

**FISHERY MANAGEMENT PLAN UPDATE
ESTUARINE STRIPED BASS
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	January 1994 May 2004
Amendments:	Amendment 1 – May 2013
Revisions:	November 2014
Supplements:	None
Information Updates:	None
Schedule Changes:	August 2016
Next Benchmark Review:	Fall 2018

The North Carolina Marine Fisheries Commission (NCMFC) and the North Carolina Wildlife Resources Commission (NCWRC) implemented a Memorandum of Agreement in 1990 to address management of striped bass in the Albemarle Sound and Roanoke River. The original Estuarine Striped Bass FMP was approved by the NCMFC in 1994 and was targeted at the continued recovery of the A/R stock, which at the time was at historically low levels of abundance and was experiencing chronic spawning failures (Laney et. al. 1993). The comprehensive plan for the first time addressed the management of all estuarine stocks of striped bass in the state. The plan also satisfied the recommendation, contained in the Report to Congress for the North Carolina Striped Bass Study (U.S. Fish and Wildlife Service 1992) that such a plan be prepared.

The North Carolina Estuarine Striped Bass FMP approved in May 2004 was the first FMP developed under the criteria and standards of the 1997 Fisheries Reform Act (NCDMF 2004). The plan focused on identifying water flow, water quality, and habitat issues throughout the state, reducing discard mortality in the commercial anchored gill net fisheries, continued stocking of striped bass in the Central and Southern areas of the state, and developing creel surveys in the Tar/Pamlico, Neuse, and Cape Fear rivers to estimate recreational harvest in those systems.

Estuarine striped bass (*Morone saxatilis*) in North Carolina are currently managed under Amendment 1 to the North Carolina Estuarine Striped Bass Fishery Management Plan (FMP) and its subsequent revision (NCDMF 2014). It is a joint plan between the NCMFC and the

NCWRC. Amendment 1, adopted in 2013, lays out separate management strategies for the Albemarle/Roanoke (A/R) stock and the Central and Southern stocks in the Tar/Pamlico, Neuse, and Cape Fear rivers. Management programs in Amendment 1 consist of daily possession limits, open and closed harvest seasons, gill net mesh size and yardage restrictions, seasonal attendance requirements, barbless hook requirements in some areas, minimum size limits, and slot limits to maintain a sustainable harvest and reduce regulatory discard mortality in all sectors. Amendment 1 also maintains the stocking regime in the Central and Southern systems and the harvest moratorium on striped bass in the Cape Fear River and its tributaries (NCDMF 2013). Striped bass fisheries in the Atlantic Ocean of North Carolina are managed under the Atlantic States Marine Fisheries Commission's (ASMFC) Amendment 6 to the Interstate FMP for Atlantic Striped Bass and subsequent addenda.

In response to the results of the 2013 benchmark A/R striped bass stock assessment that indicated fishing mortality was above its target, the NCMFC approved a Revision to Amendment 1 in November 2014 (NCDMF 2014). Management programs for the A/R stock in the November 2014 Revision utilize total allowable landings (TAL) instead of total allowable catch (TAC). The term TAC does not accurately describe the existing management strategy, because the term "catch" refers to landings and discards. Since its inception the quota used to maintain striped bass harvest in the A/R and the Central and Southern systems at sustainable levels is for landings only, not landings and discards. Discards are accounted for in the stock assessment model, but are not part of the TAC. The revision reduced the TAL for the A/R stock from 550,000 pounds to 275,000 pounds, to be split evenly between the commercial and recreational sectors. Stock assessment projections indicated a TAL of 275,000 pounds would maintain fishing mortality and spawning stock at their respective targets and provide a sustainable harvest. The Central and Southern stocks continue to be managed under a 25,000 pound commercial TAL, daily possession limits and a closed summer season to control recreational harvest, and a total harvest moratorium in the Cape Fear River and its tributaries.

In August 2016, the NCMFC approved a schedule change to the Fishery Management Plan Review Schedule so that the comprehensive review of the Estuarine Striped Bass FMP would begin in July 2017 instead of July 2018. NCDMF and NCWRC staffs continue to work collaboratively to prepare stock assessments for the CSMA stocks and the A/R stock as well as developing Amendment 2. Results from stock assessments are expected in early 2019.

Management Unit

There are two geographic management units and four striped bass stocks included in Amendment 1 to the North Carolina Estuarine Striped Bass FMP. The northern management unit is comprised of two harvest management areas; the Albemarle Sound Management Area (ASMA) and the Roanoke River Management Area (RRMA). The ASMA includes the Albemarle Sound and all its coastal, joint and inland water tributaries, (except for the Roanoke, Middle, Eastmost and Cashie rivers), Currituck, Roanoke and Croatan sounds and all their joint and inland water tributaries, including Oregon Inlet, north of a line from Roanoke Marshes Point across to the north point of Eagle Nest Bay in Dare county. The RRMA includes the Roanoke River and its joint and inland water tributaries, including Middle, Eastmost and Cashie rivers, up to the Roanoke Rapids Dam. The striped bass stock in these two harvest management areas is

referred to as the A/R stock, and its spawning grounds are in the Roanoke River in the vicinity of Weldon, NC. Management of recreational and commercial striped bass regulations within the ASMA is the responsibility of the NCMFC. Within the RRMA commercial regulations are the responsibility of the NCMFC while recreational regulations are the responsibility of the NCWRC. The A/R stock is also included in the management unit of Amendment 6 to the ASMFC Interstate FMP for Atlantic Striped Bass.

The southern geographic management unit is the Central Southern Management Area (CSMA) and includes all internal coastal, joint and contiguous inland waters of North Carolina south of the ASMA to the South Carolina state line. There are spawning stocks in each of the major river systems within the CSMA; the Tar/Pamlico, the Neuse, and the Cape Fear. These stocks are collectively referred to as the CSMA stocks. Spawning grounds are not clearly defined in these systems as access to spawning areas is influenced by river flows as well as impediments to migration. Management of striped bass within the CSMA is the sole responsibility of the NCMFC and the NCWRC, and is not subject to compliance with the ASMFC Interstate FMP for Atlantic Striped Bass.

To ensure compliance with interstate requirements, North Carolina also manages the A/R striped bass stock under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries (IJ FMP). The goal of the IJ FMP is to adopt fishery management plans, consistent with N.C. law, approved by the Mid-Atlantic Fishery Management Council, South Atlantic Fishery Management Council, or the ASMFC by reference and implement corresponding fishery regulations in North Carolina to provide compliance or compatibility with approved fishery management plans and amendments, now and in the future. The goal of these plans, established under the Magnuson-Stevens Fishery Conservation and Management Act (federal council plans) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC plans) are like the goals of the Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

Goals and Objectives

The goals of Amendment 1 to the North Carolina Estuarine Striped Bass FMP are to achieve sustainable harvest through science based decision-making processes that conserve adequate spawning stock, provide and maintain a broad age structure, and protect the integrity of critical habitats. To achieve these goals, the following objectives must be met:

1. Identify and describe population attributes, including age structure, necessary to achieve sustainable harvest.
2. Restore, improve, and protect striped bass habitat and environmental quality consistent with the Coastal Habitat Protection Plan (CHPP) to increase growth, survival and reproduction.
3. Manage the fishery in a manner that considers biological, social, and economic factors.

4. Initiate, enhance, and/or continue programs to collect and analyze biological, social, economic, fishery, habitat, and environmental data needed to effectively monitor and manage the fishery.
5. Initiate, enhance, and/or continue information and education programs to elevate public awareness of the causes and nature of issues in the striped bass stocks, habitat, and fisheries, and explain management programs.
6. Develop management measures, including regulations that consider the needs of all user groups and provide sustainable harvest.
7. Promote practices that minimize bycatch and discard mortality in recreational and commercial fisheries.

STATUS OF THE STOCK

Life History

Striped bass (*Morone saxatilis*) are an estuarine dependent species found from the lower St. Lawrence River in Canada to the west coast of Florida through the northern shore of the Gulf of Mexico to Texas. In North Carolina, the species is also known as striper, rockfish, or rock. The only stocks considered migratory are the stocks from Maine to the Albemarle Sound/Roanoke River in North Carolina. These migratory stocks are under the management authority of the Atlantic States Marine Fisheries Commission. The migratory striped bass are considered anadromous, meaning they spend most of their adult life in the waters of the estuaries and nearshore ocean, migrating to fresh water to spawn in the spring. For more southern stocks down through Florida, including the Central Southern Management Area (Tar/Pamlico, Neuse, and Cape Fear stocks), striped bass are riverine, meaning they do not migrate to the ocean like northern striped bass stocks and, instead, spend their entire life in the upper estuary and riverine system.

Females in the Albemarle Sound/Roanoke River stock are 29 % mature at age 3 and 97% mature at age 4, while females in the Tar/Pamlico and Neuse rivers are 50 % maturity at 2.7 years and 98 % mature by age 3. Female striped bass in both systems produce large quantities of eggs which are broadcast into riverine spawning areas and fertilized by mature males, age 2 and older. Fertilized eggs drift with the downstream currents and continue to develop through a larval stage for several days, eventually arriving in river mouths and the inland portions of coastal estuaries where they develop into juveniles. Striped bass require flowing, freshwater habitats in order to spawn successfully, allowing the eggs to remain suspended until they hatch, and to transport larvae to the nursery areas. Environmental conditions including temperature, rainfall and river flows are important factors in determining the number of juveniles produced annually. Spawning in North Carolina takes place from late March until early June. Peak spawning activity for Albemarle/Roanoke striped bass occurs when water reaches 62 to 67 degrees Fahrenheit in the Roanoke River at Weldon. Spawning grounds are not clearly defined in the CSMA systems as access to spawning areas is influenced by river flows as well as impediments to migration.

Striped bass are relatively long-lived and capable of attaining moderately large sizes. Fish weighing 50 or 60 pounds are not exceptional. In general, females grow larger than males with reported maximum lengths of 60 inches and 45 inches. In recent years, the oldest observed striped bass in the Albemarle Sound/Roanoke River stock was 23 years old. The largest striped bass on record are two females caught in the early 1900s in Albemarle Sound which weighed 125 pounds each. Estuarine striped bass from the Albemarle/Roanoke stock contribute minimally to the total coastal migratory stock when compared to the contributions from larger systems like the Chesapeake Bay, Delaware and Hudson rivers.

Striped bass can form large schools feeding on whatever fishes are seasonally and geographically available. They also feed on a wide variety of invertebrates. In general, oily fish such as menhaden, herrings and shads are very important prey items, but they will also readily eat spot, mullet, croaker, American eel, and various invertebrates like blue crabs.

Stock Status

A/R Stock

The 2016 A/R striped bass stock assessment update indicated the resource is not overfished or experiencing overfishing. Fishing mortality is well below the threshold and the estimate of female SSB is above its respective threshold. Terminal year (2014) estimates, especially the estimate of SSB, should be interpreted with caution as they are uncertain and associated with a bias as illustrated by the retrospective analysis. While the bias is not consistent over time, it is present and will influence terminal year estimates.

CSMA Stocks

The lack of adequate data makes it difficult to quantitatively assess the Central Southern Management Area stocks regarding the overfishing and overfished stock status. The need for continued conservation management efforts are supported by the low overall abundance, minimal recruitment, quantifying sources of mortality, the absence of older fish on the spawning grounds, non-optimal environmental conditions on the spawning grounds in the spring, potential impacts from stocked juveniles and hybrid striped bass, and the high percentage of stocked fish in the population. Prior studies indicated stocked fish contributed minimally to the spawning stock; however, in 2016, new genetic research showed that the striped bass stocks in the Tar/Pamlico, Neuse and Cape Fear rivers were overall comprised of 85 percent hatchery reared fish, indicating there is extremely limited natural reproduction and survival occurring in the Central Southern Management Area. The percent contribution of hatchery fish differs significantly between river system and area within each river. Dams blocking access to spawning habitat and low water flow associated with droughts, municipal withdrawals, and electrical power production limit the spawning success of this species in the Central Southern Management Area.

