FISHERY MANAGEMENT PLAN UPDATE
ESTUARINE STRIPED BASS
AUGUST 2020

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption:	January 1994 May 2004
Amendments:	Amendment 1 – May 2013 Amendment 2 – In Progress
Revisions:	November 2014
Supplements:	Supplement A – February 2019
Information Updates:	None
Schedule Changes:	August 2016
Next Benchmark Review:	Review started in 2017

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 the striped bass stock in the Albemarle Sound and Roanoke River (A-R). 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 addressed the management of all estuarine stocks of striped bass in the state, satisfying 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), its subsequent revision (NCDMF 2014), and Supplement A. It is a joint plan between the NCMFC

and the NCWRC. Amendment 1, adopted in 2013, lays out separate management strategies for the 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 (Central Southern Management Area, CSMA) 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 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). The revision reduced the total allowable landings (TAL) for the A-R stock from 550,000 pounds to 275,000 pounds, 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, providing a sustainable harvest. The Revision maintained for the CSMA the 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. The Revision utilizes total allowable landings (TAL) instead of total allowable catch (TAC). The term TAC did 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 at sustainable levels in the A-R and the CSMA is for landings only, not landings and discards. Discards are accounted for in the stock assessment model but are not part of the TAC.

In August 2016, the NCMFC approved a change to the FMP review schedule so that the comprehensive review of the Estuarine Striped Bass FMP would begin in July 2017 instead of July 2018 due to concerns about the high percentage of stock fish and minimal natural recruitment in the CSMA systems. Review of the plan began in 2017 and is ongoing.

On June 1, 2018, a NCWRC rule change implementing a 26-inch total length minimum size limit in the Inland Fishing Waters of the Tar-Pamlico and Neuse rivers became effective. At the November 2018 NCMFC business meeting, the division recommended development of temporary management measures to supplement the FMP providing for a no-possession provision for striped bass in the internal coastal and joint waters of the CSMA to protect important year classes of striped bass while Amendment 2 to the N.C. Estuarine Striped Bass Fishery Management Plan is developed. Supplement A to the Estuarine Striped Bass FMP was adopted by the NCMFC at their February 2019 business meeting and NCWRC in March 2019. Supplement actions in the FMP implemented March 29, 2019 consisted of the following:

- Commercial and recreational no possession measure for striped bass (including hybrids) in coastal and inland fishing waters of the CSMA (FF-6-2019). The WRC hook and line closure proclamation had the effect of suspending rules 15A NCAC 10C .0107 (l) and 10C .0314 (g). A no-possession requirement already exists for the Cape Fear River by rule.

- Additionally, consistent with Amendment 1, commercial set gill-net restrictions requiring tie-downs and distance from shore (DFS) measures will apply year-round (M-5-2019).

On March 13, 2019 the Marine Fisheries Commission held an emergency meeting that directed the division to issue a proclamation regarding gill nets, beyond what was contained in Supplement A. Proclamation (M-6-2019) implemented the following:

- Prohibits the use of ALL gill nets upstream of the ferry lines from the Bayview Ferry to Aurora Ferry on the Pamlico River and the Minnesott Beach Ferry to Cherry Branch Ferry on the Neuse River.
- Maintains tie-down (vertical net height restrictions) and distance from shore restrictions for gill nets with a stretched mesh length 5 inches and greater in the western Pamlico Sound and rivers (superseded M-5-2019).

An emergency meeting called under North Carolina General Statute section 113-221.1(d), authorizes the commission to review the desirability of directing the fisheries director to issue a proclamation. Once the commission votes under this provision to direct issuance of a proclamation, the fisheries director has no discretion to choose another management option and is bound by law to follow the commission decision. In these cases, under existing law, the decision of the commission to direct the director to issue a proclamation is final and can only be overruled by the courts.

NCDMF and NCWRC staffs continue to work collaboratively in development of Amendment 2 to the NC Estuarine Striped Bass FMP.

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. Implementation 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 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).

Goal and Objectives

The goal of Amendment 1 to the North Carolina Estuarine Striped Bass FMP is 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 this goal, 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 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 ASMFC. 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 CSMA (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 A-R stock are 29% mature at age 3 and 97% mature ate age 4, while females in the Tar-Pamlico and Neuse rivers are 50% mature (L50) at 2.7 years and 98% mature by age 3 (Knight 2015). The length at 50% maturity (L50) for striped bass in the A-R stock is 16.8 inches. (Boyd 2011). 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. In the Tar-Pamlico and Neuse rivers, fecundity ranged from 223,110 eggs for an Age-3 female to 3,273,206 eggs for an Age-10 female (Knight 2015). Fertilized eggs drift with downstream currents and need 1.5 to 3 days to hatch and then continue to develop through the larval stage for several more days, eventually arriving in river mouths and the inland portions of coastal estuaries where they develop into juveniles. Striped bass require flowing, freshwater habitats to spawn successfully, allowing the eggs to remain suspended until they hatch, and to transport larvae to 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 A-R stock occurs when water temperature reaches 62 to 67 degrees Fahrenheit in the Roanoke River at Weldon. Spawning grounds are not clearly defined in CSMA systems as access to spawning areas is influenced by river flows as well as impediments to migration. Results of genetics-based analysis have found that rather than contributing minimally to the CSMA stocks of striped bass as previously thought, hatchery stocked fish were nearing 100% on the spawning grounds and in internal coastal fishing waters of the Tar-Pamlico, Neuse, and Cape Fear rivers (O'Donnell and Farrae 2017).

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 A-R stock was 23 years. The oldest observed striped bass within the CSMA were; 7 years in the Cape Fear River and 12 years in the Tar-Pamlico and Neuse rivers. The largest striped bass on record are several females caught in the early 1900s in Albemarle Sound which weighed 125 pounds each. Large Roanoke River striped bass (>900 mm TL) rapidly emigrate (~ 59 km/d) after spawning to distant (>1,000 km) northern ocean waters (New Jersey to Massachusetts), where they spend their summers and migrate southward in the fall to

overwintering habitats off Virginia and North Carolina and complete their migration circuit the following spring by returning to the Roanoke River to spawn. (Callihan et al. 2015). Estuarine striped bass from the A-R 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 Atlantic menhaden, herrings and shads are very important prey items, but they will also readily eat spot, mullet, Atlantic 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

No formal peer-reviewed stock assessments have been conducted for CSMA striped bass, however, an index-based method of catch curve analysis was used to assess the status of striped bass populations in the CSMA (NCDMF 2013). The large confidence intervals and lack of precision in the catch curve Z estimates (total instantaneous mortality rate) made them unsuitable for making a stock status determination. Therefore, striped bass in the Tar-Pamlico and Neuse rivers have an unknown stock status. The need for continued conservation management efforts has been supported by persistent low overall abundance, minimal natural recruitment, multiple 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 in most years. Prior studies suggested stocked fish contributed minimally to the spawning stock; however, results of genetics-based analysis revealed stocked fish composed nearly 100% of the fish sampled from the spawning grounds and internal coastal fishing waters of the Tar-Pamlico, Neuse, and Cape Fear rivers in 2016 indicating there is extremely limited natural reproduction and survival occurring in the CSMA (O'Donnell and Farrae 2017). However, genetic analysis of fish sampled in 2017, revealed a noticeable decrease in contribution of stocked fish (Farrae and Darden 2018). In 2018, NCWRC genetics-based analysis revealed stocked fish composed of 44%, 79%, and 92% for the Tar-Pamlico, Neuse, and Cape Fear rivers, respectively (SCDNR 2018). 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 are additional factors that potentially limit the spawning success of this species in the CSMA.

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 NCDMF and NCWRC staff.

Results from the assessment update indicate the stock is not overfished and overfishing is not occurring relative to biological reference points (AR_Figures 1 and 2). Female spawning stock biomass is estimated at 2,024,583 pounds, which is above the threshold of 772,588 pounds; therefore, the stock is not considered overfished. However, caution should be used 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). The A-R stock 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 (AR_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; therefore, overfishing is not occurring (AR_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). 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). A benchmark stock assessment for CSMA striped bass was begun in 2017. After reviewing available data, life history information, and stock assessment techniques, the Estuarine Striped Bass FMP Plan Development Team determined traditional stock assessment methods would not be appropriate for CSMA stocks because of the high hatchery contribution and lack of natural recruitment in these systems. Instead, the stocks are evaluated using a matrix model for the Tar-Pamlico and Neuse rivers and a tagging model for the Cape Fear River.

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 high, poor reproductive success can 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 (TL) size limit. The commercial fishery is prosecuted as a non-directed bycatch fishery, with most landings occurring in large mesh (≥ 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 22 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

Commercial and recreational harvest in the CSMA is prohibited. Supplement A to the Estuarine Striped Bass FMP was adopted by the NCMFC at their February 2019 business meeting and by

the NCWRC in March 2019. Supplement actions implemented March 29, 2019 consisted of the following:

- Commercial and recreational no possession measure for striped bass (including hybrids) in coastal and inland fishing waters of the CSMA (FF-6-2019). The WRC hook and line closure proclamation had the effect of suspending rules 15A NCAC 10C .0107 (l) and 10C .0314 (g). A no-possession requirement already exists for the Cape Fear River by rule.
- Additionally, consistent with Amendment 1, commercial set gill-net restrictions requiring tie-downs and distance from shore (DFS) measures will apply year-round (M-5-2019).

Commercial Landings

ASMA

Commercial landings in the ASMA have been controlled by an annual TAL since 1991 (AR_Table 1). 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 (AR_Figure 3).

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. Most landings traditionally have come during the American shad season. Length frequency distribution in 2019 is presented in AR_Figure 4. Length at age for all commercial samples collected from 1972 through 2019 are presented in AR_Figure 5. Commercial length frequencies are represented in AR_Figure 6. Modal length increased in 1991 and has stayed steady due to the 18-inch minimum. A larger abundance of older fish was present in 2004 and a there was a decrease in modal length in 2018. Fish between 18 and 24 inches dominate the fishery.

CSMA

Due to the no possession measure approved in Supplement A, the commercial striped bass fishery was closed in 2019 while Amendment 2 is developed. From 1994 to 2018 commercial landings in the CSMA were constrained by an annual TAL of 25,000 pounds. Landings closely follow the annual TAL, except for 2008 when less than half of the TAL was landed. From 2004 through 2018 striped bass commercial landings in the CSMA averaged 24,179 pounds and ranged from a low of 10,115 pounds in 2008 to a high of 32,479 pounds in 2004 (CS_Figure 1). Most commercial landings come from the Tar-Pamlico and Pungo rivers and the Neuse and Bay rivers, with the remainder coming from the Pamlico Sound (CS_Figure 2). From 2004 to 2018,

there was only a spring harvest season, opening March 1 each year and closing when the TAL was reached.

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 1). 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. (AR_Figure 3). 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 from 1982-2019 has averaged 42,466 pounds in the ASMA, well below the current 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 24,051 fish (Table 1). Length frequency distribution in 2019 is presented in AR_Figure 4. ASMA recreational length frequencies are presented in AR_Figure 7. Since 1996 the shift in abundance of younger fish is apparent with older fish still showing up in the fishery. Since 2014 the abundance of younger fish has increased likely due to the large 2014 and 2015 year classes with a slight uptick in landings for 2019 from the previous year.

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 from 1982 through 2019 has averaged 54,103 pounds in the RRMA (Table 1). 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 from 2005 through 2019 in the RRMA have averaged 80,821 fish (Table 1).

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; AR_Figure 3). 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 rates 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. Length frequency distribution in 2019 is presented in AR_Figure 4. RRMA recreational length frequencies are presented in AR_Figure 8. Since 2005 abundance of older fish in the recreational survey has decreased. Abundance of fish between 18 and 22 inches has stayed consistent from 2005 to 2019.

CSMA

The NCDMF started collecting recreational striped bass data in the major rivers of the CSMA in 2004. Due to the recreational no possession measure approved as part of Supplement A in February 2019 minimal recreational harvest occurred in 2019. In 2019, 959 pounds of striped bass were harvested in the CSMA. Recreational landings have fluctuated between 2004 and 2018, ranging from lows in 2008 and 2009 to a high of 26,973 pounds in 2017 (Table 1). In recent years (2016-2017) both the number of trips and the hours spent targeting striped bass within the CSMA have increased although there was a moderate decline observed in 2018. Since 2011, harvest in the Tar-Pamlico and Neuse rivers has fluctuated little, ranging from 4,000 pounds to 9,000 pounds, however in 2016 and 2017 there was a sharp increase in recreational harvest (25,260 and 26,973 pounds, respectively). In 2018, recreational harvest dropped sharply by more than half of the 2016 and 2017 values (Table 1; CS_Figure 3). Harvest on the Pungo River has remained consistent at a relatively low level compared to fluctuations in the Tar-Pamlico and Neuse rivers.

