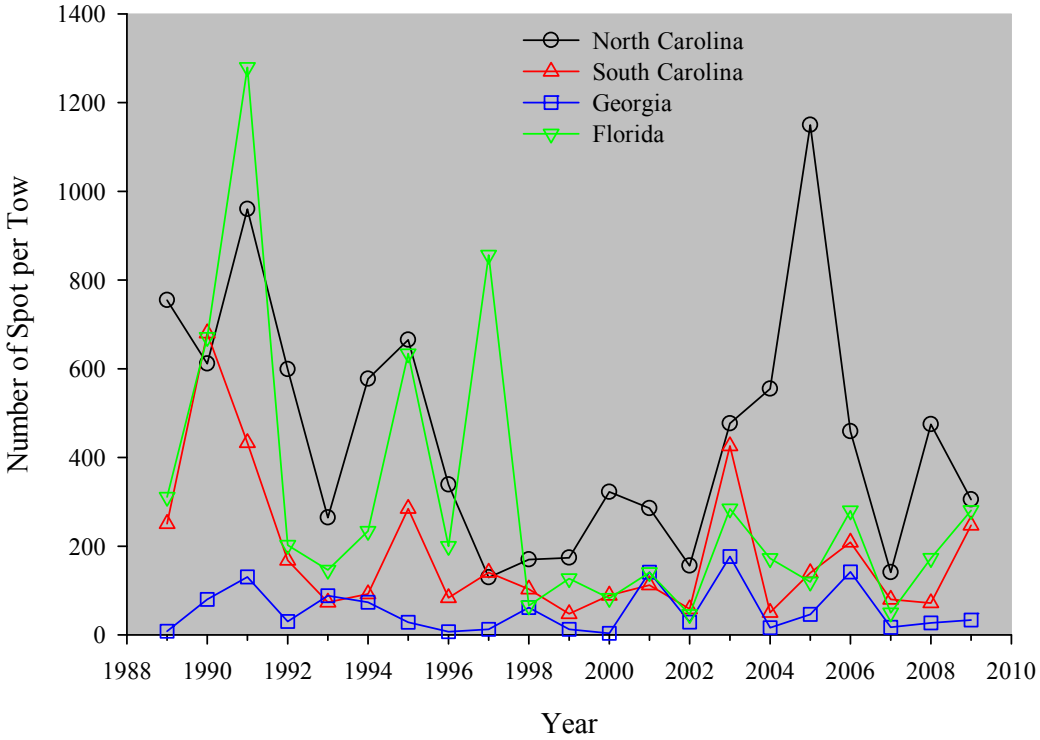


Figure 10. Mean annual catch per unit effort by state from the SEAMAP survey from 1989 to 2009.



Analysis of the NMFS Fall Ground-fish Survey for Spot (*Leiostomus xanthurus*) off the East Coast of the United States 1972 – 2008.

Report to the Spot Plan Review Team, Atlantic States Marine Fisheries Commission

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INTRODUCTION

The Woods Hole Laboratory of the National Marine Fisheries Service (NMFS) has performed a randomly stratified groundfish survey along the U.S. east coast since 1972. To date, these survey data have not been examined by the Spot Plan Review Team, although they are a valuable source of information because *Leiostomus xanthurus* is one of the main species caught throughout much of the survey area.

The purpose of this report is to provide a general overview of the *L. xanthurus* catch and life history information from the NMFS groundfish survey.

METHODS

NMFS trawl survey and database

Since 1972, the NMFS groundfish survey has conducted a biannual, fishery-independent trawl survey along the U.S. east coast, with cruises occurring during spring and fall (Grosslein, 1969; Azarovitz 1981; Azarovitz 1994). NMFS divide the coastal shelf into numerous strata that extend as far as Cape Hatteras NC in the south (**Fig. 1**). Within each stratum, ~30 minute tows are performed at stations selected at random from a 1 nm^2 grid. A #36-Yankee otter trawl is used, rigged with rollers, 5 fathom legs and a 1000 pound polyvalent door. The cod end and upper belly of the net are lined with 0.5-inch mesh to retain young-of-year fish. The NMFS database parameters that are recorded at each station are shown in **Table 1**.

In this report, we have only analyzed fall trawl data that were collected between Long Island NY and Cape Hatteras NC. *L. xanthurus* was more prevalent during fall, and very rare in strata further north.

Pooling of strata

Sampling frequency varied among years and NMFS strata, making it necessary to pool data across strata in order to generate comparable, non-biased metrics of abundance across years. This was achieved according to the procedures outlined in **Fig. 1**, which resulted in 15 pooled strata arranged into five latitudinally separated regions (Region 1 = most northerly, Region 5 = most southerly), each comprising an inshore, midshore and offshore section. These pooled strata were denoted 1Near, 1Mid, 1Off .... 5Off.

Data from only the midshore and offshore strata were used for calculating catch per unit effort (10 strata in total) because the inshore strata were sampled infrequently. Data from all 15 strata were used for examining life history parameters.

Catch per unit effort (CPUE)

For calculating CPUE, only tows with a NMFS "SHG" code < 125 were included (i.e. random tows of 26-34 minutes duration that did not experience gear problems), and only the midshore and offshore strata were used.

The number of tows that was analyzed for CPUE, by year and stratum, is shown in **Table 2**. Note, however, that there were temporal changes in the vessels used, and also a temporal shift in the time of year that tows were made over the duration of the survey (**Table 3**). The effects of these two methodology changes are difficult to elucidate because of the lack of overlap between contrasting survey methods. This leaves some potential for temporal bias in the CPUE time series.

The geographical area (nm^2) that was available for sampling within each stratum, and summary information of the depth of tows that occurred within them, are shown in **Table 4**. Mean tow depths increase from inshore to offshore. They also varied slightly from year to year in each stratum, but without any long-term trends (**Fig. 2**).

Annual stratified mean CPUE values for *L. xanthurus* were calculated based on methods described by Krebs (1998). For this, the arithmetic mean CPUE in each stratum was initially calculated as:

$$\overline{CPUE}_{a,h} = \frac{\sum_{t=1}^{T_{a,h}} n_{a,h,t}}{T_{a,h}}$$

where $\overline{CPUE}_h$ is the mean CPUE in stratum h during year a; $n_{a,h,t}$ is the number of spot caught in tow t within stratum h during year a; and $T_{a,h}$ is the total number of tows made within stratum h during year a.

The stratified mean CPUE was calculated as:

$$\overline{CPUE}_a = \frac{\sum_{h=1}^{10} A_h \overline{CPUE}_{a,h}}{A}$$

where $\overline{CPUE}_a$ is the stratified mean CPUE (i.e. coastwide); A_h is the area available for sampling in stratum h (**Table 4**); and A is the total area of all strata (i.e. $\sum_{h=1}^{10} A_h$, where stratum 1 through 10 represents the strata: 1Mid, 1Off, 2Mid.....5Off).

The variance of the stratified mean during year *a* was calculated as:

$$s_a^2 = \sum_{h=1}^{10} \left[\frac{W_h^2 \, s_{a,h}^2}{T_{a,h}} \right]$$

where W_h is the weighting factor of each stratum ($W_h = \frac{A_h}{A}$; see **Table 4**). The standard error of the stratified mean was calculated as the square root of the variance.

Body size, sex and maturity

From 1997 onwards, fork length (L_F, nearest centimeter), total wet weight (W, nearest gram), sex (immature, male, female) and gonad development stage (gross visual assessment) were recorded from sub-samples of some of the catches, but unfortunately no hard structures (otoliths or scales) were taken for age determination.

Gonads stages included: immature, developing, eyed (females), ripe, ripe and running (males), spent, resting and unknown. A fish was considered mature unless it was staged as 'immature' or 'unknown'.

Biological data were analyzed to determine size-frequency distributions, weight-length relationships and size at maturity. The number of specimens examined by year and stratum is shown in **Table 5**.

RESULTS

Catch per unit effort

In general, both the proportion of tows that caught *L. xanthurus* (i.e. catches > 0) and mean CPUE of *L. xanthurus* increased from north to south, and decreased from midshore to offshore (**Table 6**).