Stock Assessment

A/R Stock

The most recent A/R benchmark stock assessment (data through 2012) utilized the ASAP3 statistical catch-at-age model. This model was peer reviewed and approved for management use

by an outside panel of experts and the ASMFC Atlantic Striped Bass Management Board. The model was updated in 2016 with data through 2014. The model incorporated all commercial and recreational harvest and discard data, as well as abundance data from fishery independent surveys conducted by North Carolina Division of Marine Fisheries (NCDMF) and NCWRC staff.

Results from the assessment update indicated the stock is not overfished or experiencing overfishing relative to its biological reference points (Table 1, Figures 1 and 2). Female spawning stock biomass is above the peak from 2003, and is estimated at 2,024,583 pounds, above the threshold of 772,588 pounds. This value is greater than the SSB threshold; therefore, the stock is not considered overfished. Caution should be used, however, when evaluating the estimate of SSB and F in the last year of the assessment. The estimated SSB value in 2014 is the largest value in the entire time series and is likely an overestimate, based on past years of retrospective bias exhibited by the model. Subsequent assessments, incorporating additional years of data and possibly a revised stock-recruit relationship, may reduce the magnitude of this peak. (Flowers, J., et al. 2016). Albemarle/Roanoke striped bass experienced a period of unusually strong recruitment (number of age-1 fish entering the population) from 1994-2001 followed by a period of lower recruitment from 2002-2013 and higher recruitment again in 2014 and 2015 (Figure 1). Total stock abundance reached its peak in the late 1990s and has declined gradually since. Additionally, fishing mortality is estimated at 0.06, below the target of 0.33 (Figure 2).

CSMA Stocks

The index-based method of catch curve analysis was used to assess the status of striped bass populations in the CSMA (NCDMF 2013, Appendix 14.7). Exploitation and mortality were estimated for the Tar/Pamlico and Neuse river stocks using catch-per-unit-effort (CPUE) from the NCWRC electrofishing spawning grounds survey and the NCDMF Program 915 independent gill net survey. The large confidence intervals and lack of precision in the catch curve Z estimates (total mortality rate) made them unsuitable for making a stock status determination (NCDMF 2013). For this reason, catch curve results (especially annual estimates of mortality) were supplemented with additional quantitative information (such as trends in mean CPUE).

Improvements in the age structure of the CSMA striped bass stocks are expected from the regulatory restrictions implemented under the 2004 FMP and from the protective measures for endangered species implemented in May 2010 (NCDMF 2010) and further codified in Incidental Take Permits for sea turtles and Atlantic sturgeon from the National Oceanic and Atmospheric Administration.

STATUS OF THE FISHERY

Annual spawning success of anadromous fish and fish that spawn in or use estuaries for nursery habitat, is largely dependent upon environmental conditions, both natural and manmade. Even when female spawning stock biomass is very high, very poor reproductive success can still occur due to unfavorable environmental conditions. This fact is important to keep in mind when discussing trends in landings data and stock abundance. For species that have long term juvenile abundance surveys, this phenomenon is evident when we observe a year with above average

spawning success (termed a “strong year class”) followed by a year when practically no eggs survive to the juvenile stage (a “weak year class”). This cycle of spawning success and failure results in annual harvests that increase and decrease depending on the abundance of the year classes available to the fishery.

Current Regulations

ASMA

Harvest in the commercial sector is limited by an annual TAL of 137,500 pounds (see the November 2014 Revision of Amendment 1 to the North Carolina Estuarine Striped Bass FMP for a thorough discussion of how the current TAL was determined). There is also an 18-inch minimum total length size limit. The commercial fishery is prosecuted as a non-directed bycatch fishery, with most landings occurring in large mesh (\geq 5-inch stretched mesh) floating gill nets during the spring American shad fishery. Pound nets and flounder nets account for the remainder of the harvest. Daily trip limits are set by proclamation. Daily reporting of the number and pounds of striped bass landed from all licensed striped bass dealers ensure the TAL is not exceeded. There is a fall harvest season from October 1 through December 31 and a spring harvest season from January 1 through April 30. The harvest season is closed from May 1 through September 30 each year. The seasons may be closed early by proclamation if the TAL is reached. There is mandatory attendance on all small mesh ($<$ 5-inch stretched mesh) gill nets during the summer closed season to reduce discard mortality in that fishery. There are areas within the ASMA that are closed to all gill netting to further reduce undersize discards and to protect females as they enter the mouth of the Roanoke River during their spring spawning migration.

Harvest in the recreational sector is limited by an annual TAL of 68,750 pounds. The recreational sector also has an 18-inch total length minimum size limit and a two fish per person daily possession limit. The harvest seasons are the same as the commercial sector. Harvest is estimated via a creel survey designed for striped bass in the ASMA. The daily possession limit may be changed and/or seasons closed early by proclamation to ensure the TAL is not exceeded.

Check with the NCDMF for the most recent proclamation on striped bass harvest limits including trip limits and bycatch requirements.

RRMA

Commercial harvest in the RRMA is prohibited. The RRMA recreational sector also has an annual TAL of 68,750 pounds. The harvest season is open from March 1 through April 30 each year. There is an 18-inch total length minimum size limit and a no possession slot where fish between 18 and 27 inches total length may not be possessed. There is a two fish per person daily possession limit and only one of those fish may be greater than 27 inches total length. Only a single barbless hook may be used in inland waters of the RRMA upstream of the U.S. Highway 258 Bridge from April 1 – June 30.

CSMA

Both commercial and recreational fishermen are subject to an 18-inch total length minimum size limit for striped bass within the CSMA. As a protective measure in joint and inland CSMA

waters, it is unlawful for recreational fishermen to possess striped bass between 22 and 27 inches total length. Recreational harvest season for striped bass within the CSMA is October 1 through April 30. Recreational fishermen are subject to a two fish per person per day creel limit.

Unlike the fishery in the ASMA, this is a directed fishery for striped bass primarily using anchored gill nets (except in Pamlico Sound where bycatch requirements are in place). Commercial fishermen are subject to 10 fish per person per day limit with a maximum of two limits per commercial operation. Daily reporting of the number and pounds of striped bass landed from all licensed striped bass dealers ensure the TAL is not exceeded. The commercial season opens by proclamation and may occur between January 1 and April 30, and is closed by proclamation once the annual 25,000 pound TAL is reached or on April 30, whichever occurs first. After the closure of the commercial harvest season through December 31, commercial fishermen are required to use a three-foot tie down in gill nets with a stretch mesh length ≥ 5 inches in internal coastal fishing waters west of the 76 28.0000' W longitude line. They must also maintain a minimum distance from shore (DFS) of 50 yards for these nets upstream of the existing DFS line. There is a harvest moratorium for all recreational and commercial fisheries in the Cape Fear River and its tributaries.

On February 16, 2016, the NCWRC voted to modify the exception to the general statewide regulation for striped bass in inland waters of the Tar/Pamlico, Pungo, and Neuse rivers by increasing the minimum size limit from 18 inches to 26 inches. The daily creel limit (two fish per person per day) and harvest season (October 1 – April 30) was not changed. This change was scheduled to go into effect in August 2017, however in March 2017, 10 letters of objection were received requesting legislative review of the rule, so the rule will have a delayed effective date pending legislative review in the 2018 short session (Spring 2018).

Check with the NCDMF for the most recent proclamation on striped bass harvest limits including trip limits and bycatch requirements.

Commercial Landings

ASMA

Commercial landings in the ASMA have been controlled by an annual TAL since 1991 (Table 2). Due to gill net mesh regulations and minimum size limits in place since 1993, most harvest consists of fish 4 to 6 years of age. From 1990 through 1997 the TAL was set at 98,000 pounds because the A/R stock was at historical low levels of abundance. The stock was declared recovered in 1997 and the TAL was gradually increased as stock abundance increased. The TAL reached its maximum level of 275,000 pounds in 2003 as the stock reached record levels of abundance.

Through 2004 the TAL was reached easily. As stock abundance started to decline, commercial landings no longer reached the annual TAL, even with increases in the number of harvest days and daily possession limits. From 2005 through 2009 landings steadily declined and averaged about 150,000 pounds, even though gill net trips remained steady during that period (Figure 3). Gill net trips in this instance are all anchored gill net trips occurring in the ASMA as reported through the North Carolina Trip Ticket Program. Because of several caveats, including this is not

a directed fishery, the trip data cannot be used to calculate any type of catch per unit of effort, but are shown to provide a general idea about the trends in anchored gill net effort in the ASMA.

The decline in landings during 2005-2009 was due to poor year classes produced from 2001 to 2004. An increase in landings in 2010 to over 200,000 pounds was due to the strong 2005-year class. Since 2013 landings have been reduced in part because of a shortened American shad season resulting from triggers being met in the American Shad Sustainable Fishery Plan. The majority of landings traditionally have come during the American shad season.

CSMA

Commercial landings in the CSMA have been controlled by an annual TAL of 25,000 pounds since 1994. Over the past 10 years, landings have closely followed the annual TAL, except for 2008 when less than half of the TAL was landed. The majority of landings have been split between the Pamlico and Pungo rivers and the Neuse and Bay rivers, with the remainder coming from the Pamlico Sound (Figure 4). Since 2004 there has only been a spring harvest season, recently opening March 1 each year and closing when the TAL is reached, usually near the end of March.

Recreational Landings

ASMA

The recreational sector's landings in the ASMA are dominated by fish age 3 to 5 due in part to a statewide rule that prohibits possession of river herring cut bait or whole river herring over six inches in length while engaged in fishing activities, the migratory nature of larger, older fish, and general angling techniques in the ASMA. Very few anglers use the large size artificial lures or natural bait required to catch striped bass over 28 inches, so very few fish over nine or 10 years old are observed in the creel survey. Plus, these older fish make up a relatively small portion of the total overall stock abundance.

Landings in the ASMA have been controlled by a TAL since 1991 (Table 2). Starting in 1998 the TAL was split evenly between the commercial and recreational sectors. The recreational TAL increased incrementally from 29,400 pounds in 1997 to 137,500 pounds in 2003. The recreational sector reached its TAL consistently until 2002, when landings started declining. Recreational landings peaked in 2001 at 118,506 pounds. (Figure 5). The harvest season increased from four days a week to seven in the fall of 2005 and the daily recreational possession limit increased from two to three fish in the fall of 2006, but landings continued to decline. Several poor year classes produced since 2001 have accounted for the decline in stock abundance and recreational harvest since 2006. The recreational limit went back down to two fish per person per day in January 2016. Harvest during the past 10 years has averaged 32,614 pounds (10,338 fish) in the ASMA, well below the TAL of 68,750 pounds. Releases are usually greater than harvest and are dominated by fish less than the 18-inch minimum length limit. Undersized releases during the last 10 years have averaged 24,747 fish (Table 3).

RRMA

The recreational sector's landings in the RRMA are dominated by fish age 3 to 5 due to a no possession rule of fish between 22 and 27 inches total length in the RRMA, a statewide rule that

prohibits possession of river herring cut bait or whole river herring over six inches in length while engaged in fishing activities, and general angling techniques in the RRMA. Very few anglers use the large size artificial lures or natural bait required to catch striped bass over 28 inches, so very few fish over nine or 10 years old are observed in the creel survey. Plus, these older fish make up a relatively small portion of the total overall stock abundance. Harvest during the past 10 years averaged 55,691 pounds (17,859 fish) in the RRMA (Table 3). Many more striped bass are caught and released by recreational anglers each year than are harvested, especially in the RRMA where concentrations of fish on the spawning grounds can be dense. Annual releases over the past 10 years in the RRMA have averaged 104,721 fish (Table 3).