In 2019, discard of legal sized striped bass returned to more normal levels (n=7,817), after a high of 26,501 in 2017. Fish released that were within the slot limit, have fluctuated since 2004 and have ranged from a low in 2004, 2006, and 2007 of zero fish to a high of 6,779 fish in 2016 (Table 1). In 2019, there were approximately 2,481 discarded striped bass that were within the slot limit. In 2017, mainly due to the large number of undersized striped bass available, there was more than a fivefold increase in the number of discards occurring in the fishery since 2015. However, in 2018 and 2019 there was a sizeable decline back in under sized discards to more normal discard numbers (34,128 and 24,857, respectively; Table 1 and CS_Figure 4). Within the CSMA there is 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 46,262 fish (Table 1). CSMA recreational length frequencies are presented in CS_Figure 5. In 2018, the modal length of striped bass in the recreational harvest from the Tar-Pamlico/Pungo rivers was 18 inches with few fish over 22 inches harvested, and the modal length from the Neuse River was 19 inches with few fish over 20 inches harvested (CS_ Figure 6).

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 1972. Since 1994 anchored gill nets have accounted for 88 percent of the harvest in the ASMA (AR_Figure 9). 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 2005 to 2018 was 21 inches (AR_Table 2).

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 2005 to 2019 was 20 inches total length for the ASMA and 19 inches total length for the RRMA (AR_Tables 3 and 4). Age data from the dependent and independent surveys are presented in AR_Table 5. The minimum and maximum age for the independent and dependent surveys are 1 and 17 years respectively with an average age of 4.

CSMA Stocks

Monitoring of the commercial fishery in the CSMA follows the same methodology as in the ASMA. There has been a commercial and recreational harvest moratorium in the Cape Fear River since 2008 and in the CSMA since March 2019. From 2004 to 2018, length data from the commercial harvest shows that on average striped bass harvested in the Neuse and Bay rivers are slightly larger than fish harvested in the Pamlico and Pungo rivers (CS_Table 1). Additionally, maximum lengths are generally larger in the Neuse and Bay rivers compared to the Pamlico and Pungo rivers.

In 2018, the modal length of CSMA striped bass in the commercial harvest from the Tar-Pamlico/Pungo rivers was 20 inches with few fish over 25 inches harvested and in the Neuse/Bay rivers striped bass modal length was 23 inches with few fish over 27 inches harvested (CS Figure 6). CSMA commercial length frequencies are represented in CS_Figure 7 and show that striped bass are routinely harvested up to 30 inches total length, and that few fish under the 18 inch total length minimum size limit are harvested.

In North Carolina, hybrid striped bass (a cross between a striped bass and white bass; *Morone chrysops*) are commercially harvested from both the Tar-Pamlico and Neuse river systems and are not distinguished from striped bass for management purposes. Data collected on hybrid striped bass 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 (CS_Table 1, CS_Figure 8). It is hypothesized that most of the hybrid striped bass observed in these systems originated from aquaculture facilities and escaped during flooding events. The last major flooding events in the CSMA were during Hurricane Irene in 2011 and Hurricane Florence in 2018. During Hurricane Irene, river waters rose and flooded local aquaculture facilities. It was reported that tens of thousands of yearling hybrids were lost, presumably into the Pamlico River. While, it is likely the majority of hybrids within the CSMA river systems escaped from

aquaculture facilities, it is also possible that hybridization occurs in the wild. Additional studies are needed to determine if this is occurring.

From 2004 to 2018, the CSMA recreational creel survey sampled on average 160 striped bass per year. In 2018, the creel survey measured 155 striped bass that averaged 19 inches and ranged in length from 16 to 29 inches, however, only 32 striped bass were measured in 2019 that averaged 20 inches and ranged in length from 16 to 26 inches due to the season closure in March 2019 (CS_Table 2).

Age data from fishery dependent surveys are presented in CS_Table 3 and CS_Figure 9; from 2016 to 2018, 65 otolith and 438 genetic samples were collected from commercial and recreational surveys that provided striped bass ages. Limited genetic age data was collected in 2019 from the recreational creel survey (n=15) and no commercial samples were collected, however these data have not been analyzed.

Fishery-Independent Monitoring

A-R Stock

A young-of-year (age-0) A-R striped bass juvenile abundance survey used to calculate a 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 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 water flow regimes 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; AR_Figure 10). 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 2016 the stock has seen improved annual spawning success, with above average JAI values in 2011, 2014, and 2015, with one year (2013) below the spawning failure threshold. The JAI values for 2018 and 2019 were 0.4 and 1.18 respectively and are below the spawning failure threshold of 1.33, (AR_Figure 10).

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, near 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 (AR_Figure 11). 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. In 2019 the abundance of 4 to 6-year-old fish was below average in the fall/winter portion of the survey and increased in the spring.

An electrofishing survey has been conducted by the NCWRC on the spawning grounds 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 (AR_Figure 12). The abundance of fish in 2019 was slightly higher than 2018, but still lower than the peaks in 2001, 2006 and 2008. 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 age 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 over one fish per hour (AR_Figure 13). 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 2001-2011, 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. Age 9+ fish abundance from 2016 to 2019 is similar to the abundance levels seen in the early 90's.

CSMA Stocks

The Fishery Independent Gill Net Survey (P915) was initiated by the NCDMF in May of 2001 in Pamlico Sound. The survey was expanded to the Pamlico, Pungo, and Neuse rivers in 2003, expanded to the Cape Fear and New rivers in 2008, and expanded into Core Sound, Bogue Sound and the White Oak River in May 2018. Due to a commercial and recreational no possession measure implemented in March 2019, fishery-independent programs like P915 are currently the only source of CSMA striped bass data. Samples collected from P915 on the Tar-Pamlico, Pungo, and Neuse rivers show most striped bass were captured in the upper and middle portions of the rivers. Over the past twelve years (2004-2019), striped bass relative abundance has been higher in the Tar-Pamlico/Pungo, and Neuse rivers when compared to the Cape Fear River (CS_Table 4 and CS_Figure 10). Since 2004, striped bass relative abundance in the Tar-Pamlico/Pungo and Neuse rivers ranged from 2.04 to 9.00 fish per sample, whereas relative abundance in the Cape Fear River ranged from 0 to 0.14 fish per sample (CS_Table 4). In 2019, striped bass relative abundance in the Tar-Pamlico/Pungo and Neuse rivers was 5.06 and 4.21 fish per sample, respectively, compared to 0.03 fish per sample in the Cape Fear River (CS_Table 4; CS_Figure 10). Length frequencies from P915 are represented in CS_Figure 11. Length frequency distributions are variable between years but generally range from 10 to 25 inches TL, however in 2016-2017 in the Tar-Pamlico/Pungo and 2015-2017 in the Neuse rivers there was a higher percentage of small fish that could represent the two year classes of striped bass thought to be the result of successful natural reproduction in 2014 and 2015. In 2018 and 2019, there were larger fish in the Tar-Pamlico/Pungo and Neuse rivers that could represent growth and perpetuation of the two year classes of striped bass.

In 2017, the Juvenile Anadromous Survey (P100) which was developed in the Albemarle Sound to determine relative abundance, growth and distribution of juvenile alosines and striped bass was expanded to include the Tar-Pamlico, Neuse, Cape Fear, and Northeast Cape Fear rivers. The survey employs both seines (June-July) and trawls (July-October) to monitor the status of the striped bass stocks in North Carolina in order to assess the effectiveness of management measures within the CSMA. In 2017-2019 young-of-year sampling in the Central Southern Management Area (CSMA) did not capture any juvenile striped bass in the Tar-Pamlico, Neuse, and Cape Fear rivers, however 24 juvenile striped bass were captured in the Northeast Cape Fear River in 2018 and four in 2019.

Age data from fishery independent surveys are presented in CS_Table 3 and CS_Figure 9; from 2004 to 2019, 1,808 otolith samples were collected and from 2016 to 2018, 333 genetic samples were collected that provided striped bass ages from fishery independent surveys (CS_Table 3). Figure CS_Figure 9 shows an increasing trend of size at length with a maximum age of 12 years old.

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 (see AR_Table 6). 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. Results from a peer-reviewed benchmark stock assessment utilizing data through 2017 are expected in 2020. Any change to stock status will be addressed in Amendment 2 to the N.C. Estuarine Striped Bass Fishery Management Plan that is being jointly developed with the Wildlife Resources Commission.

CSMA Stocks

Estuarine striped bass in North Carolina are managed under Amendment 1 to the North Carolina Estuarine Striped Bass FMP and subsequent revisions (see CS_Table 5), however due to concerns about the high percentage of stocked fish and minimal natural recruitment in the CSMA systems, the comprehensive review of the Estuarine Striped Bass FMP began in July 2017 instead of as originally scheduled in 2018. Since adoption of 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 from the WRC electrofishing survey on the Neuse River in 2014 was the highest since the sample record began and continued an increasing trend since 2008 (Rachels and Ricks 2015). 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). Results from genetic testing of sampled fish in 2017 suggest there were two recent naturally spawned year classes and in February 2019, Supplement A to Amendment 1 to the North Carolina Estuarine Striped Bass FMP was approved instituting a recreational and commercial no-possession limit in the CSMA. The no-possession measure is temporary and provides additional protection for non-hatchery fish until Amendment 2 to the North Carolina Estuarine Striped Bass FMP is adopted. The stocks will be evaluated using a matrix model for the Tar-Pamlico and Neuse rivers and a tagging model for the Cape Fear River. This evaluation will inform recovery metrics for the CSMA stocks in Amendment 2.

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 outline 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 and NCDMF genetics study)
- Acquire life history information: maturity, fecundity, size and weight at age, egg and larval survival - HIGH. (Ongoing through CRFL funded projects. See Knight (2015) for recent publication on maturation and fecundity in the Neuse and Tar-Pamlico rivers and ongoing through NCDMF P930)
- 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 (Buckley et al. 2019)
- 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; In 2017, NCSU was awarded a CRFL grant to conduct research on striped bass egg yolk, egg buoyancy, and striped bass recruitment. Work for this project was completed in September 2019 and the final report is expected in June 2020)
- Determine extent of spawning grounds – LOW (See Rock et al. (2018) for recent publication on acoustic tagged striped bass in the CSMA)
- 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
- Conduct independent surveys that adequately capture all life stages of striped bass - HIGH (Ongoing through expansion of juvenile striped bass independent survey (P100) into the Pamlico, Neuse, Cape Fear, and Northeast Cape Fear rivers in 2017)
- 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 (NCSU has a marine fisheries fellow that is looking at selectivity-based tagging data)

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 (CSMA – Ongoing through NCDMF Program 100; Buckley et al. 2019; In 2017, NCSU was awarded a CRFL grant to conduct research on striped bass egg yolk, egg buoyancy, and striped bass recruitment)
- 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. In 2017, NCSU was awarded a CRFL grant to conduct research on striped bass eggs, including evaluating for Gen X)
- 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 – Ongoing through NCDMF Program 100; Buckley et al. 2019)
- 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 (Bradley et al. 2018)
- 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, which is being jointly developed with the Wildlife Resources Commission. Results from a peer-reviewed benchmark stock assessment utilizing data through 2017 are expected in 2020.

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.

Boyd, J. 2011. Maturation, Fecundity, and Spawning Frequency of the Albemarle/Roanoke Striped Bass Stock. (Under the direction of Dr. Roger Rulifson). Department of Biology, December 2011. 132 pp.

Bradley, C., J. Rice and D. Aday. 2018. Modeling the Effects of Vital Rate Manipulation and Management
Scenarios to Predict the Population Impact of Restoration Programs on an Unrecovered Coastal Population of Striped Bass

Callihan, J., J. Harris, and J. Hightower. 2015. Coastal Migration and Homing of Roanoke River Striped
Bass. North Carolina Cooperative Fish and Wildlife Research Unit, Department of Applied Ecology, North Carolina State University, Raleigh, NC. 15 pp.

Buckley, C., L. Kelsey, K. Rachels, and B. Ricks. 2019. Striped Bass Icthyoplankton Surveys in the Neuse River, 2016–2017. Federal Aid in Sport Fish Restoration Project F-108. North Carolina Wildlife Resources Commission, Inland Fisheries Division, Raleigh, NC. 17 pp.

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.

O'Donnell T., and D. Farrae. 2017. South Carolina Department of Natural Resources. North Carolina Wildlife Resources Commission 2016 Striped Bass Genotyping and Parentage Analyses 2016 Final Report.

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, J., 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.

Rock, J., D. Zapf. J. Facendola, C. Stewart. 2018. Assessing critical habitat, movement patterns, and spawning grounds of anadromous fishes in the Tar/Pamlico, Neuse, and Cape Fear rivers using telemetry tagging techniques. North Carolina Department of Environmental

Quality, Division of Marine Fisheries. Morehead City, NC. CRFL Grant 2013-F-013 Final Report. 120 pp.

SCDNR. 2018. North Carolina Wildlife Resources Commission 2018 Striped Bass Genotyping and Parentage Analyses. 2018 Final Report. 47 pp.