Coastal-wide, annual stratified mean CPUE values are shown in **Table 7** and **Fig. 3**. The long-term mean CPUE was 204.8 *L. xanthurus* per tow, with four main phases of fluction: (i) CPUE increased and then peaked during the 1970s and early 1980s before declining sharply in 1982 (ii) CPUE increased until 1989 and then declined until 1993 (ii) CPUE remained low throughout most of the 1990s, (iv) After 2001, CPUE generally increased to levels near or above the long-term mean.

There was no obvious relationship between variation in CPUE (**Fig. 3**) and changes in sampling protocol (survey month or survey vessel; **Table 3**), suggesting that the effects of sampling protocol were probably minor.

Body size, sex and maturity

Body size

In general, the mean body size of *L. xanthurus* increased from inshore to offshore, and from Region 5 (low latitude) to Region 1 (high latitude) (**Fig. 4**). For example, during 2006 (when L_F and W were measured in all strata), both L_F and W differed significantly among strata (1-way ANOVA, $p < 0.0001$). At one extreme, stratum 1Off had significantly longer and heavier fish than all other strata, whereas at the other extreme, stratum 5Near had significantly shorter and lighter fish than all of the strata in Region 1, and the mid- and offshore strata in Regions 2 and 3 (Tukeys tests, $p \leq 0.0001$).

Females were also larger than males. For example, in 2006, both sex and its interaction with stratum were significant when these terms were added to ANOVA models described above for L_F and W. Similarly, they were significant when data from all years combined were analyzed (**Fig. 5**).

Weight-length relationships

Analyses of relationships between total wet weight (W) and body length (L_F) revealed no significant differences between males and females ($p > 0.50$). However, significant effects of year and strata were detected. For example, both the slope (a) and intercept (b) of the relationship $\log_{10}W = a.\log_{10}L_F + b$ differed significantly among years ($p < 0.008$) when tested using 1997-2008 data from stratum 5Mid, which had measures taken in each year. In addition, both of these regression parameters differed significantly among strata ($p < 0.00001$) when tested using just the 2006 data (when measures were available from all strata).

Although the effects of stratum and year were significant, the magnitude of their effects was relatively minor when compared against the relationship fitted to the dataset pooled across all years and strata (**Fig. 6**).

Size at maturity

Size at maturity was analyzed by region (Regions 1-5). Preliminary analysis revealed significant differences in size at maturity between males and females, and among regions (logistic regression with L_F as a covariate, sex and region entered as factors; $p < 0.0001$ for sex

and region). Logistic regressions run on data separated by sex and region revealed two general patterns: (i) males matured at a smaller L_F that females, and (ii) low latitude fish matured at a smaller L_F than high latitude fish (**Fig. 7**). The effects of year have not been analyzed in detail.

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Table 1. Database parameters within the NMFS groundfish survey

Variable	Columns	Definition
Cruise code	1-4	First two digits are the year; second two digits sequentially assigned to indicate the order in which the cruise were coded
Station	5-8	Sequential station number
Stratum	9-13	Strata identification numbers
Tow number	14-16	Number of tow within a given stratum
Station value	17	Station type – [1] survey haul; [2] non-random haul; [3] special random add-on station haul [4] comparison haul; [5] no trawl – other gear; [6] site=specific; [7] systematic grid; [8] depletion site; [9] systematic parallel tracts; [0] systematic zigzag transects.
	18	Relative success of haul [1] good tow – no gear or tow duration problems; [2] representative but with some problems due to gear or tow time; [3] problem tow – may or may not be representative due to gear or tow time; [4] not representative due to gear or time; [5] no trawl tow – other gear used
	19	Gear condition – [1] no damage to insignificant damage; [2] Twisted wing small tears in belly; [3] hang with no to minor damage; [4] parted legs, sweep or headrope; [5] tear-up. But not total; [6] obstruction in net; [7] crossed doors; [8] open gear; [9] hang with major damage
Statistical area	20-22	International statistical area where tow made
Vessel	23-24	AL = Albatross IV; AT = Atlantic Twin; DE = Delaware II
Cruise	25-26	Assigned vessel cruise number
Time	27	[1] = Eastern standard time; [2] = eastern daylight savings Time
Yr-mo-day	28-33	First two = year; second two = month; last two = day
Gear code	34-35	Type of gear used (numerous code values)
Time	36-39	Local time with 24-hour clock
Minutes out	40-42	Actual time for gear out to with tenths of minutes
Depth start/end	43-50	First four digits = start depth; last four digits = end depth
Min/max	51-58	First four digits = minimum depth; second four digits = maximum depth
Lat/long	59-66	Replace by GPS reading in 1999; prior to that, first four digits = beginning latitude last four digits beginning longitude; both rounded to whole minutes
Loran	67-98	Loran readings
Cable	99-102	Cable in water measured in meters at the water's surface
Pitch	103-105	Pitch of prop if applicable
Heading	106-108	Vessel's heading in degrees
Course	109-111	Actual course the vessel made good in degrees
Rpm	112-114	Average shaft rpm under tow
Doppler bottom	115-117	Speed over bottom
Doppler water	118-120	Used on special occasions
Des speed	121-122	Designated towing speed for a particular gear to 0.1 knots
Gear- id	123-124	Gear -id number (each net has it's own number)
Door -id	125-126	Door id number
Head-rope height	127-129	Not used leave blank
Other gear	130-131	Code for other gear (hydro, plankton, etc)
Air temp	134-136	Air temp to nearest whole degree
Cloud cover	137-138	Code for cloud cover

Table 1 continued

Variable	Columns	Definition
Insol	139-142	Not used – blank
Bar	143-146	Barometric pressure to nearest millibar
Wind dir & speed	147-151	Wind direction in degrees; wind velocity in knots
Weather	152-153	Weather codes
Wave height	154-155	Height of waves to nearest tenth of meter
Swell direction & hgt	156-160	First three digits swell direction in degrees, second two digits = swell height in tenths of meters
Surf temp	161-163	Surface temp in tenths of degrees C
Surf salinity	164-167	Salinity parts per 1000
Wingspread	168-171	Not used – blank
Sal depth	172-175	Not used leave blank
Xbt	176	Type of temperature profiler used
Surf & bot temp	177-182	First three digits = surface degrees c to tenths; second three digits = bottom from xbt or ctd
Coded species	183-184	Number of species caught and coded at station
Trash	185-188	Amount of trash in liters
Fullness of dredge	189-191	Not used leave blank
Sed type	192-194	Not used leave blank
Trash by %	195-203	Not used leave blank
Ave depth	203-207	Average depth in meters between start and end of tow
Calc speed	208-210	Calculated speed of tow derived from navigational instruments
Surf sal	214-218	Surface salinity (0.001)
Bot sal	219-223	Bottom salinity (0.001)
Total weight	224-229	Total weight of species to 0.1 kg
Total number	230-235	Total number of animals at station

Table 2. Number of tows analyzed for CPUE, by year and stratum.

	Stratum										
Year	1Mid	1Off	2Mid	2Off	3Mid	3Off	4Mid	4Off	5Mid	5Off	Total
1972	7	9	7	6	7	6	6	4	10	9	71
1973	8	17	5	6	6	4	7	4	9	11	77
1974	4	7	5	6	6	5	6	4	6	12	61
1975	6	6	5	4	4	4	5	4	9	7	54
1976	5	4	4	4	4	4	4	4	6	6	45
1977	4	4	4	4	4	4	4	4	6	6	44
1978	4	4	4	4	4	4	4	4	6	6	44
1979	4	4	4	4	4	4	4	4	6	6	44
1980	4	3	4	4	4	4	4	4	6	6	43
1981	4	4	4	4	4	4	4	4	6	6	44
1982	3	4	4	4	3	4	6	3	6	2	39
1983	4	3	4	5	5	4	5	4	6	6	46
1984	4	4	4	4	4	4	4	4	6	6	44
1985	4	4	4	4	4	3	4	4	6	6	43
1986	3	3	4	3	4	4	3	4	6	6	40
1987	4	4	4	4	4	3	4	4	6	6	43
1988	3	3	4	4	4	4	4	4	6	6	42
1989	5	4	5	4	4	4	4	4	8	6	48
1990	3	5	5	4	5	4	4	4	6	5	45
1991	4	4	4	4	4	4	4	4	6	6	44
1992	5	3	4	4	4	4	4	4	4	6	42
1993	4	4	4	4	4	4	4	4	6	6	44
1994	4	3	4	4	4	3	4	4	6	6	42
1995	4	2	4	4	4	4	4	4	6	6	42
1996	4	3	4	4	3	4	4	3	6	6	41
1997	4	3	4	4	4	4	3	4	6	6	42
1998	4	4	4	3	4	4	4	4	6	6	43
1999	4	4	4	4	4	4	4	4	6	6	44
2000	4	4	4	4	5	4	5	4	6	6	46
2001	4	4	4	4	5	3	4	4	6	6	44
2002	4	3	4	4	4	4	4	4	6	6	43
2003	4	4	4	3	3	4	4	4	5	6	41
2004	5	4	4	3	4	4	3	4	6	6	43
2005	4	4	4	4	4	4	4	4	6	6	44
2006	2	4	4	4	4	4	4	3	6	6	41
2007	4	4	4	4	4	4	4	4	6	6	44
2008	4	3	4	3	4	4	4	4	6	6	42
Total	155	160	156	150	156	147	157	145	231	232	1689