Landings in the RRMA followed the TAL closely through 2002. From 2003 through 2016 landings averaged 64,389 pounds, with a few noticeable low years (2003, 2008, 2013 and 2014; Figure 6). The total number of fish caught per angler during the spring fishery in the RRMA can be large; catches of 100 fish per day are not uncommon. But angler catch rate can be impacted by spring water flows. The hydropower company operating the dams on the Roanoke River, along with the U.S. Army Corps of Engineers and biologists with the USFWS and NCWRC, coordinate releases to best mimic natural flow conditions during the spring spawn. However, droughts or heavy rainfall may still result in very low, i.e. 2,000-3,000 cubic feet per second (cfs) or very high, (20,000 cfs) flood stage flow conditions in some years. During these low or high flow years, angler success can be greatly diminished.

CSMA

Recreational landings have fluctuated since 2004 and have ranged from a low in 2008 and 2009 averaging 3,026 pounds to highs of 22,959 pounds in 2004 and 25,661 pounds in 2016 and 26,973 pounds most recently in 2017 (Table 3). In recent years both the number of trips and the hours spent targeting striped bass within the CSMA have increased. Since 2011 harvest in the Tar/Pamlico and Neuse has been similar, ranging from about 4,000 pounds to 9,000 pounds, however starting in 2016 there has been a sharp increase in the recreational harvest (Figure 7). Harvest on the Pungo River has remained consistent at a relatively low level compared to fluctuations experienced by the Tar/Pamlico and Neuse rivers. Legal sized striped bass discards have increased over the past six years, more than doubling in 2017. Fish released that are within the slot limit, have fluctuated over the past ten years and have ranged from a low in 2015 of 813 fish to a high of 6,779 fish in 2016 (Table 3). In 2017, in addition to harvesting the highest number of striped bass in over 10 years, there was a significant twofold jump in the number of undersized fish discarded of more than 100,000 striped bass (Table 3). There is also a significant catch-and-release fishery during the summer in the middle reaches of the Tar/Pamlico and Neuse rivers. Releases during the last 10 years have averaged 40,118 fish (Table 3).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

A/R Stock

The length, weight, sex, and age of the commercial harvest of striped bass has been consistently monitored through sampling at fish houses conducted by the division since 1982. For the last several decades anchored gill nets have accounted for >90 percent of the harvest in the ASMA.

Pound nets account for most of the remaining landings with minor catches coming from fyke nets, hoop nets, and pots. The mean total length from 2008 to 2017 was 22 inches (Table 4).

The recreational harvest of striped bass in the ASMA and RRMA has been consistently monitored by the NCDMF since 1990 and the NCWRC since 1988 respectively. The mean total length from 2008 to 2017 was 20 inches total length for the ASMA and 20 inches total length for the RRMA (Tables 5 and 6). Aging data from the dependent and independent surveys are presented in Table 7.

CSMA Stocks

Monitoring of the commercial fishery in the CSMA follows the same methodology as in the ASMA. The NCDMF started collecting recreational striped bass data in the major rivers of the CSMA in 2005. There has been a harvest moratorium in the Cape Fear River since 2008. Length data from the commercial harvest in the Pamlico Sound and tributaries shows that on average striped bass in the Neuse and Bay rivers are slightly larger than fish harvested in the Pamlico and Pungo rivers (Table 8). Additionally, maximum lengths are generally larger in the Neuse and Bay rivers compared to the Pamlico and Pungo rivers. In 2017, the maximum length sampled on the Neuse and Bay river was 47 inches compared to a maximum length of 29 inches on the Pamlico and Pungo rivers (Table 8). In North Carolina, striped bass and hybrid striped bass are managed collectively and are not distinguished. Data collected on hybrid striped bass by the NCDMF at commercial fish houses showed a peak abundance in the commercial fishery in 2014, since then the number of hybrid striped bass have steadily declined (Table 8). Since 2004, data collected from the CSMA recreational striped bass creel survey sampled on average 160 striped bass per year. In 2017, the CSMA recreational striped bass creel survey measured 202 striped bass that averaged 21 inches and ranged in length from 17 to 33 inches (Table 9).

Fishery-Independent Monitoring

A/R Stock

A young-of-year (age-0) A/R striped bass juvenile abundance index (JAI) was initiated by Dr. William Hassler of North Carolina State University in 1955. The NCDMF took over this critical long-term survey in 1987 at Dr. Hassler's retirement. Sampling occurs at seven fixed stations in the western Albemarle Sound from July through mid-October. Sampling gear is an 18-foot semi-balloon trawl towed for 15 minutes. Catch per unit of effort is the number of striped bass captured per tow. The JAI provided by the survey is usually a reliable indicator of relative abundance and future harvest potential. Data from the survey reveal the highly variable inter-annual spawning success of striped bass. The long time-series of data also clearly shows the extended period of spawning failure that occurred when the stock was at historical levels of low abundance during the 1980s. Starting in 1993 the stock began producing successful spawns once again, due to improved water quality, agreements about a water flow regime on the Roanoke River during the spawning season, favorable environmental conditions during the spawning season, and severe management restrictions that allowed stock abundance to increase. Within an eight-year period spanning 1993-2000, the stock produced the four highest JAI values in the entire 46-year time series. The average JAI during 1993-2000 was 24.04, over three times higher than the average of the JAI prior to the stock crashing (1955-1977 JAI = 7.9; Figure 8). However, from 2001 to 2010 the JAI was below average for most years, above average for only

one year (2010), and several years including some back to back (2003 and 2004), which were considered spawning failures. This cycle starting in 1993 led to overall stock abundance increasing steadily through the mid-2000s to all-time highs, followed by a period of stock decline. From 2010 to 2017 the stock has seen improved annual spawning success, with above average JAI values in 2011, 2014, and 2015, with only one year (2013) below the spawning failure threshold (Figure 8).

A fall/winter fishery independent gill net survey has been conducted by the NCDMF throughout the Albemarle and Croatan sounds since the fall of 1990. The survey utilizes a stratified random sampling design, employing mesh sizes from 2 ½-inch to 10-inch stretch mesh to characterize the resident and overwintering portion of the A/R stock. The survey is conducted from November through February. Catch per unit of effort is measured as the abundance of fish per 40-yard net soaked for 24 hours.

A spring survey employs the same methodology as the fall/winter survey but is conducted in the western Albemarle Sound only, in the vicinity of the mouth of the Roanoke River. The goal of the survey is to characterize the spawning portion of the A/R stock. The survey is conducted from March 1 through the end of May. Data from the surveys are used in the A/R stock assessment as an independent measure of stock abundance.

The independent gill net surveys do a good job of tracking relative abundance, but the trend in total abundance is often masked by the highly variable and often very large number of two- and three-year-old fish captured in the survey, so trends in total abundance are often less informative than trends in 4 to 6-year-old abundance. The trend in abundance of 4 to 6 year olds show the stock increasing in abundance through the 1990s, to a high in 1999 of about 90 fish per 100 net days for the spring survey and 72 fish in the fall/winter survey. The 4 to 6-year-old abundance has fluctuated since 2000, but has been on a general downward trend with abundance for both surveys at about 20 fish per 100 net days in 2014 (Figure 9). One weakness of the gill net surveys is they collect very few older fish, and under-represent the expansion of fish in the 9+ age group that has occurred since 2000. They also don't capture the decline in abundance of age 9+ fish that has occurred since the period of poor spawning success from 2001 to 2010.

An electrofishing spawning ground survey has been conducted by the NCWRC since the spring of 1990. The survey goals are the same as the spring gill net survey but takes place on the Roanoke River in the vicinity of Weldon, the location of the fall line and historical center of spawning activity for A/R striped bass. The survey uses a stratified random sampling design. Catch per unit of effort is measured as the number of fish captured per hour of electrofishing. The survey is used in the A/R stock assessment as an independent measure of stock abundance.

The trend in total abundance from the electrofishing survey is similar to the trends of age 4 to 6 fish in the gill net surveys, increasing from low levels of abundance in the early 1990s to a peak in the early 2000s of 380 fish per hour, then decreasing since to a low in 2013 of 150 fish per hour (Figure 10). Both surveys exhibit a few years with high inter-annual variability, but this is common with fisheries surveys in which environmental conditions affect relative abundance in the survey area and the catch efficiency of the gear. The electrofishing survey does a better job at tracking the abundance of the age 9+ group, and clearly shows the emergence of the 1993 cohort

into this age group in 2002. The 9+ group has been on a downward trend since the 2006 peak of 14 fish per hour, with the lowest catch in 2014 of just greater than one fish per hour (Figure 11). The strong year classes produced from 1993-2000 supported the increased abundance of fish in the 9+ age group, but since the below average spawning and several years of spawning failure during 2001-201, the abundance of the 9+ age group is declining. The oldest fish seen recently in the population is 23 years old, indicating that fishing mortality has decreased significantly since the implementation of minimum size limits and a TAL in 1990. When the survey started in 1990 fish older than seven were rarely observed in the survey.

Taken together, all the independent surveys track A/R stock dynamics well, and indicate the stock is healthy and female spawning stock biomass is adequate to produce large year classes; most recently in 2011, 2014 and 2015.

CSMA Stocks

A fishery independent gill net survey in the Central and Southern portion of the state was initiated by the NCDMF in May of 2001 in Pamlico Sound. This survey was expanded to the Pamlico, Pungo, and Neuse rivers in 2003 and expanded to the Cape Fear and New rivers in 2008. Data from the Fishery-Independent Gill Net Survey (Program 915) on the Pamlico, Pungo, and Neuse rivers demonstrated most striped bass were captured in the upper and middle portions of the rivers. Over the past twelve years, striped bass CPUE data also shows that catches have been higher in the Pamlico/Pungo, and Neuse rivers when compared to the Cape Fear River (Table 10). Striped bass in the Pamlico/Pungo and Neuse rivers ranged from 0.84 to 2.66 fish per sample, whereas the Cape Fear River ranged from 0 to 0.14 fish per sample during the reporting period (Table 10). In 2017, striped bass CPUE in the Pamlico/Pungo and Neuse rivers were 1.21 and 1.41 fish per sample respectively compared to only 0.08 fish per sample in the Cape Fear River (Table 10).

MANAGEMENT STRATEGY

A/R Stock

Estuarine striped bass in North Carolina are managed under Amendment 1 to the North Carolina Estuarine Striped Bass FMP and subsequent revisions. Striped bass fisheries in the Atlantic Ocean of North Carolina are managed under ASMFC's Amendment 6 to the Interstate FMP for Atlantic Striped Bass and subsequent addenda. The A/R stock is managed using biological reference points for spawning stock biomass and fishing mortality that are aimed at maintaining a sustainable harvest and adequate spawning stock biomass. Stock status is determined through a formal, peer reviewed stock assessment process that evaluates annual estimates of fishing mortality and biomass against their target and threshold values. An annual harvest quota for the A/R stock is calculated to keep these metrics below their targets. Juvenile abundance data generated from the survey is used in the A/R stock assessment as an independent measure of stock abundance. The index is also used as a trigger. If the JAI is below 75 percent of all other values for three consecutive years, the ASMFC Striped Bass Technical Committee will make a recommendation to the ASMFC Striped Bass Management Board about possible causes and if management action is needed.

CSMA Stocks

The need for continued conservation management efforts are supported by the constrained size and age distributions, low abundance, the absence of older fish in all stocks, and the high percentage of stocked fish in the population (Cushman et al. 2018; Farrae et al. 2018). Since the 2004 FMP there has been little change in the size and age distribution with few age-6 and older fish observed in any system, however age-6 and older CPUE in 2014 was the highest since the sample record began, and continued an increasing trend since 2008 (Rachels and Ricks 2015). Management strategies (see Table 11) in place to constrain harvest in an effort to allow for rebuilding of the stocks include a total harvest moratorium in the Cape Fear River, an annual commercial TAL of 25,000 pounds, daily creel limits, a closed summertime harvest season, a protective slot limit for the recreational fisheries, a three-foot tie down requirement for gill nets ≥ 5 inches stretch mesh in internal coastal fishing waters west of the 76 28.0000' W longitude line, and a minimum distance from shore (DFS) of 50-yards for these nets upstream of the existing DFS line after the commercial season closes. Annual stockings in all CSMA systems are designed to augment the populations during this period of low abundance until such a time successful natural reproduction in these stocks occurs.