U.S. Fish and Wildlife Service. 1992. Report to Congress for the North Carolina Striped Bass Study Albemarle Sound Roanoke River Basin.

TABLES - Combined

Table 1. Recreational striped bass effort, harvest and discards from the ASMA, RRMA (2005-2019), and CSMA (2004-2019). In the CSMA, there was a limited recreational season in 2019, lasting from January 1 to March 19, 2019.

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	2005	N/A	86,943	17,954	63,477	N/A	N/A	N/A	N/A	N/A
	2006	N/A	65,757	10,711	35,985	N/A	N/A	N/A	N/A	N/A
	2007	N/A	61,679	7,143	26,633	N/A	N/A	N/A	N/A	N/A
	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
	2018	9,057	34,764	3,465	11,763	281	21,388	3,970	N/A	25,639
	2019	18,833	71,800	10,723	36,351	52	32,020	2,896	N/A	34,968
	Total	129,567	970,419	153,379	500,349	4,583	300,880	19,435		324,900
RRMA	2005	27,527	130,755	34,122	107,530					89,550
	2006	25,394	120,621	25,355	84,521					40,805
	2007	29,868	141,874	19,306	64,986					40,879
	2008	23,286	110,608	10,541	32,725					141,646
	2009*	25,405	120,675	23,248	69,581					135,964
	2010	24,347	125,495	22,445	72,037	Disposition of discards not available for all years.				77,882
	2011	27,311	122,876	22,102	71,561					80,828
	2012	27,151	110,982	28,847	88,539					40,772
	2013	19,539	100,391	7,718	25,197					49,148
	2014	15,960	80,256	11,058	33,717					93,471
	2015	22,827	111,419	20,031	58,962					78,401
	2016	25,036	129,132	21,260	65,218					34,753
	2017	19,688	101,565	9,899	32,569					68,693
	2018	18,280	95,447	8,741	26,797					121,969
	2019	20,633	99,259	16,582	53,379					117,550
	Total	352,252	1,701,355	281,255	887,319					1,212,311

Table 1 Continued.

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
CSMA	2004	12,782	63,791	6,141	22,958	85	11,729	1,743	0	13,557
	2005	16,414	69,370	3,832	14,965	152	15,609	1,016	77	16,854
	2006	10,611	42,066	2,481	7,352	33	12,548	2,314	0	14,895
	2007	10,971	46,655	3,597	10,794	147	21,673	1,707	0	23,527
	2008	6,621	28,413	843	2,990	2,838	11,721	3,316	91	17,966
	2009	5,642	26,611	895	3,061	7	4,471	1,769	718	6,965
	2010	6,559	25,354	1,757	5,537	29	5,200	2,401	360	7,990
	2012	18,338	71,964	3,922	15,240	439	26,343	13,621	2,910	43,313
	2013	20,394	86,918	5,467	19,537	539	19,302	10,619	2,357	32,816
	2014	15,682	70,316	3,301	13,368	1,449	19,185	7,934	1,641	30,209
	2015	18,159	79,398	3,934	14,269	217	22,272	8,052	813	31,353
	2016	23,675	110,453	6,697	25,260	215	57,874	10,593	6,779	75,461
	2017	26,125	119,680	7,334	26,973	549	101,787	26,501	2,293	131,129
	2018	16,393	69,917	3,371	10,884	871	34,128	12,232	1,890	49,122
	2019**	8,820	40,580	959	3,562	942	24,857	7,817	2,481	37,039
	Total	229,792	1,003,026	57,259	206,224	8,503	405,358	117,032	24,533	556,384

*Estimates of discards not available for the post-harvest season period.
**limited season (Jan 1- March 19, 2019)

TABLES - Albemarle-Roanoke (AR)

AR_Table 1. Striped bass commercial and recreational harvest and discards in pounds from the ASMA-RRMA, NC, 1982-2019.

Year	Harvest (lb)						Discard (lb)					Combined
	ASMA Comm.	ASMA Rec.	RRMA Comm.	RRMA Rec.	Total Harvest	TAL	ASMA Comm.	ASMA Rec.	RRMA Comm.	RRMA Rec.	Total Discards	Harvest and Discards
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							291,784
1984	475,641	17,181	1,703	16,892	511,417							511,417
1985	269,671	6,603	6,200	6,492	288,966							288,966
1986	172,683	18,755	50	18,440	209,928							209,928
1987	228,861	37,621	0[#]	36,989	303,471							303,471
1988	108,791	52,434	0	74,639	235,864							235,864
1989	97,061	26,857	0	32,107	156,025							156,025
1990	103,757	36,976	0	42,204	182,937							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	84,521	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

AR_Table 1 Continued.

Year	Harvest (lb)						Discard (lb)					Combined
	ASMA Comm.	ASMA Rec.	RRMA Comm.	RRMA Rec.	Total Harvest	TAL	ASMA Comm.	ASMA Rec.	RRMA Comm.	RRMA Rec.	Total Discards	Harvest and Discards
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	88,539	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	25,942	155,655
2018	116,144	11,763	0	26,797	142,854	275,000	4,716	N/A		7,806	12,522	155,376
2019	136,820	36,351	0	53,379	226,550	275,000	7,748	N/A		N/A	7,748	234,298

AR_Table 2. Striped bass total length (inches) data from commercial landings from the ASMA, NC, 2005-2019.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2005	21	17	43	719
2006	22	17	44	926
2007	22	17	47	860
2008	22	18	46	547
2009	21	18	41	813
2010	21	17	48	940
2011	21	18	39	990
2012	22	18	39	648
2013	22	18	45	543
2014	23	18	43	484
2015	22	18	43	794
2016	22	18	43	604
2017	22	18	41	246
2018	20	16	41	456
2019	20	17	40	566

AR_Table 3. Striped bass total length (inches) data from recreational landings from the ASMA, NC, 2005-2019.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2005	20	16	36	1,653
2006	20	17	32	743
2007	20	17	39	412
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
2018	18	17	29	312
2019	18	17	27	555

AR_Table 4. Striped bass total length (inches) data from recreational landings from the RRMA, NC, 2005-2019.

Year	Mean Length	Minimum Length	Maximum Length	Total Number Measured
2005	20	16	39	981
2006	20	17	39	1,059
2007	20	17	39	709
2008	19	17	34	667
2009	19	16	32	1,049
2010	19	16	28	954
2011	19	17	31	679
2012	20	17	27	688
2013	19	17	27	512
2014	19	17	29	559
2015	19	16	26	1,340
2016	19	17	29	1,133
2017	20	17	33	498
2018	19	17	28	688
2019	19	16	29	1,032

AR_Table 5. Striped bass age data from dependent (commercial) and independent (independent gill net survey) surveys from the ASMA, NC, 2005-2019.

Year	Modal Age	Minimum Age	Maximum Age	Total Number Aged
2005	4	1	14	1,258
2006	5	1	14	1,262
2007	5	1	14	1,188
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
2018	4	1	10	674
2019	5	1	14	482

AR_Table 6. Albemarle-Roanoke management actions taken as a result of Amendment 1 to the North Carolina Estuarine Striped Bass FMP.

Management Strategy	Implementation Status
RECREATIONAL STRIPED BASS HARVEST CLOSURE (Oregon Inlet Area/Atlantic Ocean) Status Quo – Allow the fishery to continue with catch card survey (May – Oct).	No additional regulatory action required
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.	Increase angler education about proper angling and handling techniques to reduce discard mortality
ALBEMARLE SOUND MANAGEMENT AREA (Southern Boundary Line Adjustment) Support the necessary rule changes to create a new boundary point.	Rule change: 15A NCAC 03J .0209; 03R .0112; and 03R .0201
CASHIE RIVER (Change in Joint and Coastal Waters Boundary Line) Support the necessary rule changes to create a new boundary point.	Rule change 15A NCAC 03Q .0202
ALBEMARLE SOUND MANAGEMENT AREA and ROANOKE RIVER MANAGEMENT AREA STRIPED BASS MANAGEMENT MEASURES Status Quo with the current management measures in the ASMA and RRMA. Status Quo with the current management measures in the ASMA and RRMA. Status Quo for ASMA and RRMA management measures maintain the following: Biological Reference Points $F_{Target} = 0.25$ $F_{Threshold} = 0.29$ A-R stock has been managed with a Total Allowable Catch (TAC^2) since 1990	No additional regulatory action required

AR_Table 6. Continued.

Management Strategy	Implementation Status

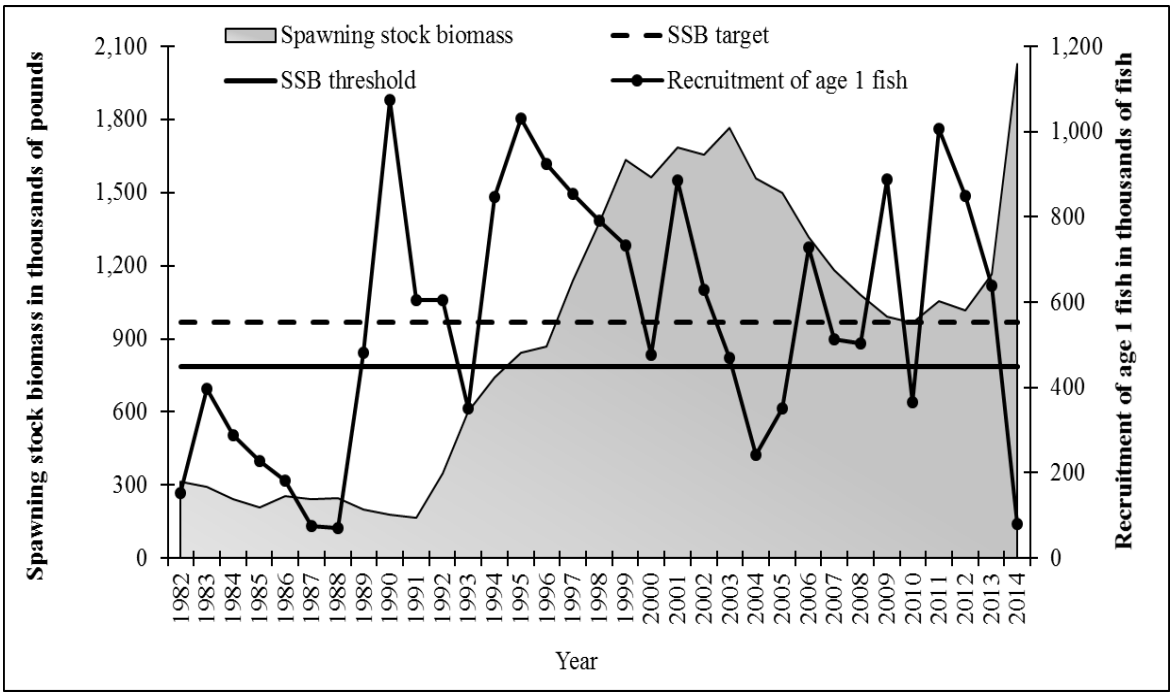
Maintain current TAC[2] of 550,000 lb.	
The TAC[2] will continue to be split evenly between commercial and recreational sectors	
ASMA commercial TAC[2] = 275,000 lb.	
ASMA recreational TAC[2] = 137,500 lb.	
RRMA recreational TAC[2] = 137,500 lb.	
ASMA Commercial Harvest (TAC[2] = 275,000 lb.)	
18 in 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 (TAC[2] = 137,500 lb.)	
18 in TL minimum size limit	
Daily creel limit (can be adjusted as necessary to keep harvest below the TAC[2])	
Open 7 days a week all season (can be adjusted as necessary to keep harvest below the TAC[2])	
Spring season, anytime between Jan 1 – Apr 30	
Fall season, anytime between Oct 1 – Dec 31	
RRMA Recreational Harvest (TAC[2] = 137,500 lb.)	
18 in TL minimum size limit	
Protective slot (no harvest): 22-27 in TL	
2 fish daily creel, only one of which can be greater than 27 in TL	
Harvest season in entire river opens on March 1 and closes on April 30 by rule since 2008	
Single barbless hook regulation from April 1 – June 30 in Inland waters above the US 258 Bridge	
Management of TACs[2] for ASMA and RRMA	

AR_Table 6. Continued.