Table 3. Number of tows analyzed for CPUE by vessel, and by month.

	Vessel name				Month				
Year	AL	AT	DE	Total	Sep	Oct	Nov	Dec	Total
1972	.	71	.	71	.	2	65	4	71
1973	.	77	.	77	.	67	10	.	77
1974	23	.	38	61	23	38	.	.	61
1975	.	.	54	54	.	20	34	.	54
1976	45	.	.	45	.	45	.	.	45
1977	.	.	44	44	7	37	.	.	44
1978	.	.	44	44	44	.	.	.	44
1979	.	.	44	44	23	21	.	.	44
1980	.	.	43	43	29	14	.	.	43
1981	.	.	44	44	34	10	.	.	44
1982	39	.	.	39	31	8	.	.	39
1983	46	.	.	46	36	10	.	.	46
1984	44	.	.	44	44	.	.	.	44
1985	.	.	43	43	.	43	.	.	43
1986	30	.	10	40	30	10	.	.	40
1987	43	.	.	43	43	.	.	.	43
1988	42	.	.	42	42	.	.	.	42
1989	.	.	48	48	48	.	.	.	48
1990	.	.	45	45	45	.	.	.	45
1991	.	.	44	44	44	.	.	.	44
1992	42	.	.	42	42	.	.	.	42
1993	.	.	44	44	44	.	.	.	44
1994	42	.	.	42	42	.	.	.	42
1995	42	.	.	42	42	.	.	.	42
1996	41	.	.	41	41	.	.	.	41
1997	42	.	.	42	42	.	.	.	42
1998	43	.	.	43	39	4	.	.	43
1999	44	.	.	44	35	9	.	.	44
2000	46	.	.	46	46	.	.	.	46
2001	44	.	.	44	44	.	.	.	44
2002	43	.	.	43	43	.	.	.	43
2003	41	.	.	41	9	32	.	.	41
2004	43	.	.	43	43	.	.	.	43
2005	44	.	.	44	44	.	.	.	44
2006	41	.	.	41	41	.	.	.	41
2007	44	.	.	44	44	.	.	.	44
2008	42	.	.	42	42	.	.	.	42
Total:	996	148	545	1689	1206	370	109	4	1689

Vessel names: AL = Albatross; AT = ; DE = Delaware; AT = Atlantic Twin.

Table 4. Geographical area and depth of each stratum. $\boldsymbol{A_h}$ is the area available for sampling in each stratum (square nautical miles). $\boldsymbol{W_h}$ is the weighting applied to each stratum (based on relative area) for calculating stratified mean CPUE parameters. $\boldsymbol{T_h}$is the total number of tows of tows that were analyzed across all years (1972-2008). Depth values (meters) and are summary statistics of the depths at which tows were made.

Stratum (h)	A_h	W_h	T_h	Mean	Min	Max
1Near*	(66)	-	(63)	11.5	6	17
1Mid	150	0.034	155	16.0	9	30
1Off	348	0.080	160	23.3	17	31
2Near*	(119)	-	(61)	10.7	6	21
2Mid	370	0.085	156	14.8	9	21
2Off	523	0.120	150	20.6	10	30
3Near*	(88)	-	(82)	12.1	7	34
3Mid	392	0.090	156	15.3	9	35
3Off	339	0.078	147	19.5	11	29
4Near*	(167)	-	(66)	10.1	6	14
4Mid	466	0.107	157	15.1	9	23
4Off	194	0.045	145	20.5	12	28
5Near*	(194)	-	(119)	11.2	7	22
5Mid	660	0.152	231	16.5	8	29
5Off	911	0.209	232	22.5	10	37
Total:	4353*	1.0*	1689*			

* Nearshore strata were not used for calculating CPUE. They are excluded from the 'Total' row shown here.

Table 5. Number of specimens from which fork length (L_F), wet weight (W), sex and gonad development stage were recorded, by year and pooled stratum. None of these parameters was recorded prior to 1997.

	STRATUM															
YEAR	1Near	1Mid	1Off	2Near	2Mid	2Off	3Near	3Mid	3Off	4Near	4Mid	4Off	5Near	5Mid	5Off	Total
1997					3			10	10							23
1998					3		19	18	24	11	41	43	83	120	61	423
1999		1			9			13	16		9	17	27	27	55	174
2000	10	10		61	66	28	46	84	13		23	63	40	51	39	534
2001	32	31		46	58	31	38	50	68	5	24	10	16	15		424
2002	1	11	1	32	25	20	64	59	82	8	42	14	23	52	9	443
2003	25	83	26	25	73	77	35	41	76		12	53	8	63	69	666
2004			25	18	43		44	56	111		36	32	1	59	104	529
2005	2	9		38	40	24	12	42	87	13	45	13	77	65	111	578
2006	64	95	23	38	126	62	67	132	137	13	49	70	44	56	70	1,046
2007		2		35	68	66	38	73	80	17	50	58	40	40	65	632
2008		29	11	23	72	19	21	92	65	33	46	47	58	70	58	644
Total	134	271	86	316	586	327	384	670	769	100	377	420	417	618	641	6,116

Table 6. Proportion of tows that caught *L. xanthurus* (i.e. catches > 0) and mean CPUE of *L. xanthurus*, by year and stratum (see Fig 1 for stratum locations).