RESEARCH NEEDS

Several research needs were identified and explored in Amendment 1 to the North Carolina Estuarine Striped Bass FMP. The bulleted items listed below outlines the specific issue, the priority ranking, and the implementation status on the recommendations:

- Determine percent contribution of stocked fish on the spawning grounds -HIGH (Ongoing through NCWRC genetics study)
- Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival. Ongoing through CRFL funded projects. See Knight (2015) for recent publication on maturation and fecundity in the Neuse and Tar/Pamlico rivers -HIGH
- Conduct a mark-recapture study utilizing conventional tags and telemetry approaches -HIGH (Ongoing through CRFL funded projects)
- Determine if suitable striped bass spawning conditions exist in the Tar/Pamlico, Neuse, and Cape Fear Rivers – MEDIUM (No Action)
- Conduct egg abundance and egg viability studies – MEDIUM (In 2016, NCWRC initiated an anadromous ichthyoplankton survey designed to investigate egg and larval fish abundance and egg viability)
- Determine extent of spawning grounds – LOW (Ongoing through CRFL funded grant acoustic tagging grant)
- Improve discard estimates and discard biological characteristics from commercial fisheries – MEDIUM (Ongoing through statewide observer coverage. See Rock et al. (2016) for recent publication on improving discard estimates through NCDMF creel survey and expanded observer program)
- Obtain biological characteristics such as length, weight, age, and sex of recreational harvest – MEDIUM (Ongoing through creel surveys but could be expanded)

- Obtain biological characteristics such as length, weight, age, and sex of commercial harvest - MEDIUM (Ongoing but sampling could be increased)
- Improve discard estimates and discard biological characteristics from recreational fisheries – LOW (Ongoing through creel survey)
- Conduct delayed mortality studies for recreational and commercial gear – LOW (Ongoing for recreational fisheries)
- Conduct independent surveys that adequately capture all life stages of striped bass - HIGH (No Action)
- Continue tagging striped bass to evaluate the possible contribution to the Atlantic Migratory stock and provide data to be used in stock assessment efforts. Develop means to better assess the tag recapture and reporting rate for use in tag-based stock assessments – HIGH (Ongoing through CRFL funded projects)
- Conduct a short-term study to determine vulnerability-at-length for survey gears – LOW (No Action)

Additional research needs were identified in Amendment 1 to the North Carolina Estuarine Striped Bass FMP, however there were no priority rankings assigned. The bulleted items listed below outlines the specific research need and the implementation status:

- Continued support and development of SHAs in NC. (Ongoing, SHAs in regions 1-3 have been designated)
- Continued protection of SHAs by the cooperating agencies once they have been designated (Ongoing)
- Work with WRC, DWQ, and others to implement management measures that will enhance water quality in areas used by striped bass (Ongoing)
- Work with American Rivers and other partners to accelerate dam removal in priority areas (Ongoing)
- Continue to protect NC coastal wetlands through the permit review process (Ongoing)
- Quantify the density and distribution of striped bass eggs, fry, and juveniles in coastal rivers to estimate potential losses to entrainment and impingement. Ongoing in the Roanoke River through ECU (Still needed in the CSMA)
- Determine if contaminants are present in striped bass habitats and identify those that are potentially detrimental to various life history stages (Ongoing through Division of Water Quality but could be expanded)
- Evaluate the effects of existing and future water withdrawals on water quality and quantity and fisheries habitat in coastal watersheds (No Action)
- Identify and designate anadromous fish nursery areas and how early juvenile striped bass move and are distributed in NC estuarine waters (No Action)
- Identify minimum flow requirements in the Tar/Pamlico, Neuse, and Cape Fear rivers necessary for successful spawning, egg development, and larval transport to nursery grounds (No Action)
- Evaluate the impacts/effects of reverse osmosis plants on receiving waters and aquatic resources. Short term studies conducted but there is a need for long term studies
- Verify condition of identified SHAs used by striped bass (No Action)

- Investigate abundance and spawning contribution of striped bass in the North Carolina and Virginia portions of the Blackwater, Nottoway and Meherrin rivers (Some sampling is by VADGIF and a CRFL grant is being completed that evaluated the potential spawning contribution on the Chowan and Meherrin rivers)
- Investigate striped bass use in the North Carolina portions of the Waccamaw River during the appropriate season (No Action)
- Continue to investigate the potential for passage of striped bass above Roanoke Rapids Dam (Ongoing)
- Support fish passage at Buckhorn Dam and Lock and Dam No.2 and No.3 and investigate anadromous fish utilization of the rock ladder at Lock and Dam No. 1 (Ongoing)
- Investigate the feasibility of fish passage at and improved water flows from Rocky Mount Mill Dam and Tar River Reservoir Dam (Ongoing)
- Support the removal of Milburnie Dam in Raleigh (COMPLETED-Dam removed November 2017)
- Support fish passage above the Yadkin chain of dams in North Carolina (Ongoing)
- Data on the density and distribution of striped bass eggs, fry, and juveniles in coastal rivers are needed so that potential losses to entrainment and impingement can be estimated (CSMA No Action)
- Identify effective engineering solutions to prevent entrainment and impingement of striped bass eggs, fry, and juveniles (Ongoing)
- NCDMF and NCWRC should work with DWQ and other agencies to determine and establish more stringent water quality standards in Anadromous Fish Spawning Areas (No Action)
- Apply for ITP for impacted fisheries. Completed, ITP's obtained for the estuarine gill net fishery.
- Continue gear development research to minimize species interactions (Ongoing)
- Implementation of outreach programs to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to protected species and fishery management (Ongoing)
- Methodology tested to accurately capture Atlantic Ocean striped bass harvest during summer months (Ongoing through catch card survey but compliance is uncertain)
- Increase surveys of stocked systems to determine percent contribution of wild versus stocked fish (Ongoing through NCWRC and NCDMF genetics survey)
- Determine if fish produced from system-specific parentage will increase stocking contribution to spawning populations (Ongoing through NCWRC and NCDMF genetics survey)
- Determine factors impacting survivability of stocked fish in each system (No Action)
- More at-sea observations made for the gill net fishery to more accurately assess the discards from this fishery (Ongoing through NCDMF Observer Program)
- Explore improvements to NCDMF programs (Trip Ticket, Fish House sampling, fisherman surveys or logbooks) in order to acquire spatially and temporally accurate gill net gear parameters (No Action)
- Investigate the impacts of delayed mortality on striped bass captured in gill nets (No Action)
- Clarify relationships between salinity, DO, temperature and catch and release mortality rates in the ASMA and CSMA (No Action)
- Year-round creel survey in the ASMA (No Action)

- Expand tagging programs to include high reward tagging (Ongoing through CRFL funded grant)
- Conduct new analysis of relationship between JAI in Albemarle Sound and flows in Roanoke River (No Action)

FISHERY MANAGEMENT PLAN RECOMMENDATION

The division is continuing with the development of Amendment 2 in conjunction with the Wildlife Resources Commission.

LITERATURE CITED

- ASMFC (Atlantic States Marine Fisheries Commission). 2003. Amendment # 6 to the Interstate Fishery Management Plan for Atlantic Striped Bass. ASMFC, Washington, DC. Fisheries Management Report No. 41.
- Cushman, B., T. O'Donnell, and D. Farrae. 2018. South Carolina Department of Natural Resources. 2017 Striped Bass Genotyping and Parentage Analysis Final Report for the North Carolina Wildlife Resources Commission. 39 pp.
- Farrae, D., and T. Darden. 2018. South Carolina Department of Natural Resources. 2017 Striped Bass Genotyping Report for the North Carolina Division of Marine Fisheries. 9 pp.
- Flowers, J., S. Darsee, L. Lee, and C. Godwin. 2016. Stock status of Albemarle Sound-Roanoke River striped bass: update 1982–2014. North Carolina Division of Marine Fisheries, NCDMF SAP-SAR-2016-01, Morehead City, NC. 88 pp.
- Knight, Evan H. 2015. Maturation and Fecundity of the Neuse and Tar-Pamlico Rivers Striped Bass (*Morone saxatilis*) Stocks in Coastal North Carolina. Master's Thesis, East Carolina University, Greenville, NC. 59 pp.
- Laney, R. W., J. C. Benton, L. T. Henry, H. Johnson, J. W. Kornegay, K. L. Nelson, S. D. Taylor, and S. E. Winslow. 1993. North Carolina Estuarine Striped Bass Fishery Management Plan. North Carolina Division of Marine Fisheries and North Carolina Wildlife Resources Commission in cooperation with the U.S. Fish and Wildlife Service under Cooperative Agreement number 14-0004-87-904.
- Mroch, R. and C. H. Godwin. 2014. Stock Status of Albemarle Sound-Roanoke River Striped Bass. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 236 pp.
- NCDMF. 2004. North Carolina Estuarine Striped Bass Fishery Management Plan. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 375 pp.

- NCDMF. 2010. Application for an Individual Incidental Take Permit under the Endangered Species Act of 1973. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries. 52 pp.
- NCDMF. 2010. Catch Curve Exploitation Estimates for Neuse River and Tar/Pamlico River Striped Bass Stocks. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 79 pp.
- NCDMF. 2013. Amendment 1 to the North Carolina Estuarine Striped Bass Fishery Management Plan. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 826 pp.
- NCDMF. 2014. November 2014 Revision to Amendment 1 to the North Carolina Estuarine Striped Bass Fishery Management Plan. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 15 pp.
- NCDMF. 2015. Fishery Management Plan for Interjurisdictional Fisheries: Information Update. North Carolina Department of Environmental Quality. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 85 pp.
- Rachels, K.T and B. R. Ricks. 2015. Neuse River Striped Bass Monitoring Programs, Population Dynamics, and Recovery Strategies. North Carolina Department of Environmental Quality, Wildlife Resources Commission, Raleigh, N.C. 47 pp.
- Rock, Jason, D. Zapf, C. Wilson, and D. Mumford. 2016. Improving Estimates of Striped Bass Discards in the Central Southern Management Area (CSMA) Through a Recreation Access Site Survey and an Expanded Observer Program. North Carolina Department of Environmental Quality, Division of Marine Fisheries. Morehead City, NC. CRFL Grant 2011-F-001 Final Report. 76 pp.
- U.S. Fish and Wildlife Service. 1992. Report to Congress for the North Carolina Striped Bass Study Albemarle Sound Roanoke River Basin.

TABLES

Table 1. Albemarle/Roanoke striped bass spawning stock biomass and fishing mortality targets and thresholds. Source: Stock Status of Albemarle Sound-Roanoke River Striped Bass, 2016.

Reference Point	Fishing Mortality (F)	Spawning Stock Biomass (SSB lb.)	Total Allowable Landings lb. (TAL)
Target	0.33	965,735	305,762
Threshold	0.41	772,588	325,905
Estimate from 2016 A/R stock assessment	0.06	2,024,583	N/A

Table 2. Striped bass commercial and recreational harvest and discards in pounds from the ASMA/RRMA, NC, 1982-2017.