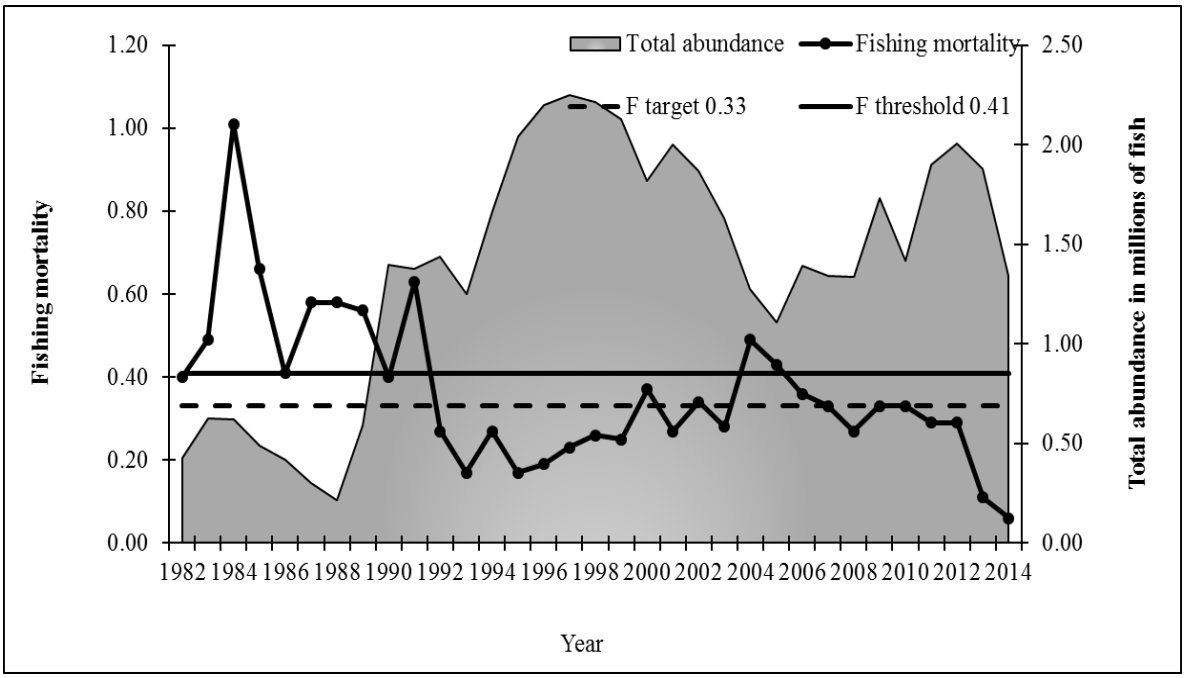
Management Strategy	Implementation Status

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) Long-term Overages: five-year running average of harvest point estimate exceeds the five-year running average of the total TAC[2] 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	
PROCLAMATION AUTHORITY For the ASMA, RRMA, and CSMA STRIPED BASS STOCKS: 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.	No additional regulatory action required

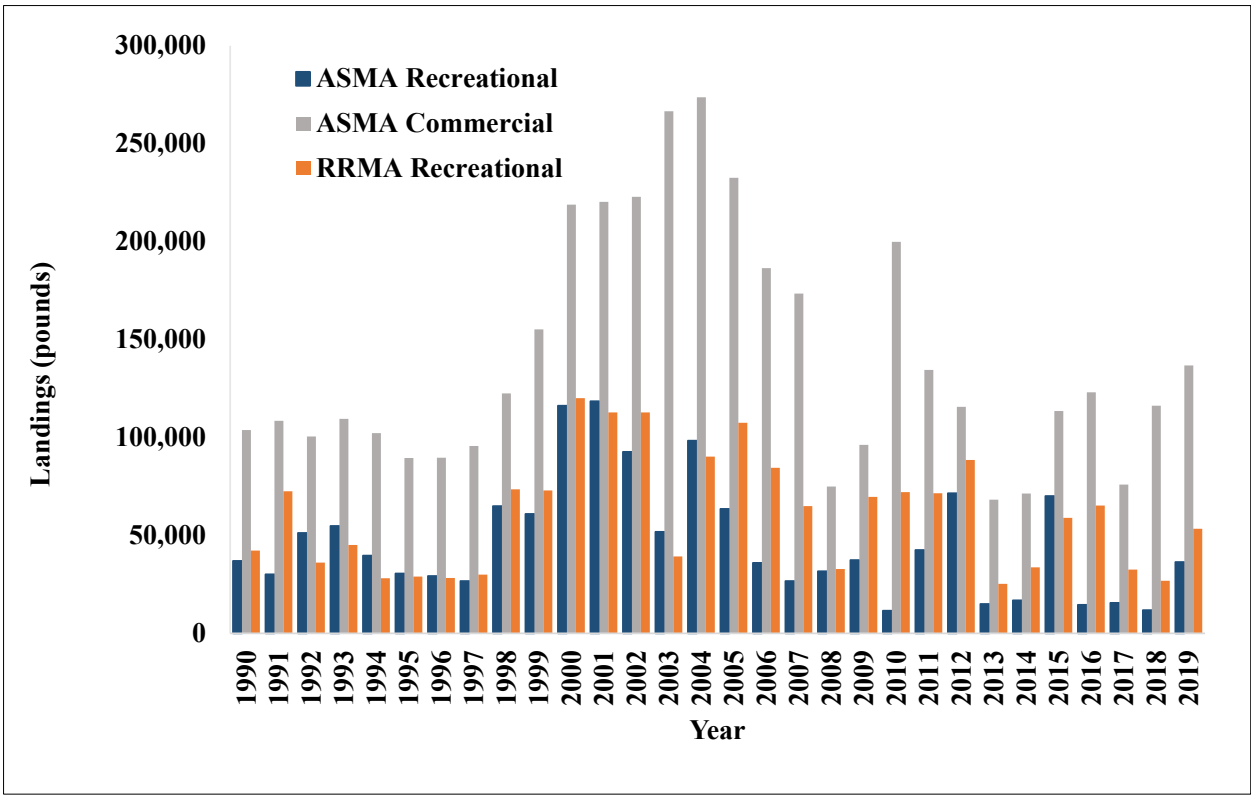
FIGURES - AR



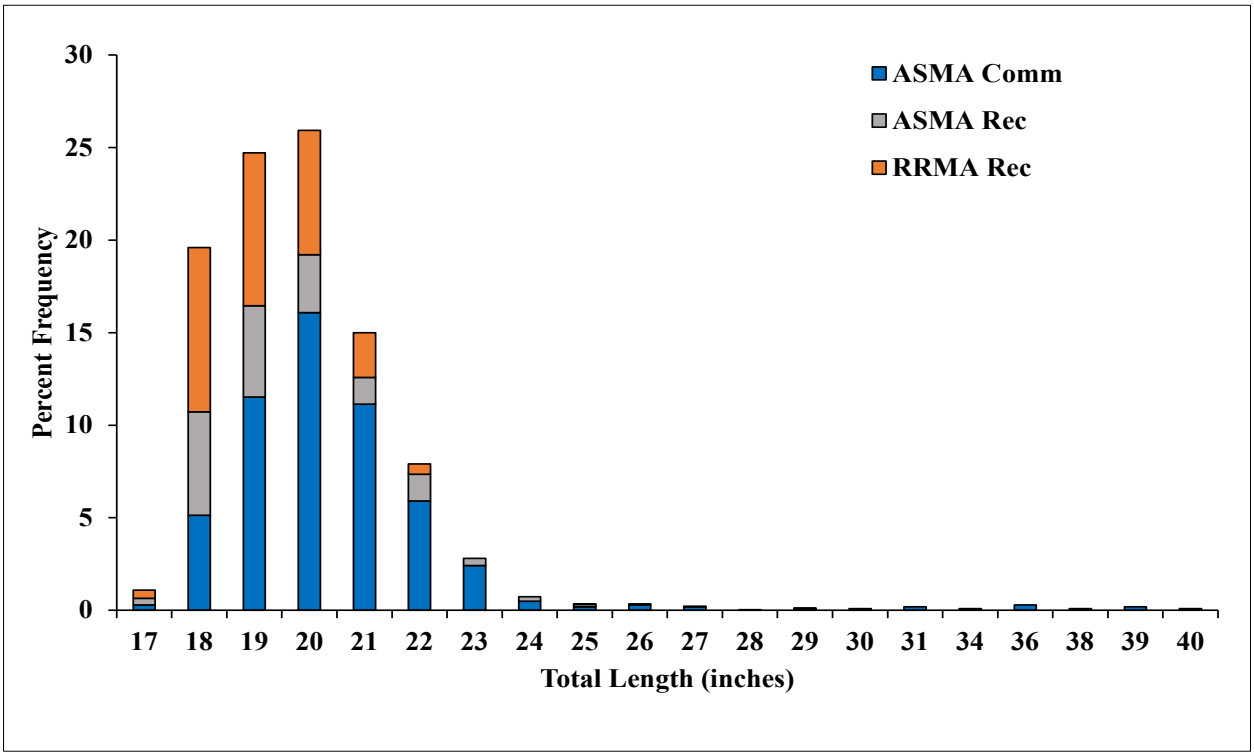
AR_Figure 1. Albemarle-Roanoke striped bass female spawning stock biomass and recruitment (abundance of age-1), 1982-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.



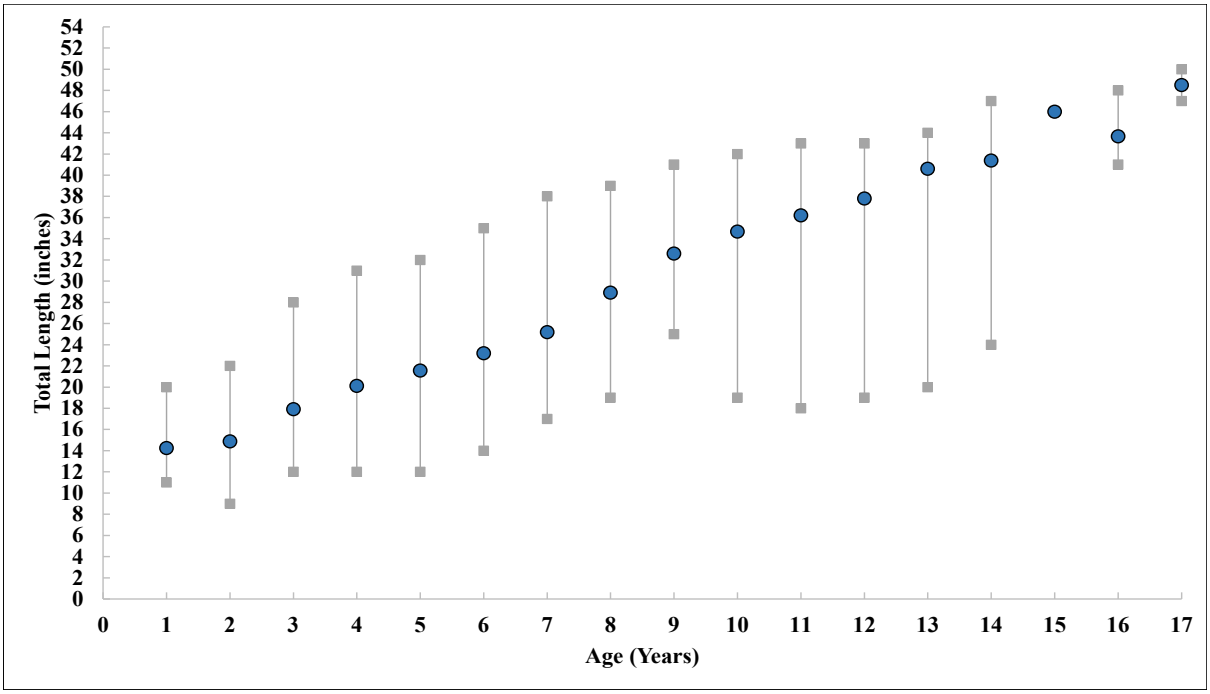
AR_Figure 2. Albemarle-Roanoke striped bass total stock abundance and fishing mortality, 1982-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.



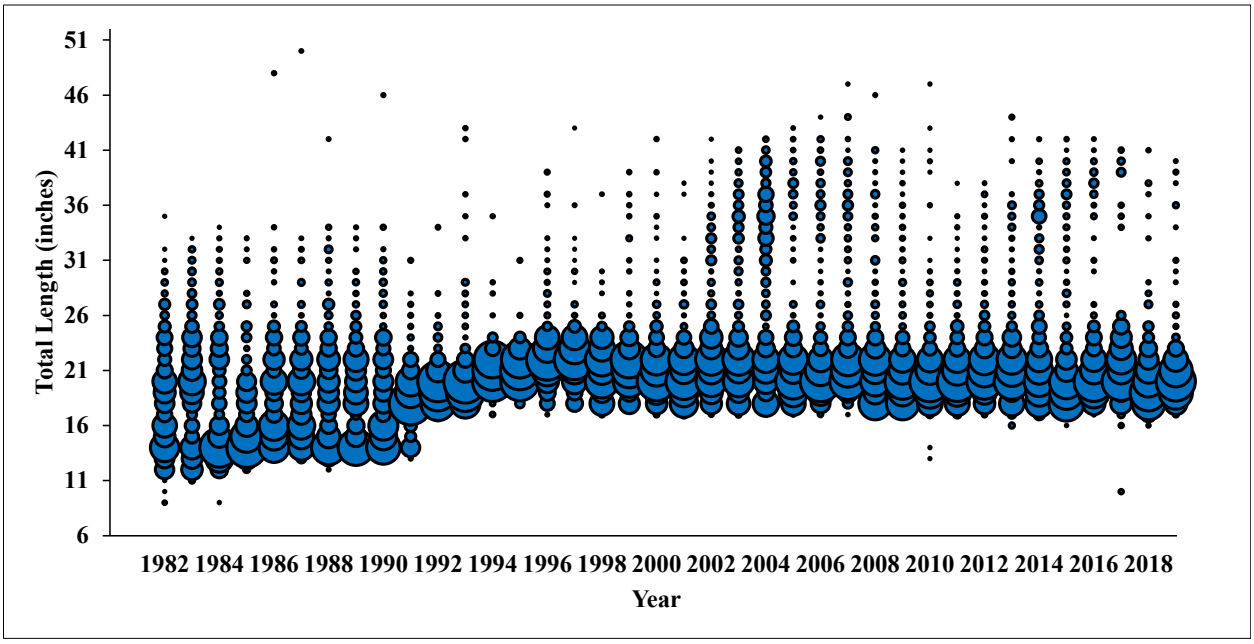
AR_Figure 3. ASMA Rec., ASMA Comm. and RRMA Rec. striped bass landings, NC, 1990-2019.