	PROPORTION OF TOW THAT CAUGHT SPOT										MEAN CPUE OF SPOT									
	Midshore strata					Offshore strata					Midshore strata					Offshore strata				
YEAR	1Mid	2Mid	3Mid	4Mid	5Mid	1Off	2Off	3Off	4Off	5Off	1Mid	2Mid	3Mid	4Mid	5Mid	1Off	2Off	3Off	4Off	5Off
1972	0.00	0.00	0.29	0.67	0.70	0.00	0.00	0.17	0.75	0.33	0.0	0.0	2.6	0.8	75.1	0.0	0.0	2.7	32.3	3.6
1973	0.75	0.20	1.00	0.86	1.00	0.00	0.00	0.25	0.25	0.91	13.0	0.2	204.8	644.0	397.4	0.0	0.0	64.5	12.3	283.6
1974	0.00	0.20	1.00	0.83	1.00	0.00	0.00	0.20	1.00	0.92	0.0	1.0	274.5	181.3	511.5	0.0	0.0	0.4	308.8	150.7
1975	0.00	0.00	0.50	1.00	0.89	0.00	0.00	0.50	0.75	0.86	0.0	0.0	37.5	36.8	666.7	0.0	0.0	0.8	49.0	247.4
1976	0.60	0.75	1.00	1.00	1.00	0.00	0.25	0.25	0.75	0.83	60.0	46.0	122.0	850.0	1250.2	0.0	9.0	0.3	624.3	350.0
1977	0.50	0.25	1.00	1.00	1.00	0.50	0.25	1.00	1.00	0.83	48.3	35.5	43.0	725.3	704.8	9.5	0.3	281.5	2011.3	656.8
1978	0.00	0.00	0.75	1.00	1.00	0.00	0.00	0.75	0.75	1.00	0.0	0.0	60.0	375.0	1644.8	0.0	0.0	502.0	314.5	101.3
1979	0.50	0.25	1.00	1.00	0.83	0.00	0.00	0.50	1.00	1.00	1.8	0.5	29.3	802.0	464.0	0.0	0.0	2.5	1178.8	452.8
1980	0.00	0.50	0.75	1.00	1.00	0.00	0.00	0.25	0.50	0.83	0.0	10.5	35.0	918.3	1432.0	0.0	0.0	7.5	301.0	322.3
1981	0.00	0.50	1.00	1.00	1.00	0.00	0.75	1.00	0.75	1.00	0.0	14.5	860.3	292.8	792.3	0.0	21.8	430.8	88.8	625.3
1982	0.00	1.00	1.00	1.00	1.00	0.25	0.25	1.00	1.00	1.00	0.0	33.5	126.3	269.8	119.8	4.8	3.5	81.3	143.3	47.0
1983	0.00	0.75	0.60	0.80	0.67	0.33	0.20	0.50	1.00	0.33	0.0	21.0	56.8	295.4	384.8	0.3	1.2	571.0	658.8	2.7
1984	0.00	0.75	1.00	1.00	1.00	0.00	0.25	1.00	1.00	0.83	0.0	30.3	181.3	842.0	313.3	0.0	1.0	806.3	655.3	152.0
1985	0.25	0.50	0.75	1.00	1.00	0.00	0.50	1.00	1.00	1.00	0.3	10.0	50.0	167.5	1088.3	0.0	9.3	44.0	58.3	154.3
1986	0.33	0.50	1.00	1.00	1.00	0.00	0.00	1.00	1.00	1.00	0.3	68.8	334.0	890.3	231.5	0.0	0.0	6.0	688.3	587.2
1987	0.00	0.25	0.50	0.75	0.83	0.00	0.00	0.33	0.50	0.83	0.0	0.8	0.8	149.0	235.8	0.0	0.0	18.3	95.5	791.5
1988	0.00	0.50	0.75	0.50	0.83	0.00	0.25	0.25	0.75	0.67	0.0	134.3	664.3	69.3	68.0	0.0	2.0	1.0	650.5	247.7
1989	0.20	1.00	1.00	1.00	0.88	0.00	0.25	1.00	1.00	1.00	0.2	96.2	775.8	214.3	147.4	0.0	1.3	582.0	246.8	1438.8
1990	0.00	0.20	0.80	1.00	0.83	0.00	0.25	0.75	1.00	1.00	0.0	97.0	453.4	542.8	526.5	0.0	0.5	12.3	315.0	277.2
1991	0.00	1.00	1.00	1.00	0.50	0.00	0.00	0.75	0.50	0.67	0.0	14.3	677.3	475.5	568.2	0.0	0.0	36.5	195.5	6.2
1992	0.00	0.25	0.75	1.00	0.75	0.00	0.00	0.50	0.25	0.17	0.0	0.8	32.5	202.8	92.5	0.0	0.0	0.5	35.0	17.3
1993	0.00	0.00	0.75	0.50	0.67	0.00	0.00	0.25	0.50	0.17	0.0	0.0	42.0	95.3	26.2	0.0	0.0	15.5	23.8	0.2
1994	1.00	0.00	0.75	1.00	0.50	0.00	0.00	0.67	1.00	0.33	483.3	0.0	288.5	624.5	12.2	0.0	0.0	99.0	1881.8	102.7
1995	0.50	0.25	0.50	1.00	1.00	0.50	0.00	1.00	1.00	1.00	1.0	0.3	10.0	87.5	49.8	0.5	0.0	14.5	193.3	117.5
1996	0.25	0.50	0.67	1.00	1.00	0.00	0.00	0.25	1.00	0.67	4.5	46.5	4.3	60.5	23.8	0.0	0.0	1.3	360.7	58.5
1997	0.00	0.00	1.00	1.00	0.83	0.00	0.00	0.75	0.50	0.67	0.0	0.0	51.3	111.7	138.2	0.0	0.0	10.5	112.3	25.7
1998	0.00	0.00	0.75	0.75	1.00	0.00	0.00	0.75	0.75	0.50	0.0	0.0	16.8	197.3	48.0	0.0	0.0	57.3	22.8	7.0
1999	0.00	0.50	1.00	1.00	1.00	0.00	0.00	0.75	0.50	1.00	0.0	1.0	22.5	324.0	283.2	0.0	0.0	24.8	60.0	254.3
2000	0.25	0.75	1.00	0.80	1.00	0.00	0.00	0.00	0.75	0.67	5.3	169.5	11.4	117.8	35.8	0.0	0.0	0.0	196.0	98.8
2001	0.00	0.00	0.60	0.50	0.33	0.00	0.00	0.00	0.25	0.00	0.0	0.0	25.6	110.8	7.5	0.0	0.0	0.0	1.0	0.0
2002	0.00	0.50	1.00	1.00	1.00	0.00	0.25	1.00	0.50	0.50	0.0	11.8	136.3	1763.8	210.5	0.0	0.3	152.0	135.8	14.0
2003	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.75	0.75	1.00	0.0	0.0	41.0	183.3	287.2	0.0	0.0	6.8	94.8	53.3
2004	0.00	1.00	0.75	1.00	1.00	0.00	0.00	0.50	0.50	0.83	0.0	10.3	269.3	75.7	143.5	0.0	0.0	11.8	157.5	255.8
2005	0.50	1.00	0.75	1.00	1.00	0.00	0.25	0.75	0.25	1.00	2.8	66.3	254.0	990.8	921.5	0.0	0.5	336.5	30.8	571.3
2006	1.00	1.00	1.00	1.00	1.00	0.00	0.50	0.75	1.00	1.00	3.5	20.8	53.3	153.3	530.2	0.0	25.0	75.8	358.3	337.5
2007	0.00	0.75	0.75	1.00	0.83	0.00	0.25	1.00	1.00	0.83	0.0	156.3	233.8	447.0	515.0	0.0	2.0	17.0	684.5	127.5
2008	0.75	1.00	1.00	1.00	1.00	0.33	0.67	1.00	1.00	1.00	43.5	127.3	129.0	590.0	609.8	21.3	0.7	204.0	619.0	286.3
Mean:	**0.20**	**0.45**	**0.83**	**0.92**	**0.89**	**0.05**	**0.14**	**0.62**	**0.75**	**0.76**	**18.0**	**33.1**	**178.6**	**402.1**	**420.5**	**1.0**	**2.1**	**121.0**	**367.4**	**249.4**
	North ⟷ South					North ⟷ South					North ⟷ South					North ⟷ South				

Table 7. Stratified mean CPUE, standard error and proportional standard error (%), by year, for *L. xanthurus* in the NMFS groundfish survey.

Year	Mean	SE	PSE
1972	14.1	7.7	54.9
1973	214.8	50.1	23.3
1974	167.5	34.3	20.5
1975	163.1	51.3	31.5
1976	401.1	73.0	18.2
1977	438.9	66.1	15.1
1978	368.8	129.0	35.0
1979	305.5	57.5	18.8
1980	403.3	152.5	37.8
1981	402.0	124.6	31.0
1982	84.8	13.8	16.3
1983	168.6	53.8	31.9
1984	278.0	58.4	21.0
1985	228.8	40.2	17.6
1986	321.3	64.0	19.9
1987	223.6	153.3	68.6
1988	169.7	72.1	42.5
1989	480.4	230.8	48.1
1990	261.6	53.8	20.6
1991	213.8	65.5	30.6
1992	44.4	13.7	31.0
1993	20.4	10.7	52.5
1994	220.7	42.9	19.5
1995	52.0	14.9	28.7
1996	42.3	16.8	39.9
1997	48.8	13.9	28.5
1998	37.0	18.9	50.9
1999	138.3	37.4	27.0
2000	63.1	19.5	31.0
2001	15.6	7.2	46.2
2002	257.9	89.9	34.9
2003	83.2	22.2	26.7
2004	116.7	37.3	32.0
2005	423.7	129.1	30.5
2006	198.7	48.0	24.1
2007	219.1	53.6	24.5
2008	284.5	66.8	23.5

Fig. 1 Pooling of NMFS groundfish strata

Details of NMFS strata numbering (circles) and pooling procedures used to create larger strata for analyzing the spot catch data.