Year	Harvest (lb)				Total Harvest	TAL	Discard (lb)				Total Discards	Combined Harvest and Discards	
	ASMA Comm.	ASMA Rec.	RRMA Comm.	RRMA Rec.			ASMA Comm.	ASMA Rec.	RRMA Comm.	RRMA Rec.			
1982	228,004	24,098	17,369	23,693	293,164	No estimates for shaded years					293,164		
1983	228,742	27,320	8,861	26,861	291,784	No estimates for shaded years					291,784		
1984	475,641	17,181	1,703	16,892	511,417	No estimates for shaded years					511,417		
1985	269,671	6,603	6,200	6,492	288,966	No estimates for shaded years					288,966		
1986	172,683	18,755	50	18,440	209,928	No estimates for shaded years					209,928		
1987	228,861	37,621	0 [#]	36,989	303,471	No estimates for shaded years					303,471		
1988	108,791	52,434	0	74,639	235,864	No estimates for shaded years					235,864		
1989	97,061	26,857	0	32,107	156,025	No estimates for shaded years					156,025		
1990	103,757	36,976	0	42,204	182,937	No estimates for shaded years					182,937		
1991	108,460	30,021	0	72,529	211,010	156,800			17,048	17,048	228,058		
1992	100,544	51,167	0	36,016	187,727	156,800			4,370	4,370	192,097		
1993	109,475	54,835	0	45,146	209,456	156,800			11,546	11,546	221,002		
1994	102,201	39,704	0	28,084	169,989	156,800	151,810			12,613	164,423	334,412	
1995	89,502	30,564	0	28,884	148,950	156,800	348,255			14,539	362,794	511,744	
1996	89,624	29,185	0	28,173	146,982	156,800	200,429			36,634	237,063	384,045	
1997	95,671	26,724	0	28,929	151,324	156,800	120,840			55,863	176,703	328,027	
1998	122,454	64,885	0	73,527	260,866	250,860	135,855			21,149	157,004	417,870	
1999	155,176	60,897	0	72,966	289,039	275,946	139,043			31,513	170,556	459,595	
2000	218,888	116,163	0	119,584	454,635	450,000	137,996	11,951			33,810	183,757	638,392
2001	220,227	118,533	0	112,825	451,585	450,000	92,047	10,540			29,284	131,871	583,456
2002	222,834	92,649	0	112,698	428,181	450,000	128,664	7,710			10,897	147,271	575,452
2003	266,555	51,794	0	39,170	357,519	550,000	162,115	5,278			8,598	175,991	533,510
2004	273,666	98,403	0	120,697	492,766	550,000	89,832	9,244			62,523	161,599	654,365
2005	232,645	63,477	0	107,530	403,652	550,000	45,393	3,360			34,313	83,066	486,718
2006	156,314	35,985	0	84,523	276,822	550,000	54,529	1,453			13,799	69,781	346,603
2007	173,509	26,633	0	64,986	265,128	550,000	43,475	1,914			11,330	56,719	321,847
2008	74,926	31,628	0	32,725	139,279	550,000	108,176	4,969			37,624	150,769	290,048
2009	96,134	37,313	0	69,581	203,028	550,000	32,494	5,452			29,523	67,469	270,497
2010	199,829	11,460	0	72,037	283,326	550,000	44,838	3,318			25,263	73,419	356,745
2011	134,538	42,536	0	71,561	248,635	550,000	52,741	2,870			29,409	85,020	333,655
2012	115,605	71,456	0	88,271	275,332	550,000	34,253	3,995			10,251	48,499	323,831
2013	68,338	14,897	0	25,197	108,432	550,000	29,006	3,453			15,675	48,134	156,566
2014	71,372	16,867	0	33,717	121,956	550,000	5,010	1,365			32,843	39,218	161,174
2015	113,475	70,008	0	58,962	251,651	275,000	14,982	3,458			14,552	32,992	267,805

2016	123,111	14,486	0	65,218	202,815	275,000	4,480	978		10,108	34,076	236,891
2017	75,990	15,479	0	32,569	129,713	275,000	7,018	2,331		16,593		

Table 3. Recreational striped bass effort, harvest and discards from the ASMA, RRMA, and CSMA, 2008-2017.

Management Area	Year	Striped Bass Fishing Angler Trips	Striped Bass Effort Angler Hours	Number Harvested	Pounds Harvested	Striped Bass Discard (#over-creel)	Striped Bass Discard (#under-sized)	Striped Bass Discard (#legal-sized)	Striped Bass Discard (# slot-sized)	Total Discards
ASMA	2008	11,793	72,673	10,048	31,628	391	36,324	260	N/A	36,975
	2009	11,326	72,021	12,069	37,313	20	38,683	1,860	N/A	40,563
	2010	9,660	66,893	3,504	11,470	569	15,398	233	N/A	16,200
	2011	13,114	85,325	13,341	42,536	317	20,114	1,141	N/A	21,572
	2012	14,490	102,787	22,345	71,456	1,024	19,977	3,970	N/A	24,971
	2013	7,053	50,643	4,299	14,897	31	16,034	316	N/A	16,381
	2014	7,264	40,478	5,529	16,867	18	22,558	510	N/A	23,086
	2015	11,132	75,009	23,240	70,008	1,573	45,559	2,402	N/A	49,534
	2016	7,023	42,276	4,794	14,486	252	8,822	1,278	N/A	10,352
	2017	8,822	41,371	4,214	15,479	55	24,003	599	N/A	24,659
	Total	101,677	649,476	103,383	326,140	4,250	247,472	12,569		264,293
RRMA	2007	31,816	151,128	19,305	62,492					52,501
	2008	27,026	128,372	10,541	32,725					189,638
	2009*	25,405	120,675	23,248	69,581					135,964
	2010	29,458	156,776	22,445	72,037					123,910
	2011	30,018	137,986	22,102	71,561					107,693
	2012	29,032	119,917	28,847	88,271	Disposition of discards not available for all years.				63,018
	2013	21,785	112,814	7,718	25,197					74,221
	2014	18,932	97,798	11,058	33,717					165,539
	2015	25,034	123,648	20,031	58,962					108,240
	2016	27,123	140,423	21,260	65,218					52,644
2017	21,004	109,011	9,899	32,569					78,566	
	Total	254,817	1,247,420	177,149	550,106					1,099,433
CSMA	2007	10,974	37,088	3,600	10,795	147	21,673	1,707	0	23,527
	2008	6,621	21,296	842	2,990	2,838	11,719	3,316	91	17,964
	2009	5,642	20,695	896	3,062	7	4,472	1,768	719	6,966
	2010	6,558	16,060	1,758	5,536	28	5,201	2,402	361	7,992
	2011	12,608	33,353	2,727	9,475	9	16,661	5,397	2,128	24,195
	2012	18,340	71,899	3,871	15,198	351	26,250	13,614	2,986	43,201
	2013	20,143	86,090	5,452	20,076	438	19,329	10,368	2,324	32,459
	2014	15,657	69,616	3,302	13,354	765	18,885	7,175	1,622	28,447
2015	18,443	80,590	3,904	14,152	40	22,896	8,193	825	31,954	

2016	23,850	110,165	6,797	25,661	203	56,957	10,747	3,890	71,797
2017	26,125	119,680	7,334	26,973	549	101,787	26,501	2,293	138,464
Total	138,392	546,032	33,120	120,243	4,794	204,045	64,615	14,956	288,409

*Estimates of discards not available for the post-harvest season period.

Table 4. Striped bass length data from commercial landings from the ASMA, NC, 2008-2017.

Year	Mean Total Length (inches)	Minimum Total Length (inches)	Maximum Total Length (inches)	Total Number Measured
2008	22	18	47	553
2009	21	18	42	813
2010	21	17	48	940
2011	21	18	39	1,004
2012	22	18	39	643
2013	22	18	45	563
2014	23	18	43	483
2015	22	18	43	733
2016	22	18	43	595
2017	22	18	41	241

Table 5. Striped bass length data from recreational landings from the ASMA, NC, 2007-2017.

Year	Mean Total Length (inches)	Minimum Total Length (inches)	Maximum Total Length (inches)	Total Number Measured
2008	20	18	30	632
2009	20	18	42	549
2010	20	17	28	337
2011	20	18	34	979
2012	20	18	36	1,059
2013	20	18	32	527
2014	19	18	28	802
2015	20	17	30	1,523
2016	21	18	28	423
2017	21	18	32	489

Table 6. Striped bass length data from recreational landings from the RRMA, NC, 2008-2017.

Year	Mean Total Length (inches)	Minimum Total Length (inches)	Maximum Total Length (inches)	Total Number Measured
2008	19	17	35	667
2009	19	17	32	1,049
2010	20	18	28	954
2011	20	18	31	679
2012	20	17	28	688
2013	20	17	27	512
2014	19	17	30	559
2015	19	16	27	1,340
2016	20	17	29	1,133
2017	20	17	34	498

Table 7. Striped bass age data from dependent (commercial) and independent (independent gill net survey) surveys from the ASMA, NC, 2008-2017.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2008	3	1	16	1,191
2009	4	1	14	1,040
2010	5	1	17	885
2011	5	1	11	1,429
2012	2	1	14	802
2013	5	1	13	921
2014	4	2	11	728
2015	4	1	11	713
2016	5	2	12	555
2017	2	2	13	504

Table 8. Striped bass length data (total length) from commercial landings from the CSMA, NC, 2000-2017. All lengths and numbers (N) of fish sampled are for striped bass, no length data are presented for hybrid striped bass other than the percent sampled.

Year	Pamlico and Pungo Rivers					Neuse and Bay Rivers				
	Total Length (inches)				% Hybrid Striped Bass in Samples	Total Length (inches)				% Hybrid Striped Bass in Samples
	Mean	Min	Max	N		Mean	Min	Max	N	
2000	22	19	33	126	1.6	24	21	29	5	0.0
2001	22	20	24	116	8.7	23	21	30	12	0.0
2002	23	17	37	96	31.4	23	18	27	31	0.0
2003	21	17	35	173	39.9	23	18	35	19	5.0
2004	23	18	39	131	34.2	24	18	35	74	1.3
2005	22	18	35	127	9.3	23	19	34	70	1.4
2006	20	17	34	119	17.4	23	18	34	144	0.7
2007	21	18	31	112	4.3	21	18	25	63	4.5
2008	21	17	40	84	4.5	22	17	42	39	0.0
2009	20	17	29	99	1.0	21	17	29	85	2.3
2010	21	18	24	194	4.4	21	18	30	263	4.0
2011	21	17	25	284	2.4	22	18	40	195	0.0
2012	23	14	28	254	9.6	23	17	28	96	1.0
2013	23	17	38	225	12.8	23	17	36	301	3.2
2014	21	17	37	52	89.7	22	19	36	56	47.7
2015	22	18	37	97	75.4	22	17	41	97	21.8
2016	22	16	27	257	29.2	22	18	27	78	14.3
2017	23	17	29	151	12.2	22	18	47	97	11.8

Table 9. Striped bass length data from recreational landings from the CSMA, NC, 2004-2017.

Year	Mean Total Length	Minimum Total Length	Maximum Total Length	Total Number Measured
2004	22	17	32	430
2005	22	18	32	318
2006	22	18	30	132
2007	22	17	30	129
2008	21	18	26	50
2009	21	17	24	95
2010	21	18	26	74
2011	21	18	28	140
2012	21	18	28	153
2013	20	17	28	169
2014	21	18	30	115
2015	21	16	27	106
2016	20	18	33	144
2017	20	17	30	202

Table 10. Annual weighted CPUE of striped bass (number of individuals per sample), total number of striped bass collected, and the number of gill net samples (N) in the Pamlico, Pungo, and Neuse rivers, 2005-2017. The Percent Standard Error (PSE) represents a measure of precision. *In 2005, fewer stations were sampled due to high gasoline prices. + The Cape Fear and New Rivers Fisheries Independent Assessment Survey sampling program began in 2008.

Year	Pamlico and Pungo Rivers				Neuse River				Cape Fear and New Rivers ⁺			
	CPUE	No. of Striped Bass	N*	PSE	CPUE	No. of Striped Bass	N*	PSE	CPUE	No. of Striped Bass	N*	PSE
2005	2.66	396	152*	14	1.37	200	152	23				
2006	2.38	371	160	17	1.74	268	160	17				
2007	1.57	241	160	22	1.16	177	160	19				
2008	1.61	249	160	21	1.25	193	161	23	0.04	3	84	100
2009	1.18	182	160	16	0.9	142	160	26	0.03	3	119	67
2010	2.11	329	160	17	2.02	311	160	23	0.01	1	120	100
2011	2.15	328	160	20	2.14	325	160	18	0.04	4	120	50
2012	0.94	143	160	20	0.84	127	160	20	0.03	3	120	67
2013	1.41	215	160	18	0.98	149	160	24	0.02	2	120	50
2014	1.43	217	160	16	1.82	273	160	20	0	0	120	-
2015	1.14	173	160	18	1.65	251	160	18	0.14	15	120	36
2016	1.16	178	160	14	1.17	178	160	14	0.11	12	120	45
2017	1.21	186	160	17	1.41	218	160	16	0.08	9	120	50

Table 11. Management action taken as a result of Amendment 1 to the North Carolina Estuarine Striped Bass FMP.