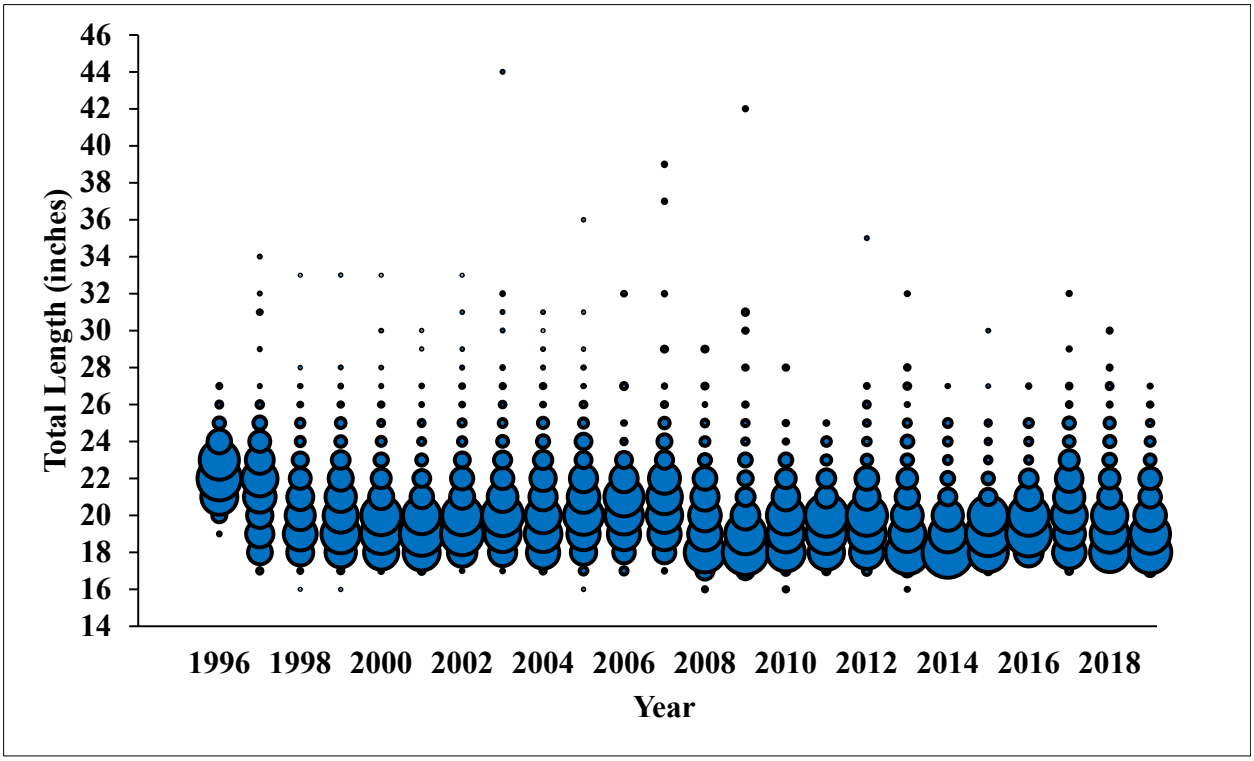
AR_Figure 4. ASMA Rec., ASMA Comm. and RRMA Rec. length frequency distribution from striped bass harvested in 2019.



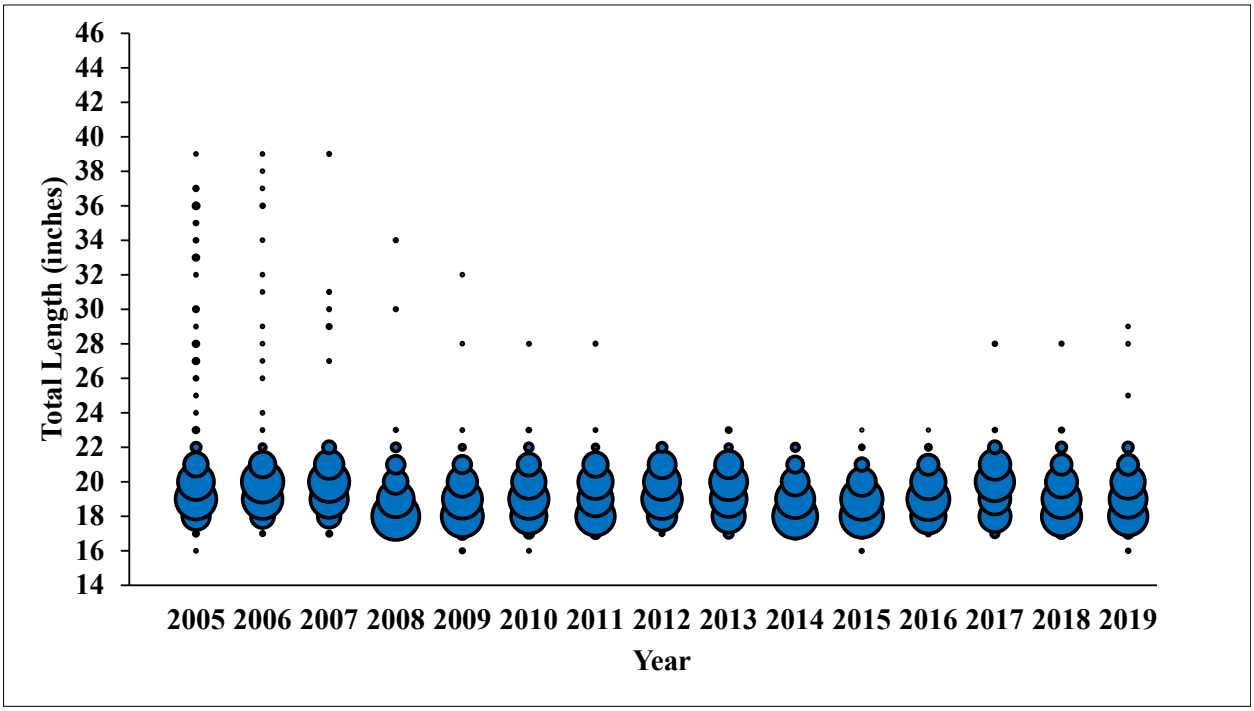
AR_Figure 5. Striped bass length at age based on all commercial samples collected from 1972 to 2019. Blue circles represent the mean size at a given age while the grey squares represent the minimum and maximum observed size for each age.



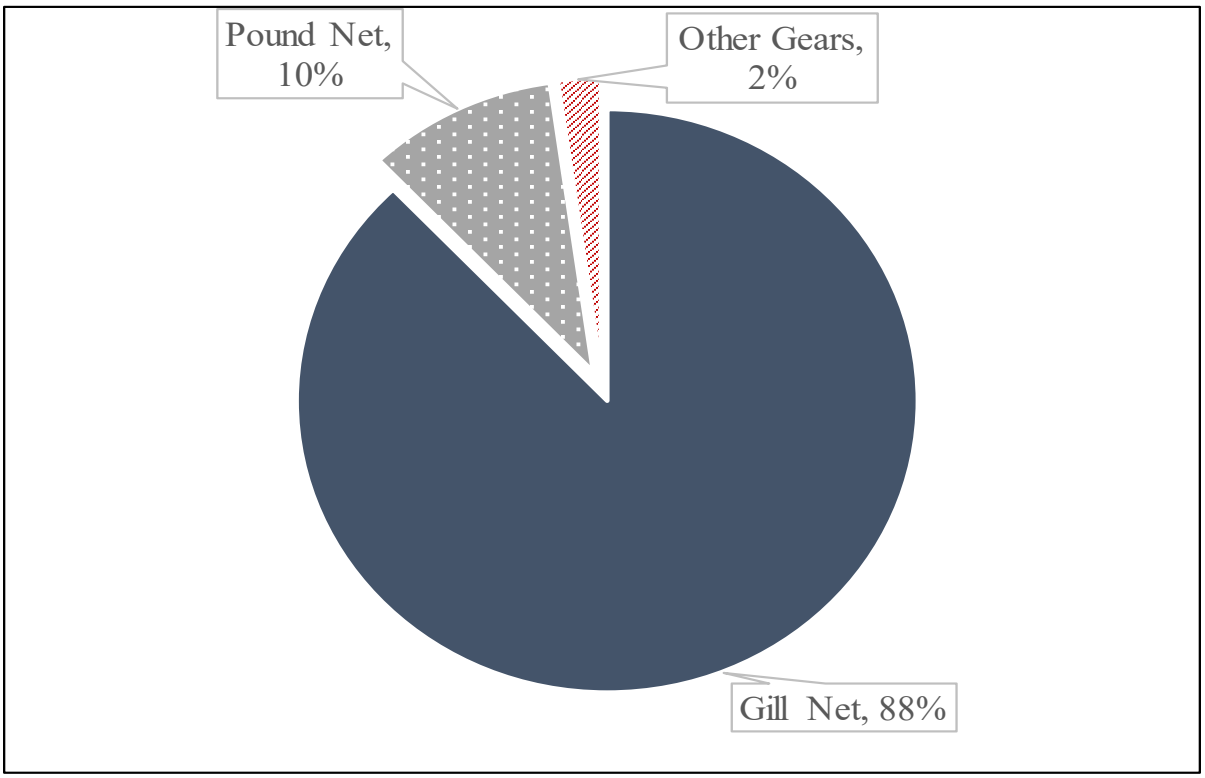
AR_Figure 6. Commercial length frequency (total length, inches) of striped bass harvested in the ASMA, NC, 1982 to 2019. Bubble size represents the proportion of fish at length.



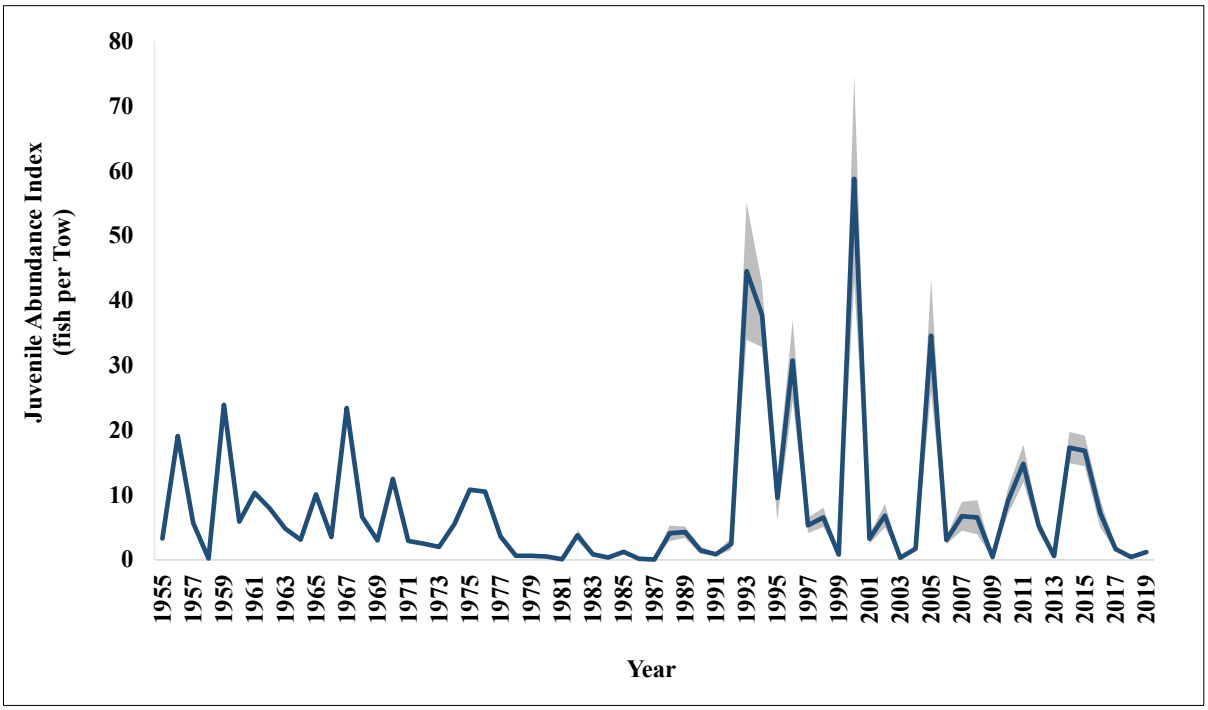
AR_Figure 7. Recreational length frequency (total length, inches) of striped bass harvested in the ASMA, NC, 1996-2019. Bubble size represents the proportion of fish at length.