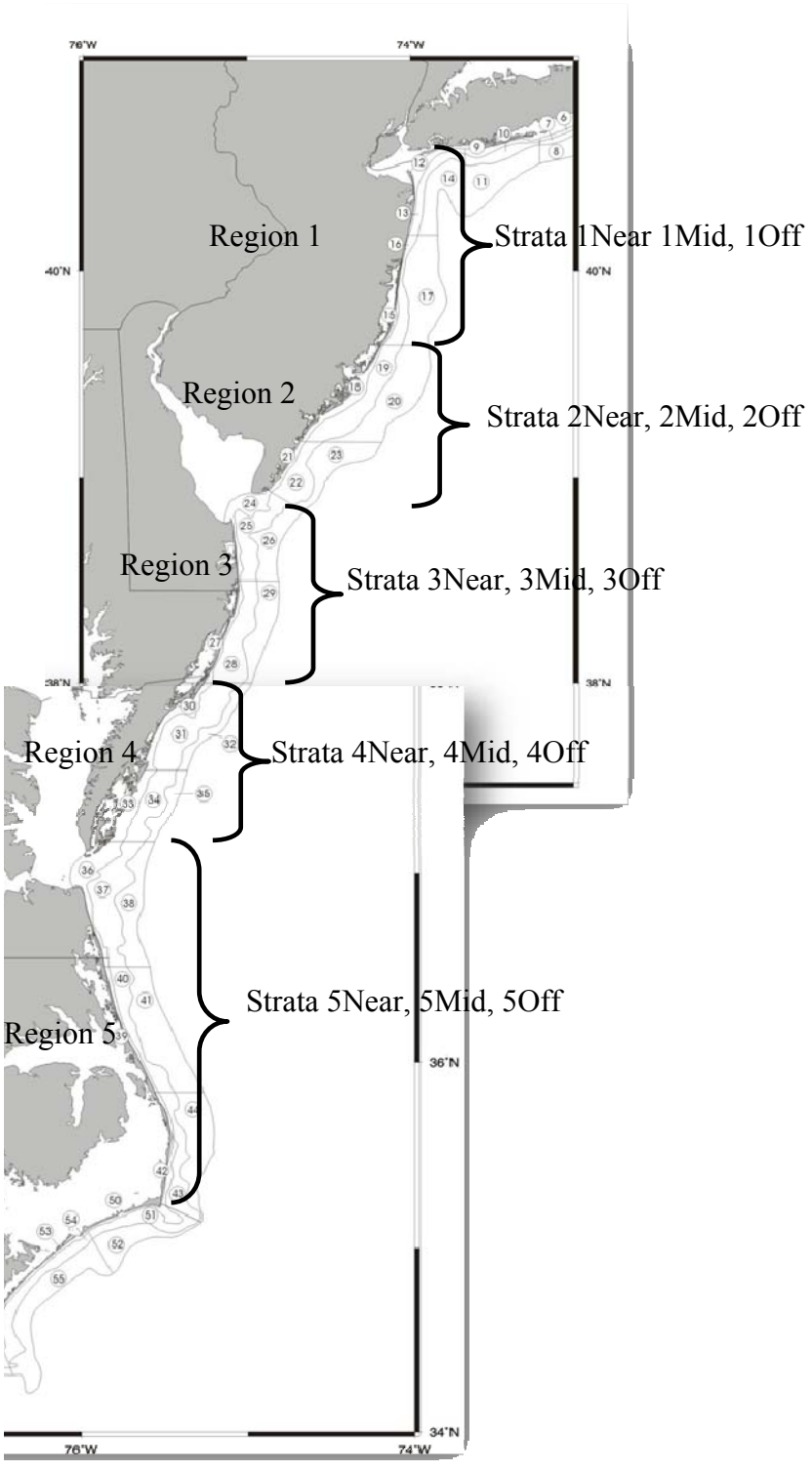
Note that along each section of the coast, there is a triplet of NMFS strata comprising a nearshore (e.g. 12), midshore (e.g. 13) and offshore stratum (e.g. 14).

Data from NMFS strata <12 and > 44 were omitted due to most years having either missing data, very low tow numbers, or very low spot catches.

Across the remaining survey area, groups of neighboring north/south NMFS strata were pooled to provide sampling coverage that was sufficient to allow the calculation of stratified mean CPUE values or biological parameters.

Pooling was performed as follows:

Pooled strata	NMFS strata
1Near*	Nearshore, 12+15
1Mid	Midshore, 13+16
1Off	Offshore, 14+17
2Near*	Nearshore, 18+21
2Mid	Midshore, 19+22
2Off	Offshore, 20+23
3Near*	Nearshore, 24+27
3Mid	Midshore, 25+28
3Off	Offshore, 26+29
4Near*	Nearshore, 30+33
4Mid	Midshore, 31+34
4Off	Offshore, 32+35
5Near*	Nearshore, 36+39+42
5Mid	Midshore, 37+40+43
5Off	Offshore, 38+41+44



* Not used for CPUE calculations due to insufficient data

Fig. 2. Mean tow depth, by year and stratum.

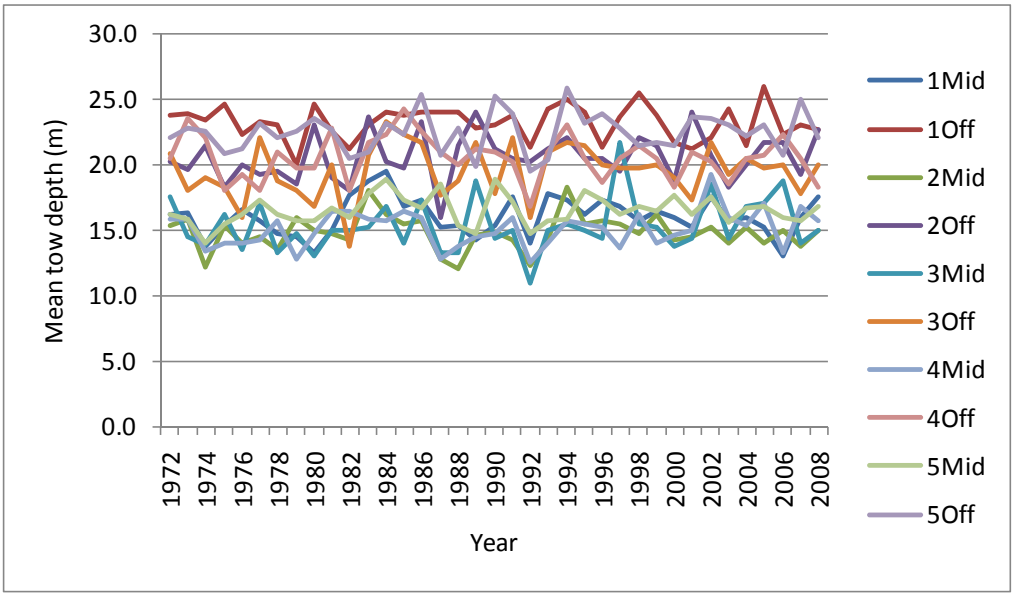


Fig. 3. Stratified arithmetic mean CPUE (±SE) of spot in the NMFS groundfish survey.