Management Strategy	Implementation Status
<p>RECREATIONAL STRIPED BASS HARVEST CLOSURE (Oregon Inlet Area/Atlantic Ocean) Status Quo – Allow the fishery to continue with catch card survey (May – Oct).</p>	No additional regulatory action required
<p>STRIPED BASS STOCKING (Coastal Rivers) Status quo and research needs – Goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse, and Cape Fear) with 3,000 stocked fish tagged annually in each system.</p>	No additional regulatory action required
<p>USE of SINGLE BARBLESS HOOKS (during Striped Bass Closed Season) Status quo (don't require barbless hooks) and continue to educate anglers on ethical angling practices, with the additional recommendation to include mortality statistics associated with various handling techniques when possible.</p>	Increase angler education about proper angling and handling techniques to reduce discard mortality
<p>ALBEMARLE SOUND MANAGEMENT AREA (Southern Boundary Line Adjustment) Support the necessary rule changes to create a new boundary point.</p>	Rule change: 15A NCAC 03J .0209; 03R .0112; and 03R .0201
<p>CASHIE RIVER (Change in Joint and Coastal Waters Boundary Line) Support the necessary rule changes to create a new boundary point.</p>	Rule change 15A NCAC 03Q .0202
<p>DISCARD MORTALITY (CSMA Commercial Gill Net Sets) Status Quo – continue the gill net requirement for tie downs and restricting gill net from within 50 yards of shore proclamation.</p>	No additional regulatory action required
<p>HOOK and LINE as COMMERCIAL GEAR in ESTUARINE STRIPED BASS FISHERIES Status Quo (don't allow hook and line as commercial gear) and support the necessary rule changes for adaptive management.</p>	Rule change 15A NCAC 03M .0201 and 03M .0202 ¹

¹ These rule changes will not initiate hook and line harvest of striped bass, only make it possible to do so in the future should unforeseen gill net regulations due to endangered species interactions make adaptive management necessary.

Management Strategy	Implementation Status
<p>CENTRAL SOUTHERN MANAGEMENT AREA STRIPED BASS MANAGEMENT MEASURES Status Quo with the addition of instituting a pound for pound payback provision for the commercial harvest TAC².</p> <p>Status Quo for CSMA management measures maintain the following:</p> <p>CSMA Recreational Harvest (Coastal, Joint, and Inland waters) Unified season Oct 1 – Apr 30 2 fish daily creel limit 18 in TL minimum size limit Protective slot (no harvest) 22 – 27 in TL (joint and inland waters only) Harvest moratorium for Cape Fear River and its tributaries</p> <p>CSMA Commercial Harvest (Coastal and Joint waters) TAC² of 25,000 lb. and commercial fishery, excluding Pamlico Sound, is not a bycatch fishery 18 in TL minimum size limit 10 fish or less trip limit Spring season only, anytime between Jan 1 – Apr 30 Gill net mesh size restrictions and yardage limits 18 in TL minimum size limit Discards – maintain existing gill net tie-down and distance from shoreline (DFS) measures implemented by proclamation. Harvest moratorium for Cape Fear River and its tributaries</p>	<p>No additional regulatory action required</p>

² The term Total Allowable Catch does not accurately describe the existing management strategy, because the term “catch” refers to landings and discards. Since its inception the quota used to maintain striped bass harvest in the ASMA, RRMA, and CSMA at sustainable levels is for landings only, not landings and discards.

Management Strategy	Implementation Status
Status Quo with the current management measures in the ASMA and RRMA.	No additional regulatory action required

Status Quo for ASMA and RRMA management measures maintain the following:

Biological Reference Points

$F_{\text{Target}} = 0.25$

$F_{\text{Threshold}} = 0.29$

A/R stock has been managed with a Total Allowable Catch (TAC²) since 1990

Maintain current TAC² of 550,000 lb.

The TAC² will continue to be split evenly between commercial and recreational sectors

ASMA commercial TAC² = 275,000 lb.

ASMA recreational TAC² = 137,500 lb.

RRMA recreational TAC² = 137,500 lb.

ASMA Commercial Harvest (TAC² = 275,000 lb.)

18 in TL minimum size limit (ASMFC compliance requirement)

Continue to operate as a bycatch fishery

Spring season, anytime between Jan 1 – Apr 30

Fall Season, anytime between Oct 1 – Dec 31

Daily trip limits for striped bass

Maintain gill net mesh size and yardage restrictions

Maintain seasonal and area closures

Maintain attendance requirements for small mesh nets (mid – May through late November)

ASMA Recreational Harvest (TAC² = 137,500 lb.)

18 in TL minimum size limit

Daily creel limit (can be adjusted as necessary to keep harvest below the TAC²)

Open 7 days a week all season (can be adjusted as necessary to keep harvest below the TAC²)

Spring season, anytime between Jan 1 – Apr 30

Fall season, anytime between Oct 1 – Dec 31

RRMA Recreational Harvest (TAC² = 137,500 lb.)

18 in TL minimum size limit

Protective slot (no harvest): 22-27 in TL

² The term Total Allowable Catch does not accurately describe the existing management strategy, because the term “catch” refers to landings and discards. Since its inception the quota used to maintain striped bass harvest in the ASMA, RRMA, and CSMA at sustainable levels is for landings only, not landings and discards.

Management Strategy	Implementation Status
<p>2 fish daily creel, only one of which can be greater than 27 in TL</p> <p>Harvest season in entire river opens on March 1 and closes on April 30 by rule since 2008</p> <p>Single barbless hook regulation from April 1 – June 30 in Inland waters above the US 258 Bridge</p> <p>Management of TACs² for ASMA and RRMA</p> <p>Short-term Overages: if the harvest point estimate exceeds the total TAC² by 10% in a single year, overage is deducted from the next year and restrictive measures implemented in the responsible fishery(ies)</p> <p>Long-term Overages: five-year running average of harvest point estimate exceeds the five-year running average of the total TAC² harvest by 2%, the responsible fishery exceeding the harvest limit will be reduced by the amount of the overage for the next five years. Should the target F be exceeded, then restrictive measures will be imposed to reduce F to the target level</p>	
<p>PROCLAMATION AUTHORITY For the ASMA, RRMA, and CSMA STRIPED BASS STOCKS:</p> <p>It should also be noted that under the provisions of this FMP the NCDMF Director and the NCWRC Chief of Inland Fisheries will maintain the ability to establish seasons, authorize or restrict fishing methods and gear, limit quantities taken or possessed, and restrict fishing areas as deemed necessary to maintain a sustainable harvest.</p>	<p>No additional regulatory action required</p>

² The term Total Allowable Catch does not accurately describe the existing management strategy, because the term “catch” refers to landings and discards. Since its inception the quota used to maintain striped bass harvest in the ASMA, RRMA, and CSMA at sustainable levels is for landings only, not landings and discards.

FIGURES

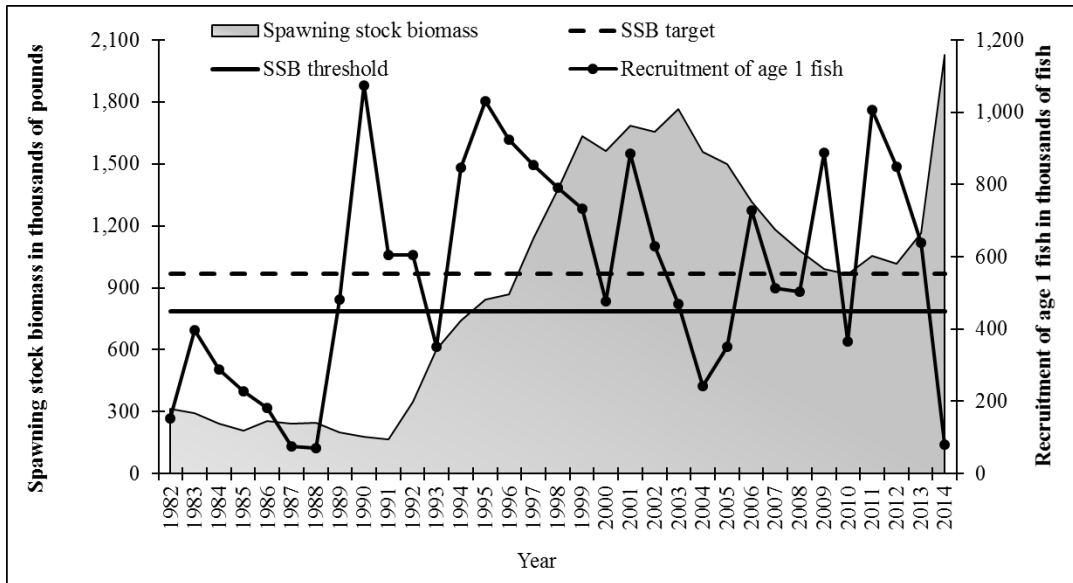


Figure 1. Albemarle/Roanoke striped bass female spawning stock biomass and recruitment (abundance of age-1), 1982-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

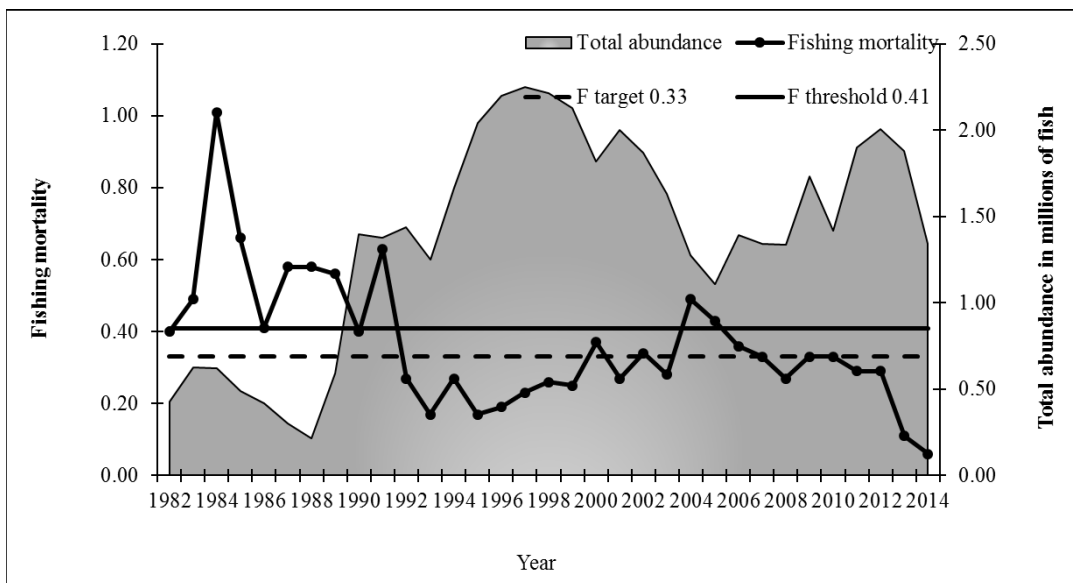


Figure 2. Albemarle/Roanoke striped bass total stock abundance and fishing mortality, 1982-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