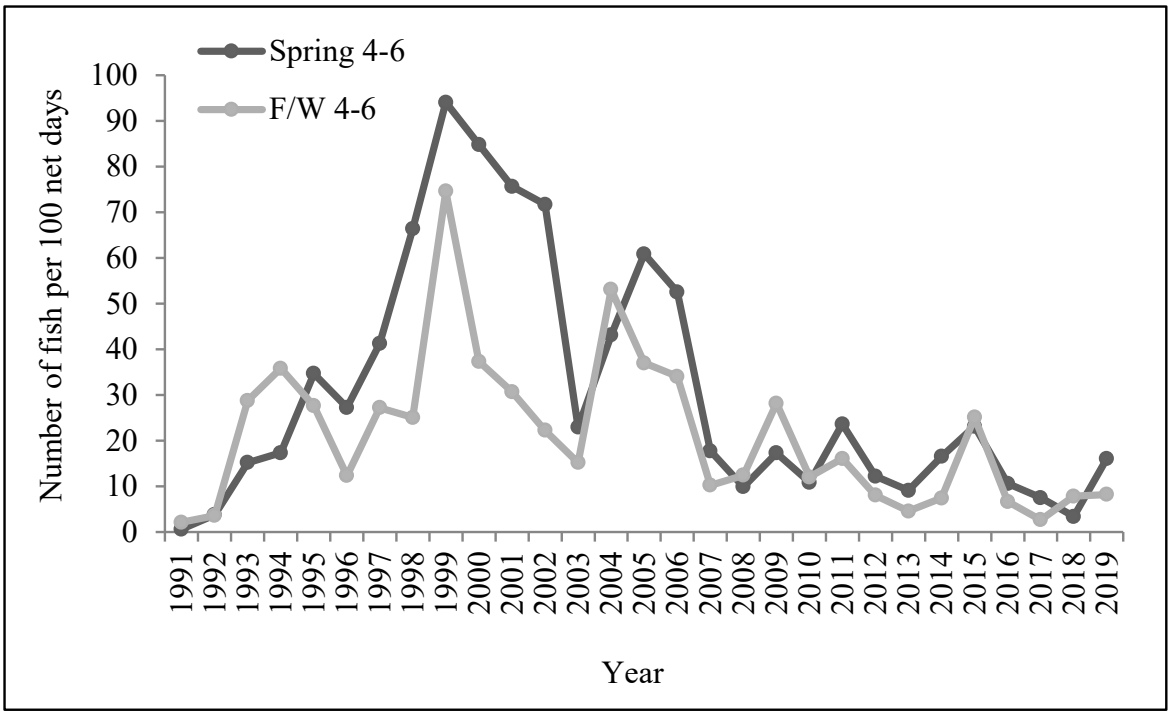
AR_Figure 8. Recreational length frequency (total length, inches) of striped bass harvested in the RRMA, NC, 2005-2019. Bubble size represents the proportion of fish at length.



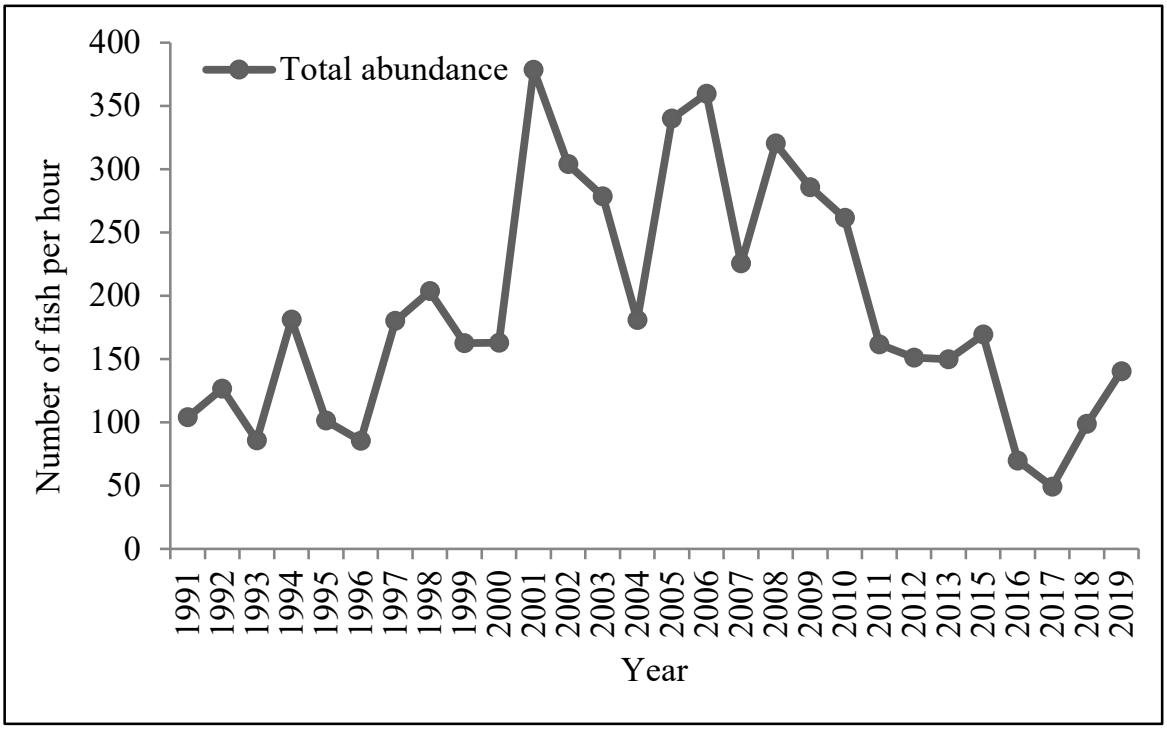
AR_Figure 9. Commercial striped bass landings broken out by major gears in the ASMA, NC, 1994-2019.



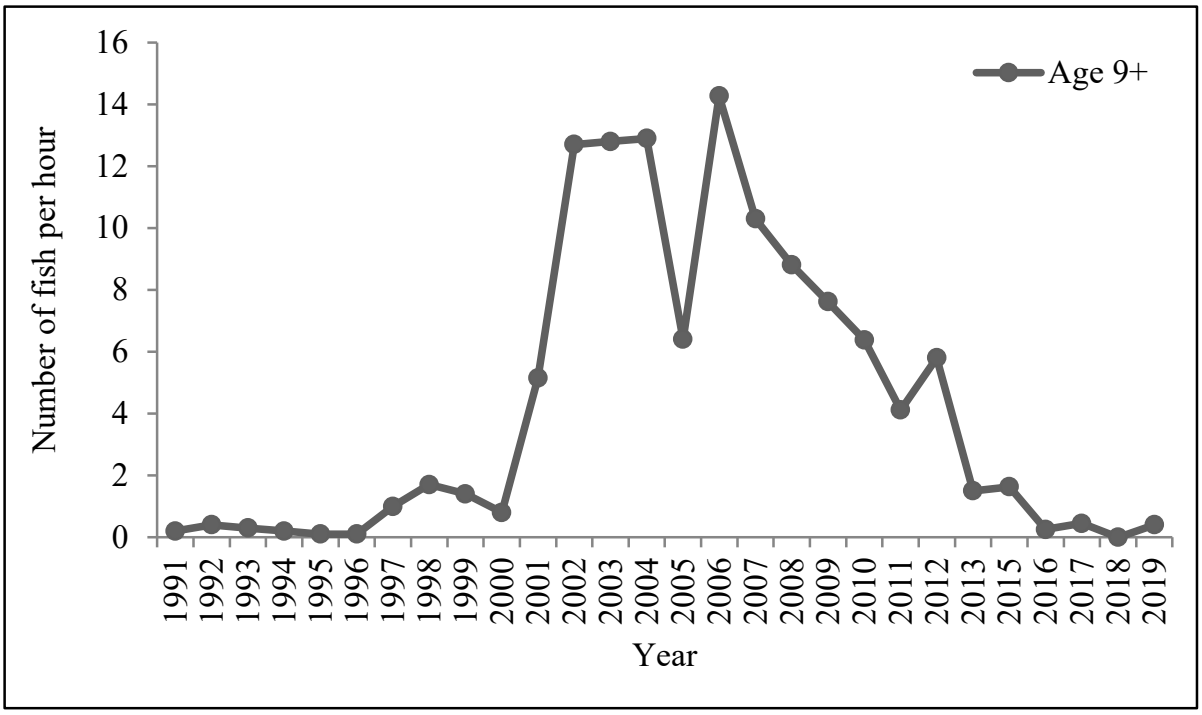
AR_Figure 10. Juvenile abundance index (JAI) of Albemarle-Roanoke striped bass from the NCDMF juvenile trawl survey, western Albemarle Sound, NC, 1955-2019.



AR_Figure 11. 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, 1991-2019.



AR_Figure 12. Relative abundance of Albemarle-Roanoke striped bass from the NCWRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991-2019.



AR_Figure 13. Relative abundance of age 9+ Albemarle-Roanoke striped bass from the NCWRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991-2019.

TABLES - Central-Southern (CS)

CS_Table 1. Striped bass length data (TL - inches) from CSMA commercial harvest, 2000-2019. 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. There was no commercial season in 2019.

	Tar-Pamlico/Pungo rivers					Neuse/Bay rivers				
	Length (mm)				% Hybrid Striped Bass in Samples	Length (mm)				% Hybrid Striped Bass in Samples
Year	Mean	Min	Max	N		Mean	Min	Max	N	
2000	23	20	35	126	1.6	25	22	31	5	0.0
2001	23	21	26	116	8.7	25	23	31	12	0.0
2002	24	19	39	96	31.4	25	19	29	31	0.0
2003	23	18	37	173	39.9	24	19	37	19	5.0
2004	24	20	42	131	34.2	25	19	37	74	1.3
2005	23	20	37	127	9.3	24	20	36	70	1.4
2006	22	18	37	119	17.4	24	19	36	144	0.7
2007	22	19	33	112	4.3	22	19	27	63	4.5
2008	22	18	43	84	4.5	23	19	44	39	0.0
2009	22	19	31	99	1.0	22	18	31	85	2.3
2010	22	19	26	194	4.4	23	19	32	263	4.0
2011	23	18	27	284	2.4	23	19	42	195	0.0
2012	24	15	30	254	9.6	24	19	29	96	1.0
2013	25	18	40	225	12.8	25	18	39	301	3.2
2014	22	18	39	52	89.7	24	20	38	56	47.7
2015	24	19	40	97	74.6	24	19	44	97	21.8
2016	24	17	29	257	29.2	23	19	28	78	14.3
2017	24	19	31	151	12.2	24	19	50	97	4.0
2018	23	19	32	76	5.0	24	18	38	163	2.4
2019	-	-	-	-	-	-	-	-	-	-

CS_Table 2. Striped bass length data (TL - inches) from CSMA recreational harvest, 2004-2019 (includes striped bass and hybrid striped bass). There was a limited recreational season in 2019, lasting from Jan 1 to March 19, 2019.

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
2018	19	16	29	155
2019	20	17	26	27

CS_Table 3. CSMA striped bass otolith and genetic age data from fishery dependent (commercial and recreational creel survey) and independent (independent gill net survey) surveys from the, 2004-2019. Otolith age data from 2019 are considered preliminary, genetic ages for 2019 are not currently available.

	Modal Age		Minimum Age		Maximum Age		Total Number Aged	
Year	otolith	genetic	otolith	genetic	otolith	genetic	otolith	genetic
2004	3	-	1	-	11	-	50	-
2005	2	-	1	-	9	-	78	-
2006	3	-	1	-	9	-	111	-
2007	3	-	1	-	9	-	86	-
2008	3	-	1	-	8	-	103	-
2009	4	-	1	-	6	-	37	-
2010	5	-	1	-	9	-	154	-
2011	3	-	2	-	6	-	56	-
2012	3	-	1	-	7	-	205	-
2013	3	-	1	-	8	-	156	-
2014	3	-	1	-	11	-	172	-
2015	3	-	1	-	9	-	113	-
2016	2	3	1	2	8	6	38	323
2017	2	4	1	1	9	7	98	247
2018	3	4	1	1	12	8	109	201
2019	4	*	1	*	11	*	307	*

CS_Table 4. Relative abundance of striped bass (number of individuals per sample), total number of striped bass collected, and the number of gill net samples (N) in the Tar-Pamlico and Neuse rivers (April, and October-November, shallow water sets (2004-2019). And in the Cape Fear and New rivers (February-December, all sets; 2008-2019) The Percent Standard Error (PSE) represents a measure of precision.