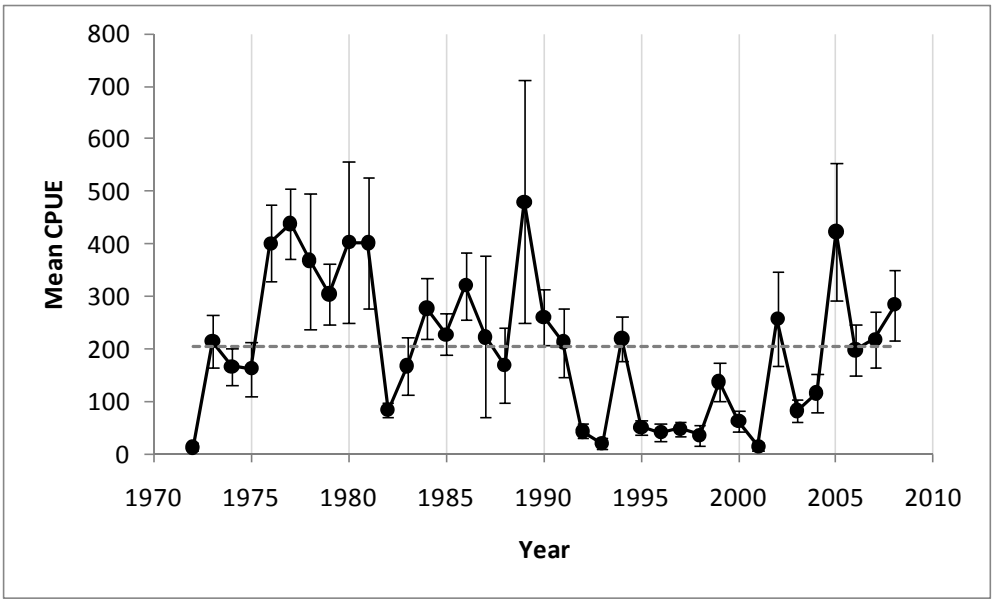


Fig. 4. Length-frequency distribution, by stratum, for *L. xanthurus* caught in the NMFS groundfish survey. Data have been pooled across sampling years. Vertical grid lines show the 20, 30 and 40 cm fork length (L_F) bins. Y-axis units are percent.

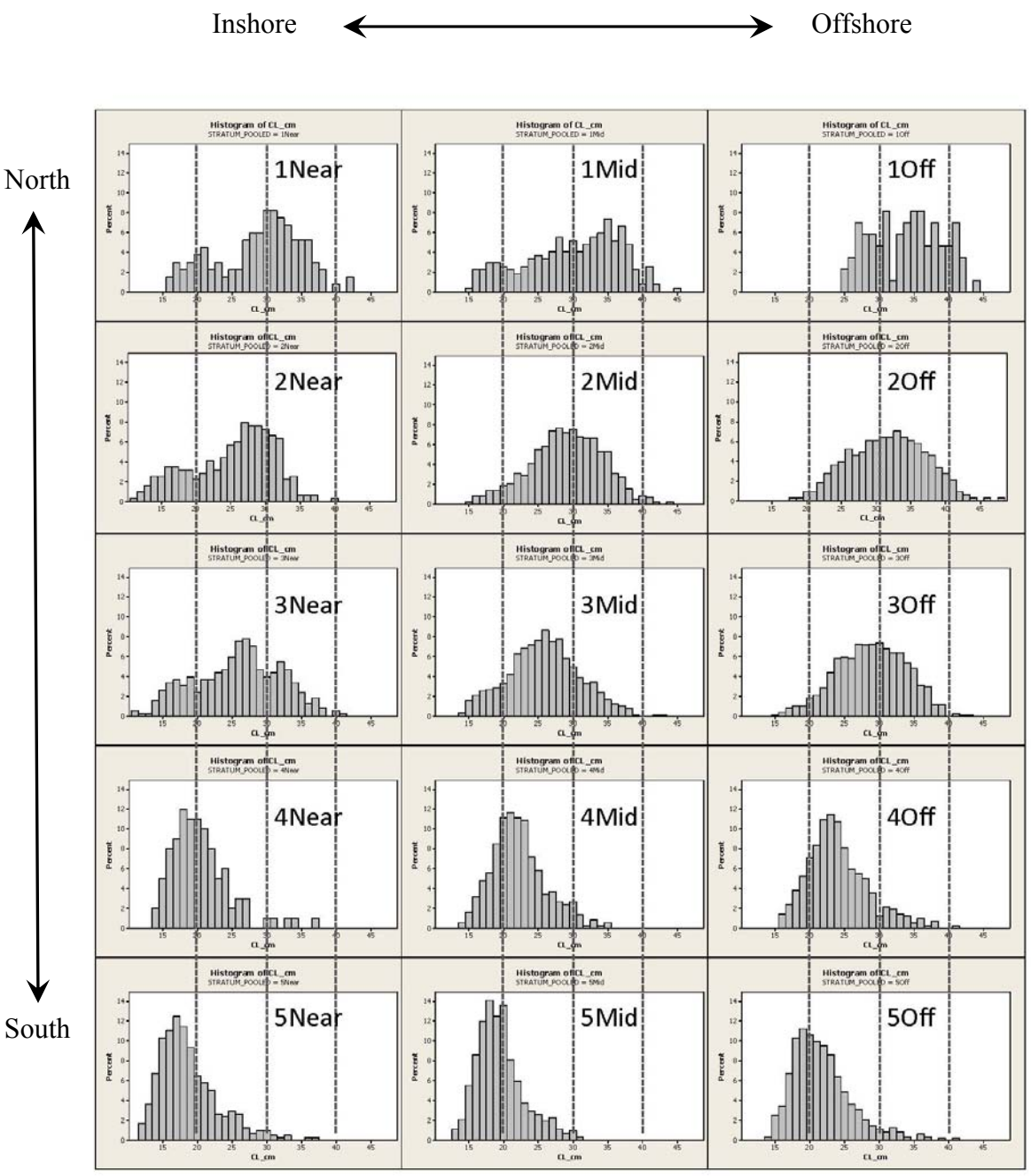


Fig. 5. *L. xanthurus* mean body size measurements, by stratum. (A) Male fork length. (B) Female fork length. (C) Male wet weight. (D) Female wet weight. Data were pooled across all years.