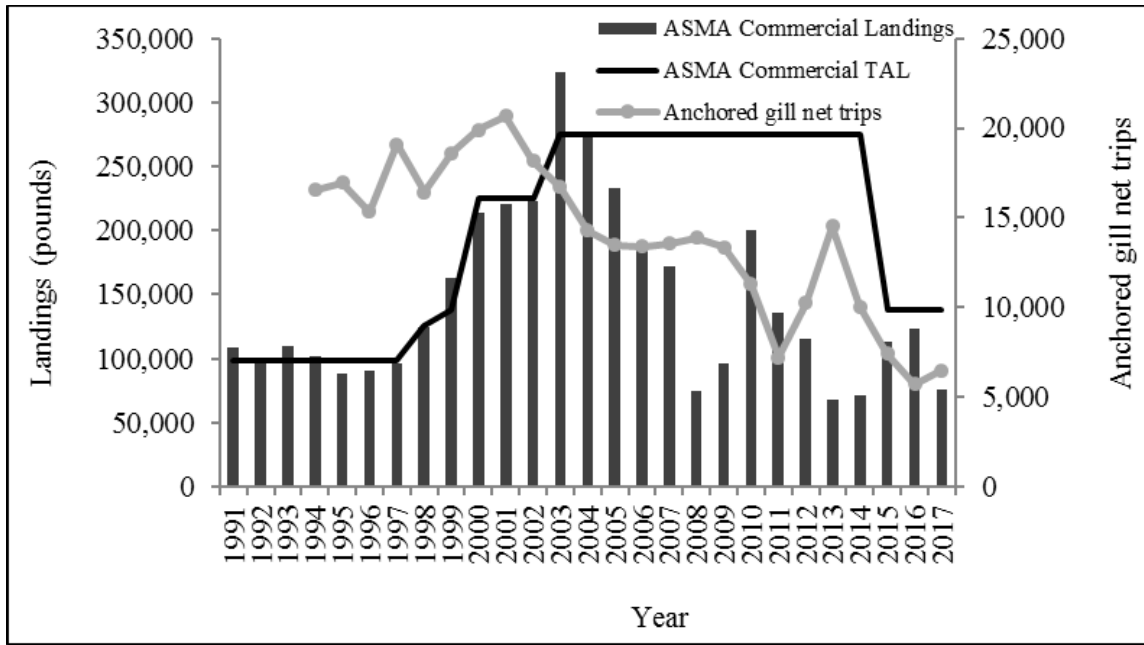


Figure 3. Commercial striped bass landings, TAL, and anchored gill net trips in the ASMA, NC, 1991-2017.

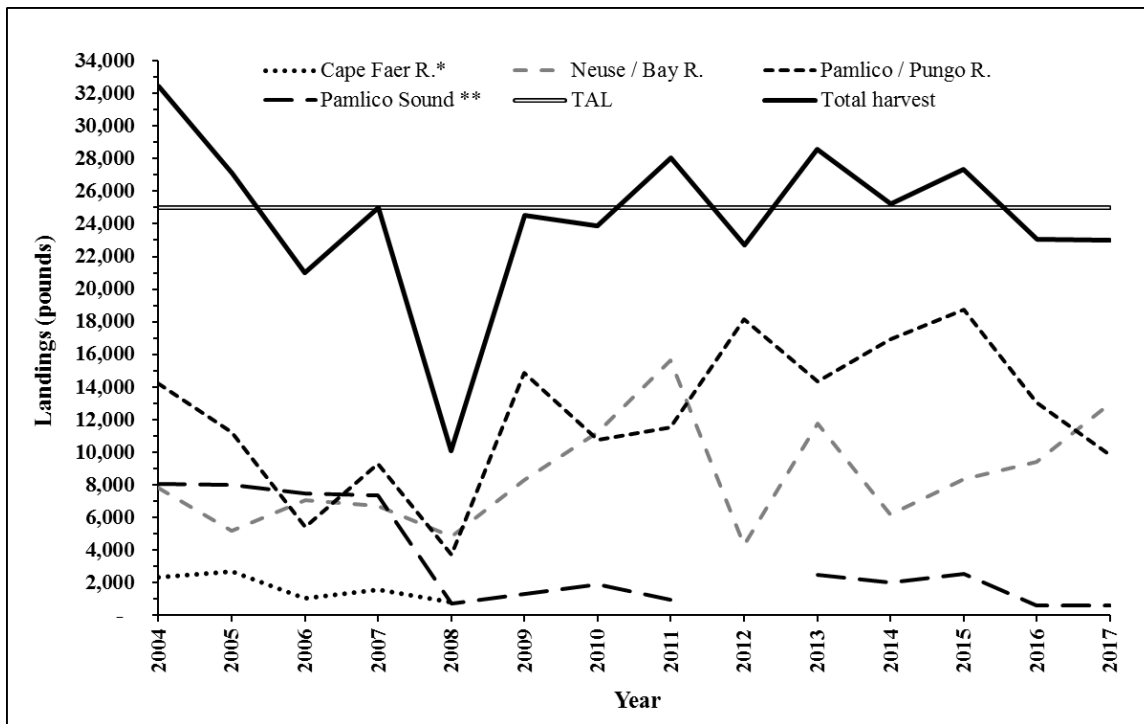


Figure 4. Commercial striped bass landings by system, and the TAL in the CSMA, NC, 2004-2017. *There has been a moratorium on harvest in the Cape Fear River since 2009. **Landings data for the Pamlico Sound in 2012 are confidential.

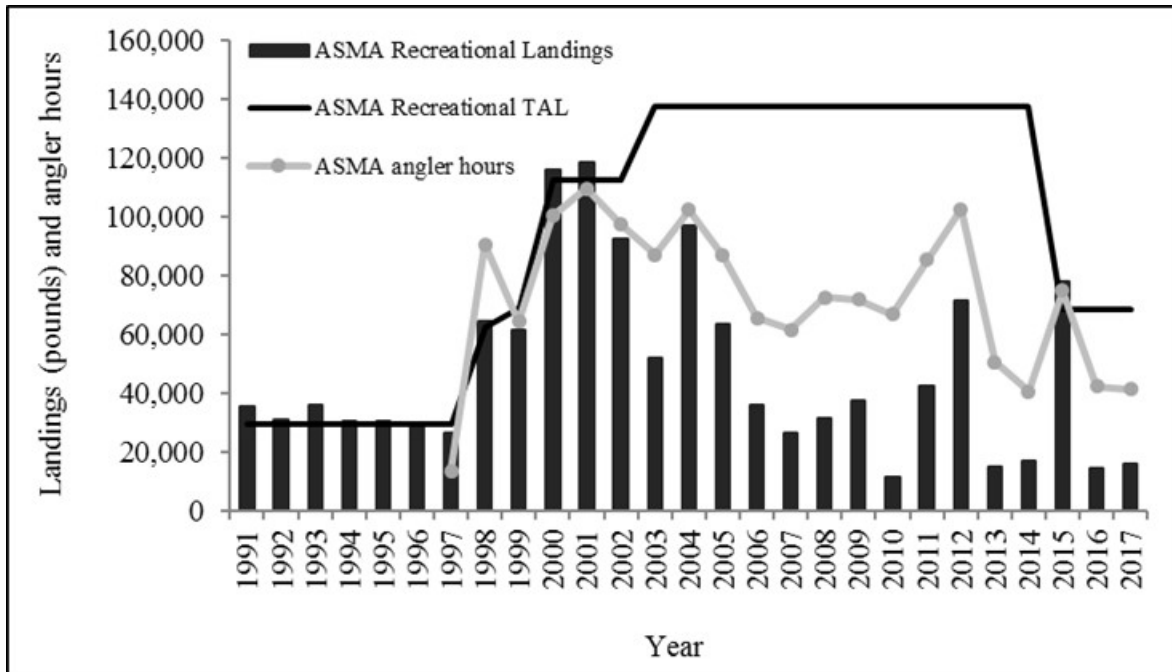


Figure 5. Recreational striped bass landings, TAL, and angler hours in the ASMA, NC, 1991-2017.

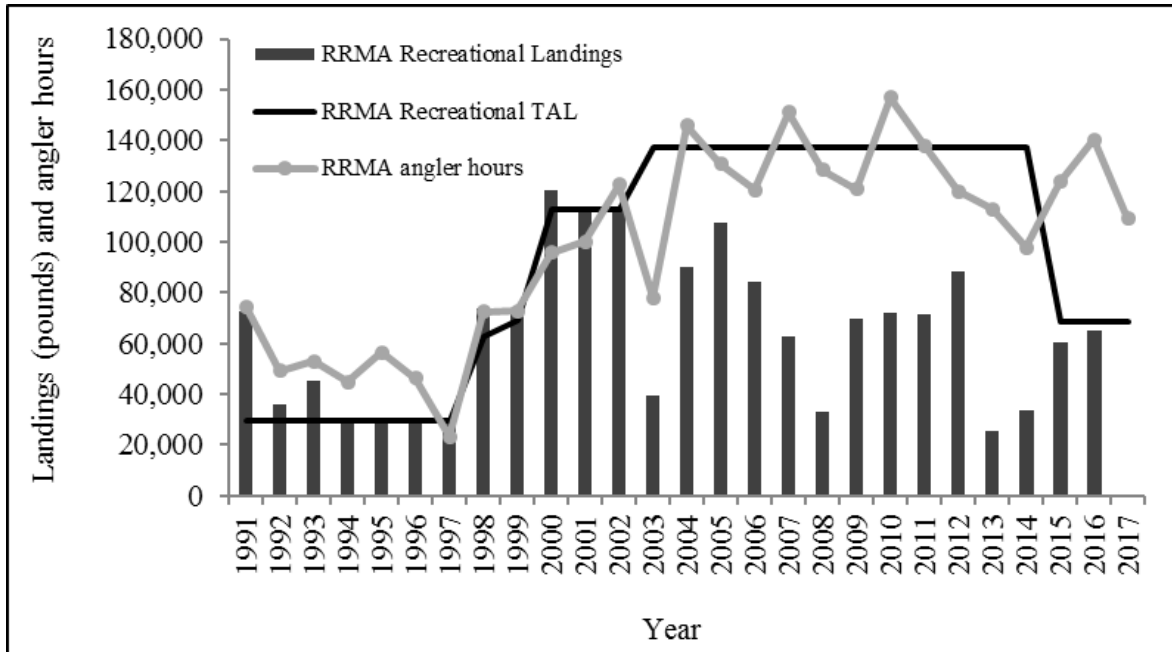


Figure 6. Recreational striped bass landings, TAL, and angler hours in the RRMA, NC, 1991-2017.

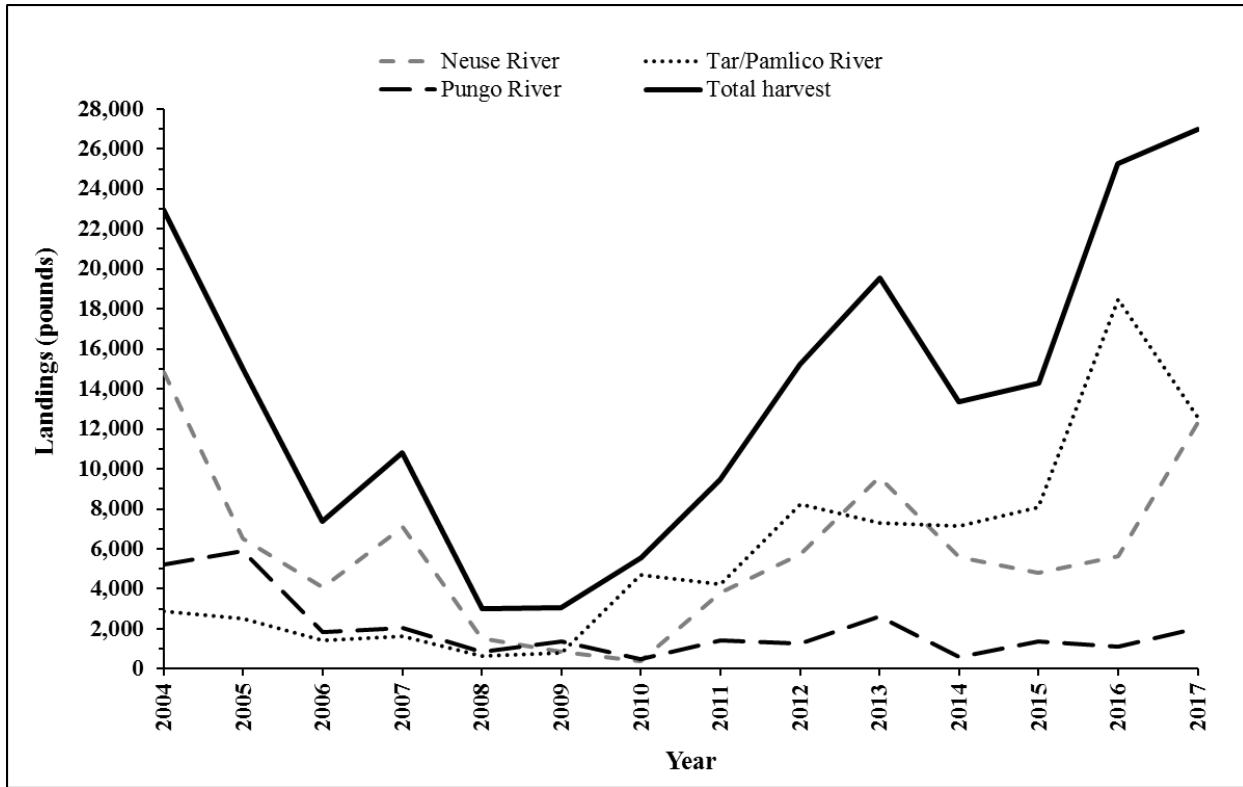


Figure 7. Recreational striped bass landings broken out by major river system in the CSMA, NC, 2004-2017.