	Tar-Pamlico River				Neuse River				Cape Fear and New rivers			
Year	CPUE	No. of Striped Bass	N	PSE	CPUE	No. of Striped Bass	N	PSE	CPUE	No. of Striped Bass	N	PSE
2004	3.94	71	18	24	2.83	68	24	44	-	-	-	-
2005	4.61	83	18	17	3.75	90	24	42	-	-	-	-
2006	4.06	73	18	41	2.33	56	24	25	-	-	-	-
2007	3.56	64	18	49	2.83	68	24	28	-	-	-	-
2008	4.61	83	18	37	3.21	77	24	44	0.04	3	84	100
2009	2.78	50	18	36	2.13	51	24	41	0.03	3	119	67
2010	5.67	102	18	26	6.25	150	24	39	0.01	1	120	100
2011	7.72	139	18	32	4.75	114	24	30	0.04	4	120	50
2012	3.28	59	18	39	2.25	54	24	36	0.03	3	120	67
2013	3.22	58	18	36	2.54	61	24	31	0.02	2	120	50
2014	4.56	82	18	20	6.75	162	24	28	0	0	120	-
2015	2.67	48	18	33	5.33	128	24	27	0.14	15	120	36
2016	2.44	44	18	27	2.04	49	24	24	0.11	12	120	45
2017	2.44	44	18	29	3.21	77	24	24	0.08	9	120	50
2018	9.00	162	18	29	3.75	90	24	31	0.03	3	113	67
2019	5.06	91	18	33	4.21	101	24	32	0.01	1	120	100

CS_Table 5. Central-Southern management actions taken as a result of Amendment 1 to the North Carolina Estuarine Striped Bass FMP.

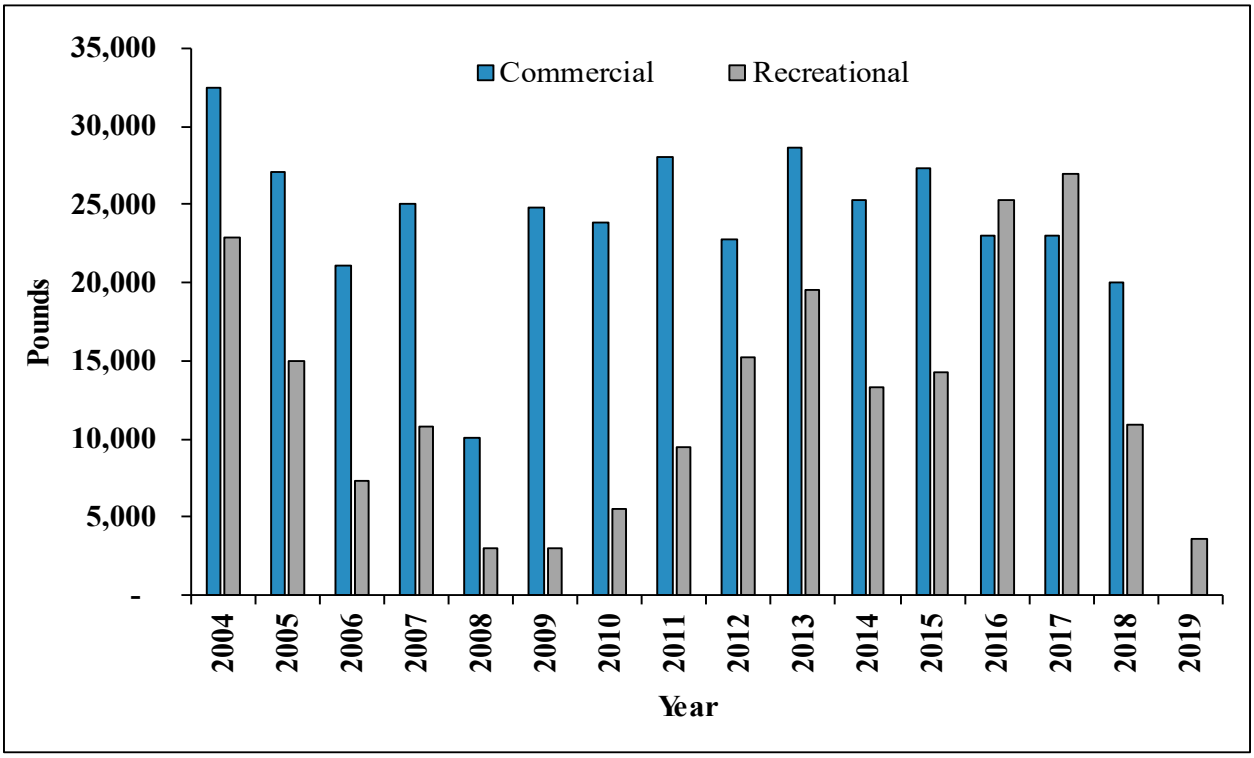
Management Strategy	Implementation Status
STRIPED BASS STOCKING (Coastal Rivers) Status quo and research needs – Goal of 100,000 Phase II striped bass stocked annually per CSMA system (Tar-Pamlico, Neuse, and Cape Fear) with 3,000 stocked fish tagged annually in each system.	No additional regulatory action required
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.	No additional regulatory action required
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.	Rule change 15A NCAC 03M .0201 and 03M .0202[1]
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 TAC[2].	No additional regulatory action required
Status Quo for CSMA management measures maintain the following:	
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	
CSMA Commercial Harvest (Coastal and Joint waters)	

CS_Table 5. Continued.

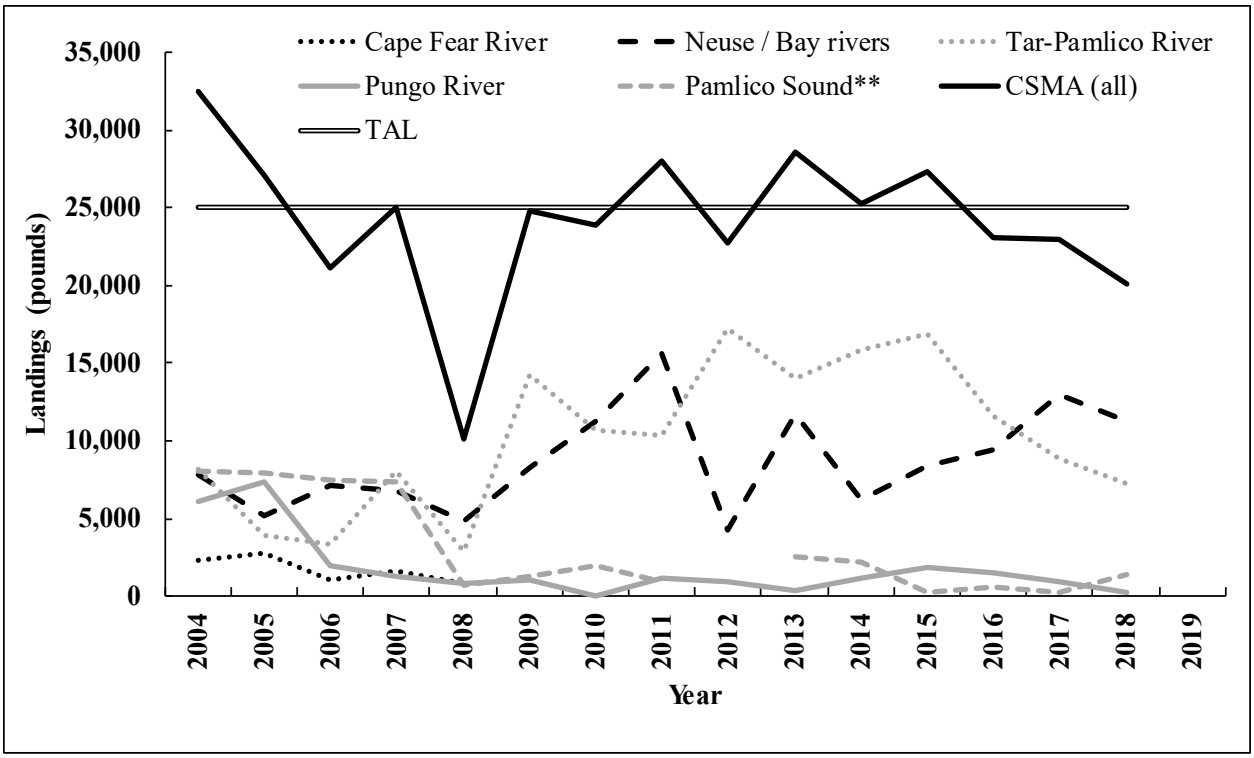
Management Strategy	Implementation Status

TAC[2] 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	
PROCLAMATION AUTHORITY For the ASMA, RRMA, and CSMA STRIPED BASS STOCKS: 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.	No additional regulatory action required