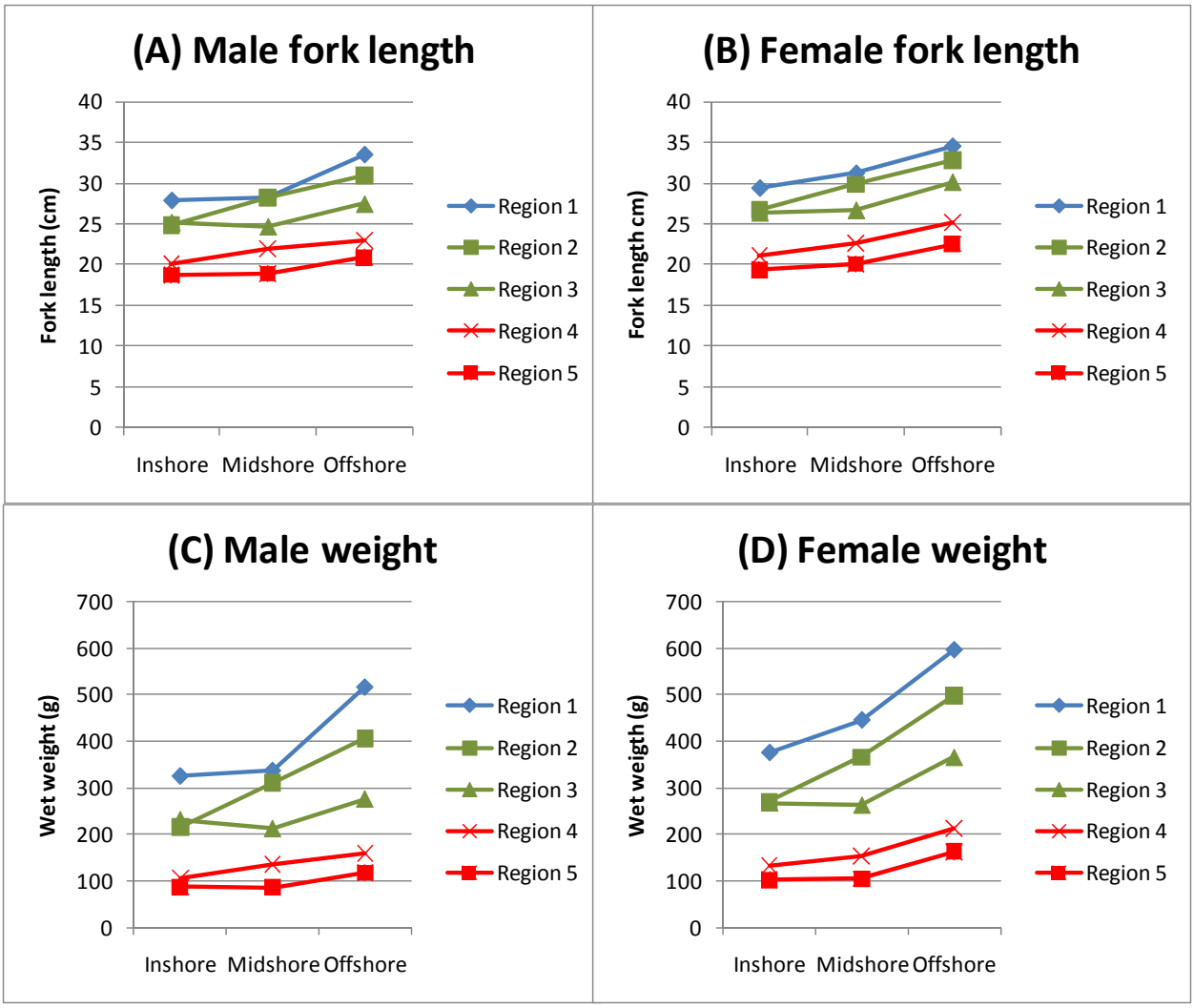


Fig. 6. Weight-length relationship for *L. xanthurus*. The gray plus symbols show the entire dataset (all strata and years), which was used for fitting the line. The superimposed red pluses (3Off) and blue squares (1Off) show the strata with the most negative and most positive residuals from the model, respectively.

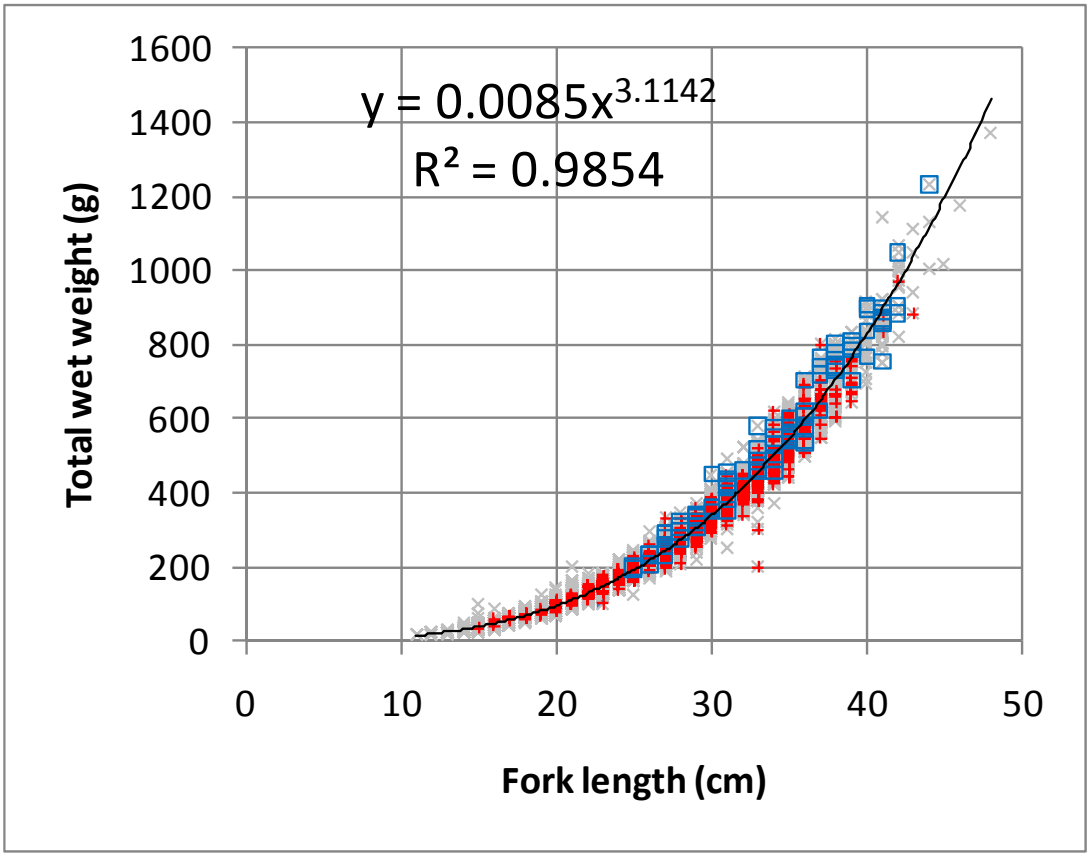
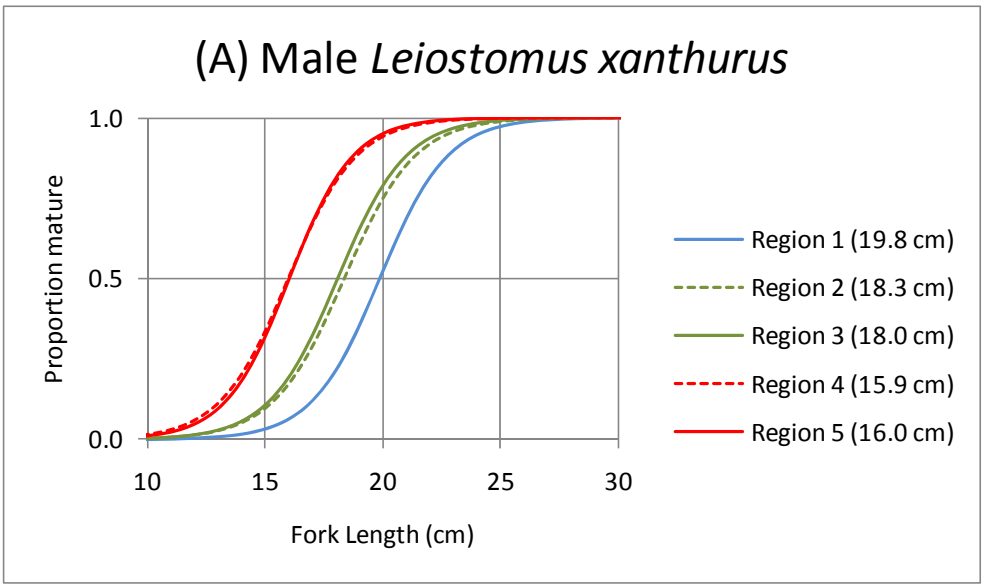
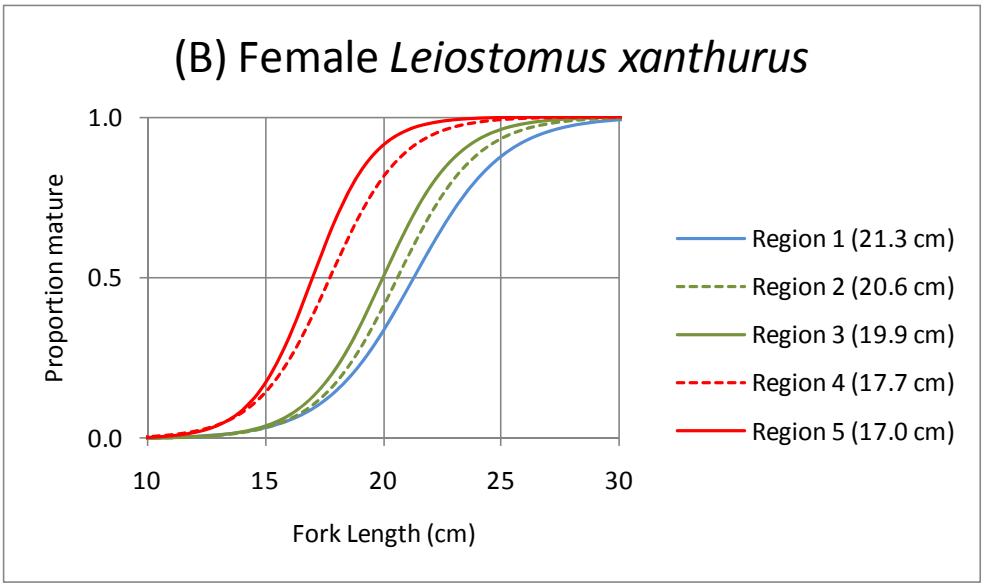


Fig. 7. Logistic regressions fits showing the proportion of *L. xanthurus* that were sexually mature with respect to fork length, by latitudinal region, in (A) males, and (B) females. Fork length at which 50% maturity occurred (as estimated by the logistic fits) is shown in parentheses. (Note: Region 1 is most north; Region 5 is most south).