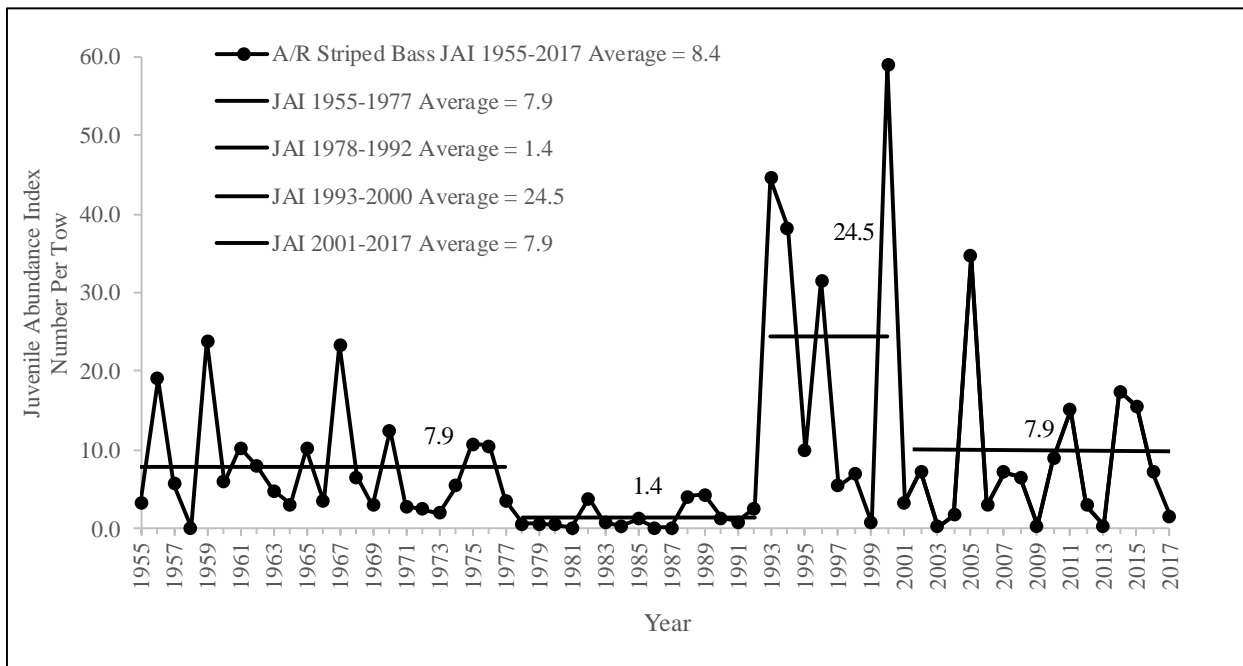


Figure 8. Juvenile abundance index (JAI) of Albemarle/Roanoke striped bass from the NCDMF juvenile trawl survey, western Albemarle Sound, NC, 1955-2017.

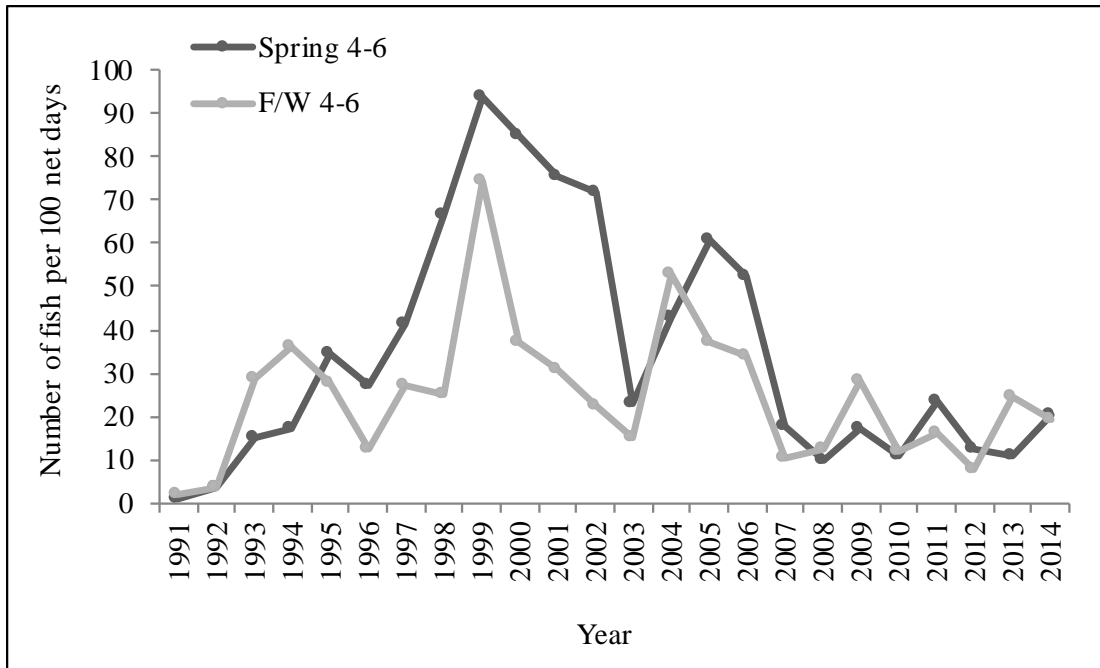


Figure 9. Relative abundance of age 4-6 Albemarle/Roanoke striped bass from the NCDMF fall/winter and spring independent gill net surveys, Albemarle Sound area, NC, 1991-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

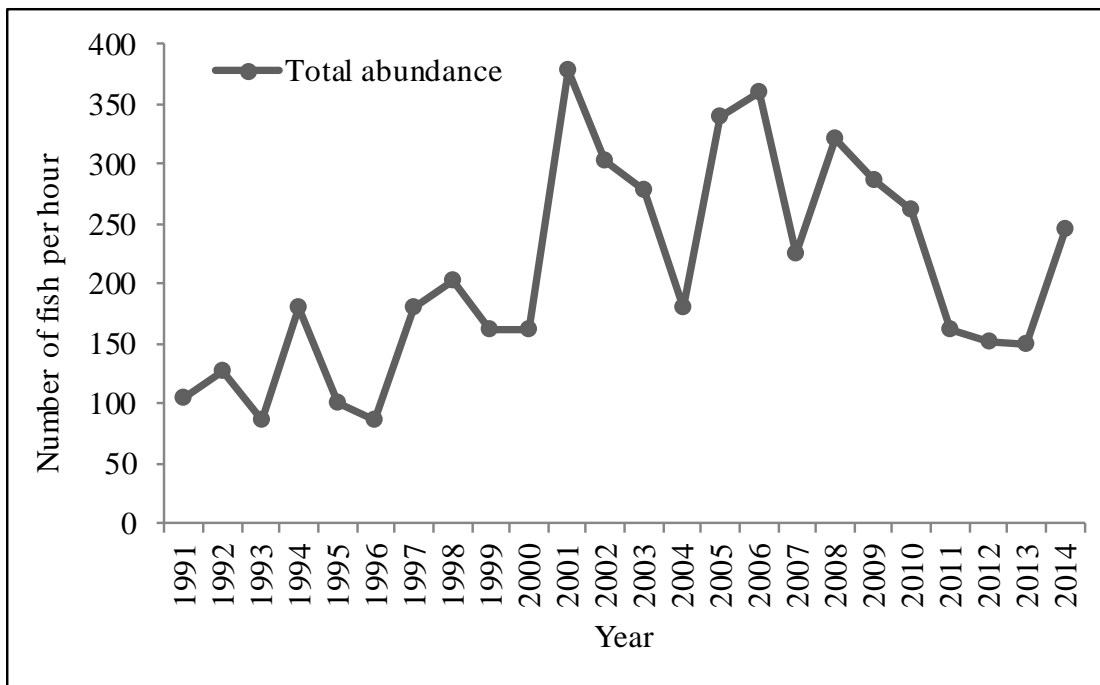


Figure 10. Relative abundance of Albemarle/Roanoke striped bass from the NCWRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

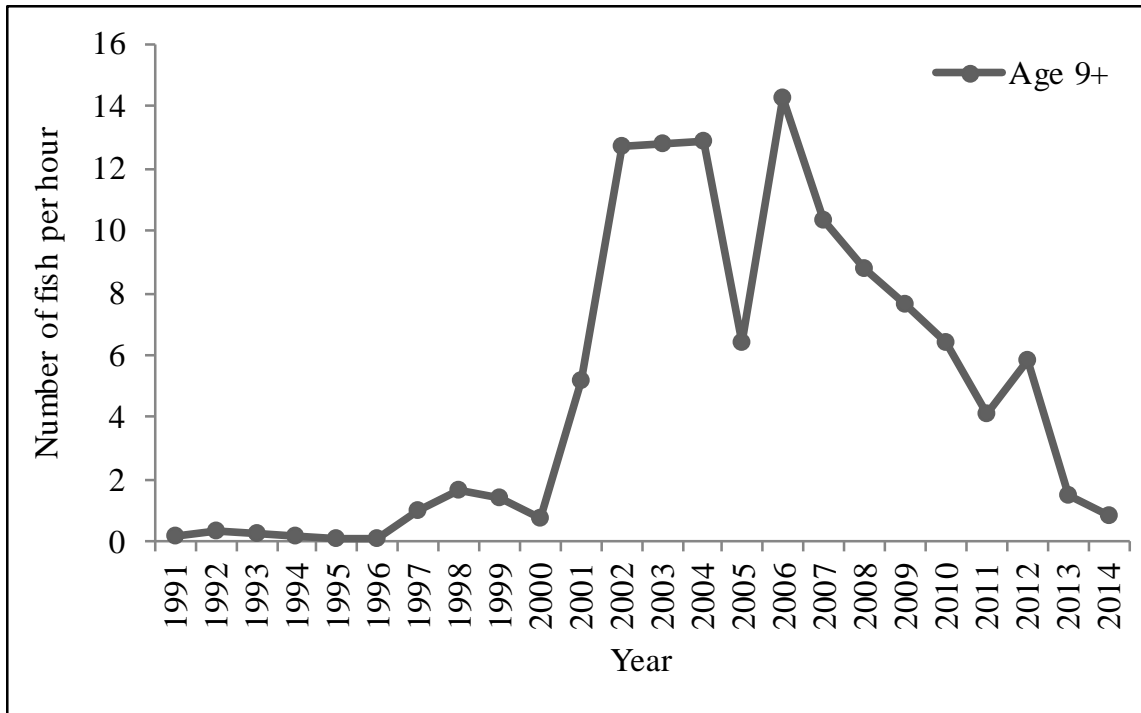


Figure 11. Relative abundance of age 9+ Albemarle/Roanoke striped bass from the NCWRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.