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

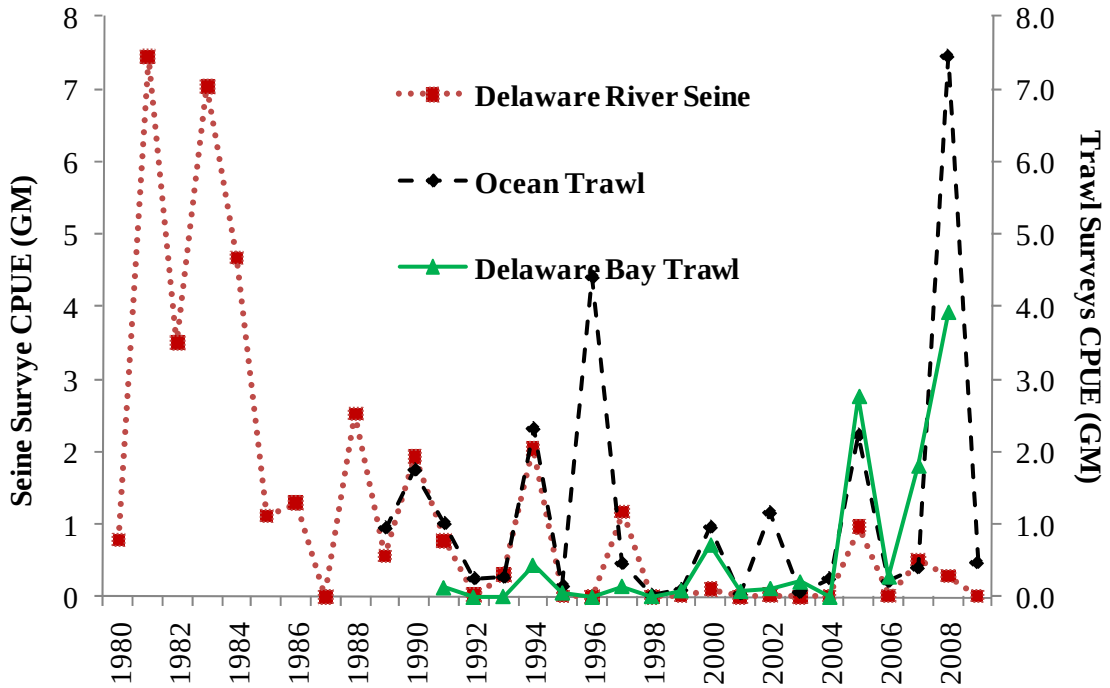
Data provided by Heather Corbett

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

The 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.

The 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.

The 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

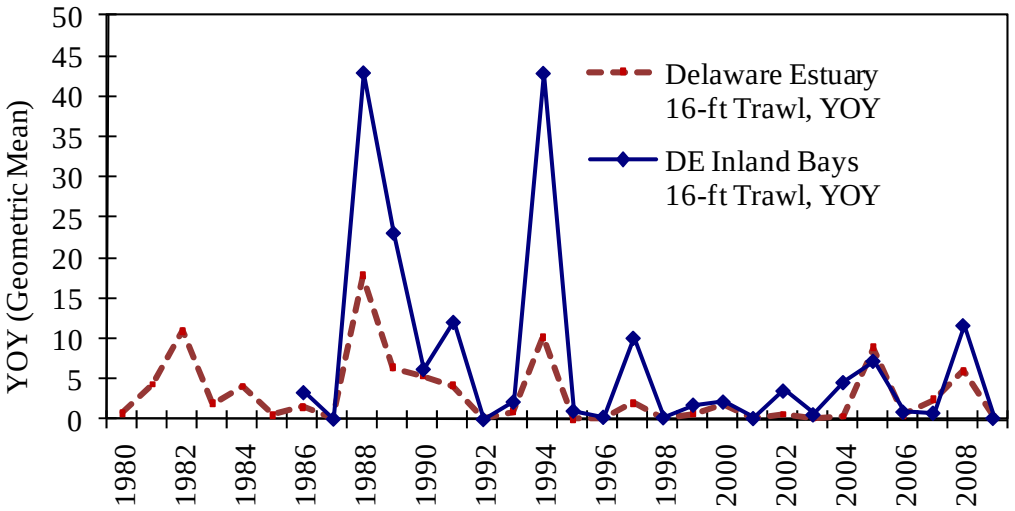
	Ocean Trawl	Delaware River Seine	Delaware Bay Trawl
1980		0.79	
1981		7.44	
1982		3.50	
1983		7.04	
1984		4.68	
1985		1.12	
1986		1.29	
1987		0.00	
1988		2.52	
1989	0.95	0.57	
1990	1.75	1.94	
1991	1.01	0.78	0.13
1992	0.25	0.02	0.00
1993	0.27	0.30	0.01
1994	2.32	2.05	0.44
1995	0.15	0.01	0.06
1996	4.41	0.00	0.00
1997	0.46	1.17	0.15
1998	0.02	0.00	0.01
1999	0.10	0.01	0.09
2000	0.96	0.11	0.72
2001	0.04	0.00	0.08
2002	1.16	0.02	0.12
2003	0.06	0.00	0.21
2004	0.25	0.01	0.00
2005	2.23	0.96	2.77
2006	0.21	0.01	0.28
2007	0.40	0.51	1.81
2008	7.46	0.29	3.93
2009	0.47	0.01	NA

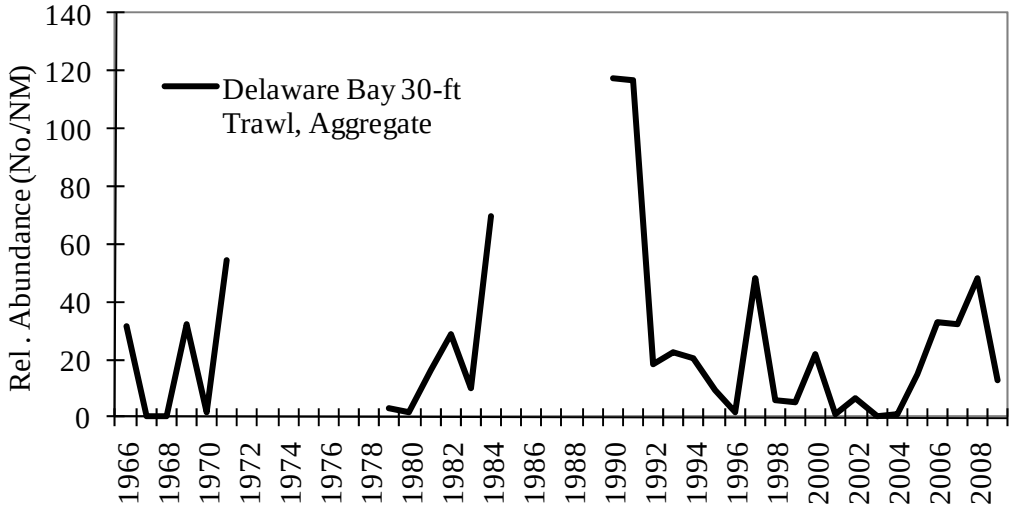
Spot Relative Abundance Indices Provided by the Delaware Division of Fish and Wildlife

Data provided by Stewart Michels

Three indices, two young-of-year and one age-aggregated, are available for spot on Delaware:

1) An annual young-of-the-year index, expressed as the geometric mean catch per tow, for spot collected during 16-foot trawl sampling in the Delaware Estuary.
2) 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
3) Spot relative abundance (No./Naut. Mile) from 30-foot trawl sampling in the Delaware Bay





Year	DE Estuary YOY (GM)	DE Inland Bays YOY (GM)	DE Bay Rel. Abundance (No./NM)
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
2009	0.25	0.21	12.55