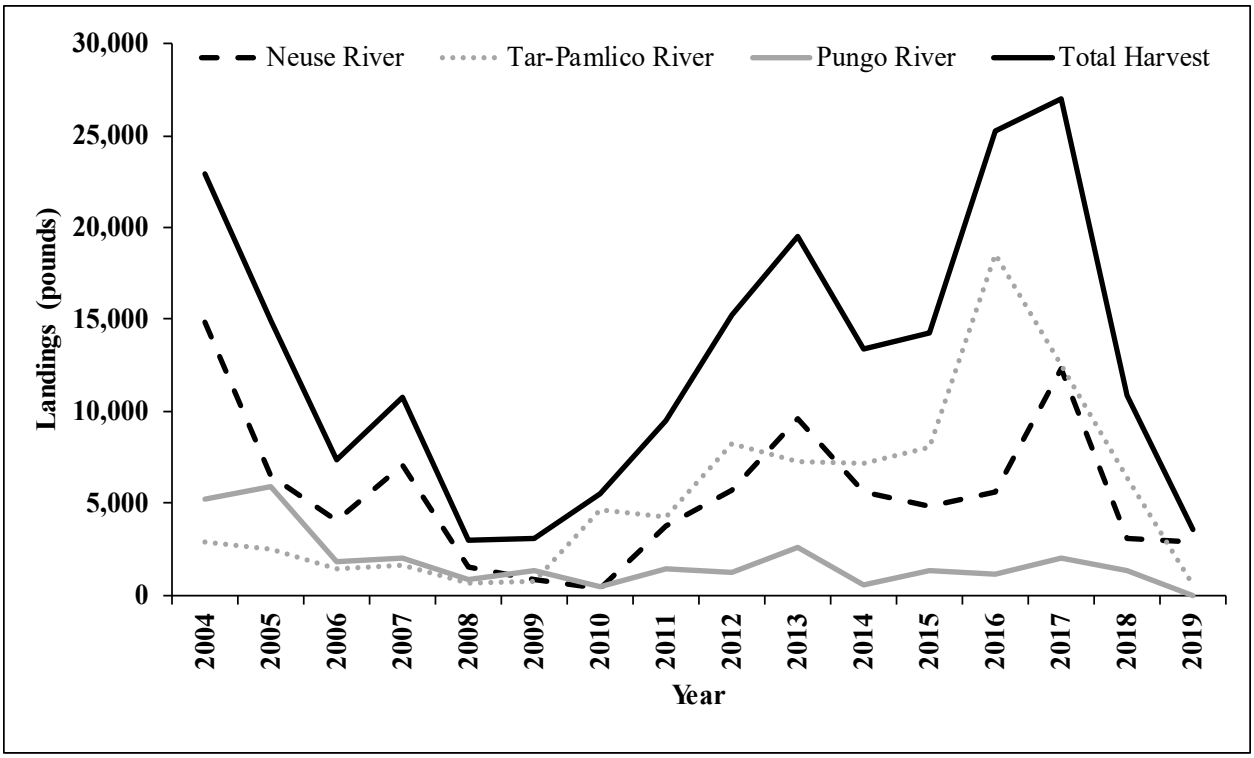
FIGURES - CS



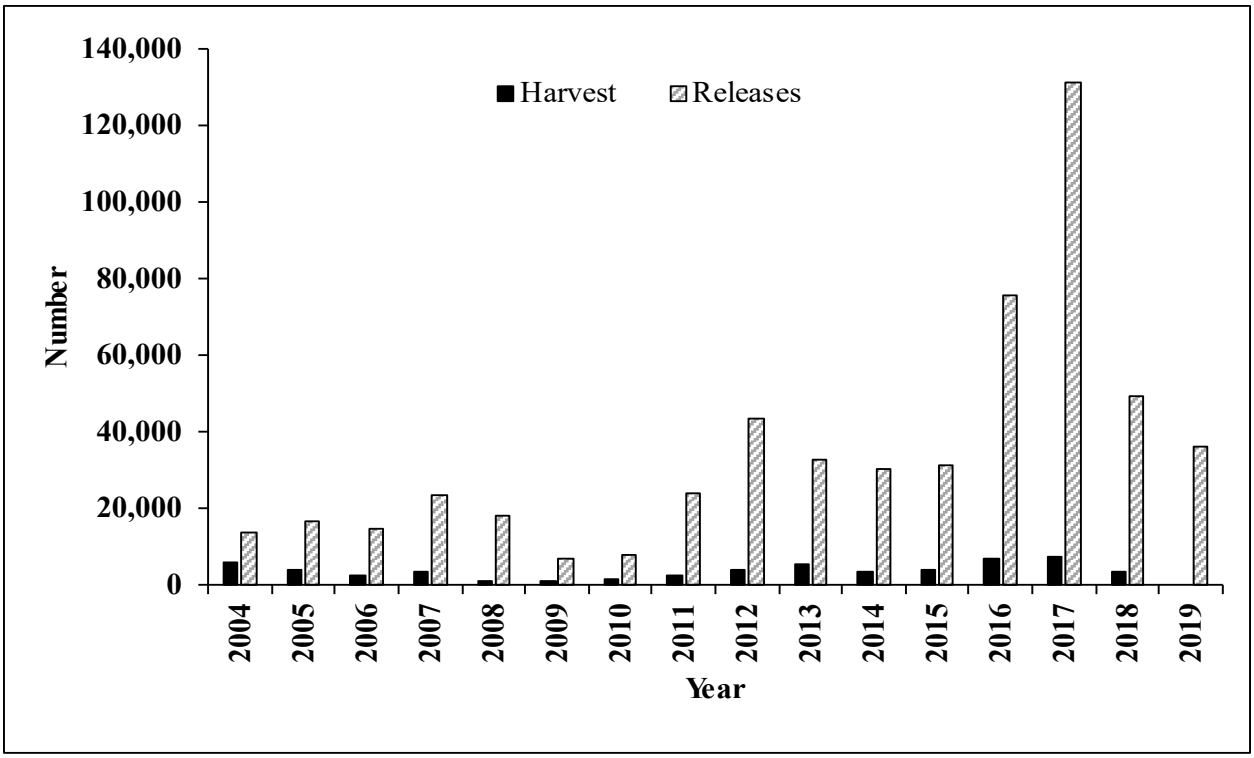
CS_Figure 1. Annual commercial and recreational CSMA striped bass harvest in pounds, 2004-2019. There was no commercial season and a limited recreational season in 2019, lasting from January 1 to March 19, 2019.



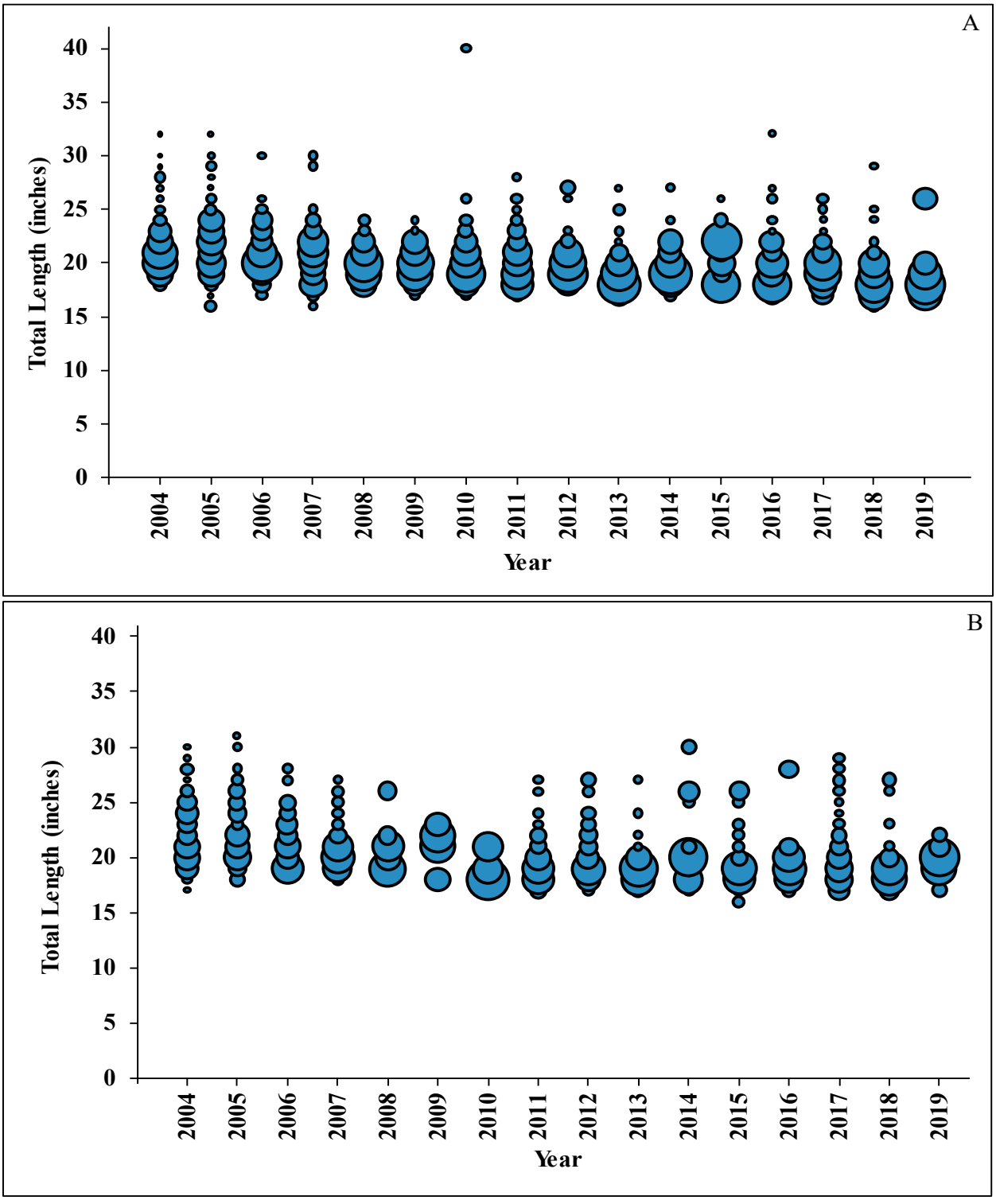
CS_Figure 2. Commercial striped bass harvest by system, and the TAL in the CSMA, 2004-2019. There has been a harvest moratorium in the Cape Fear River since 2009, and a closed season in the CSMA starting in 2019. Landings data for the Pamlico Sound in 2012 are confidential.



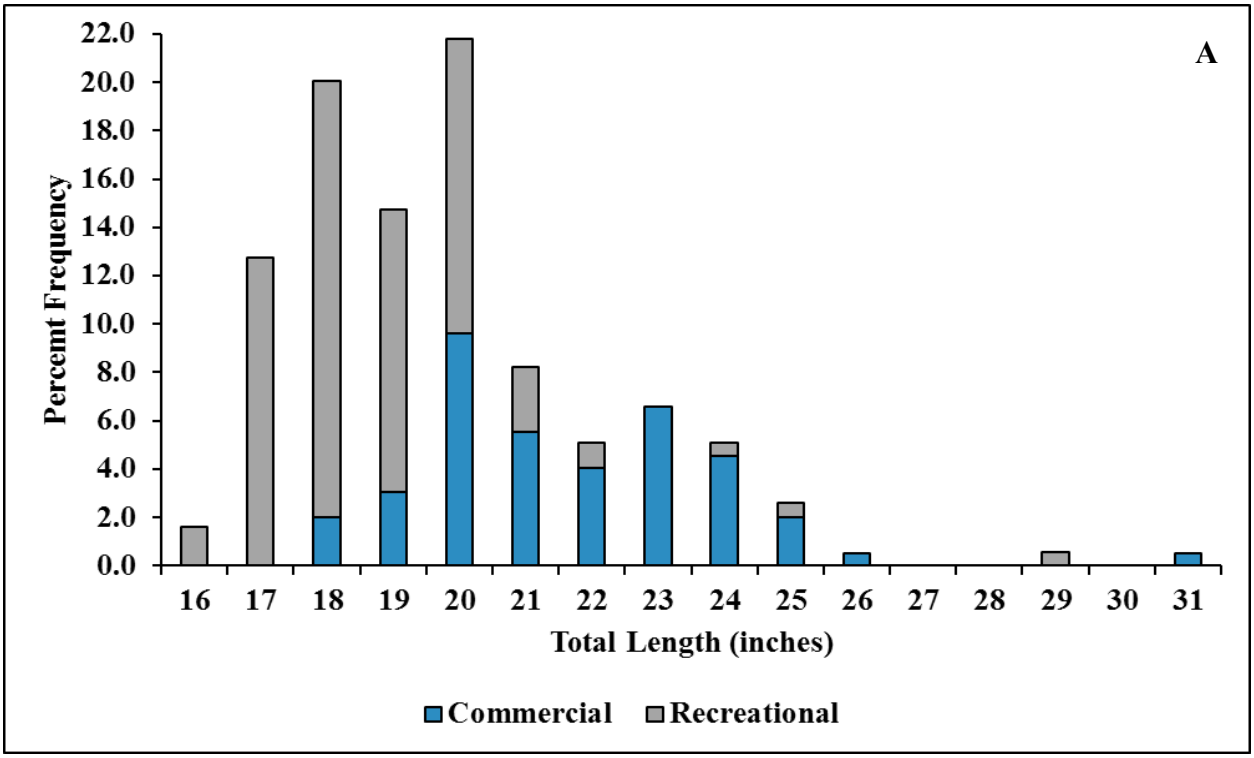
CS_Figure 3. Recreational striped bass harvest in the Tar-Pamlico, Pungo and Neuse rivers, 2004-2019. There was a limited recreational season in 2019, lasting from Jan 1-Mar 19, 2019).

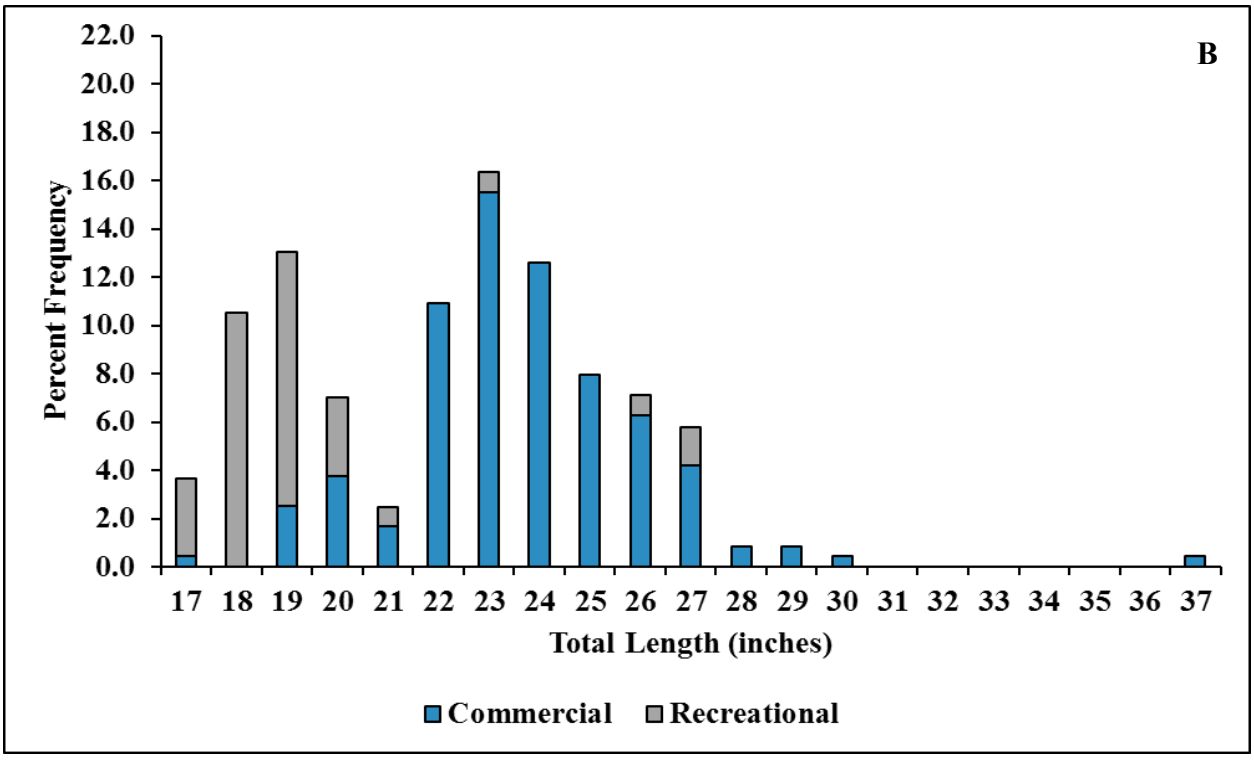


CS_Figure 4. Annual recreational catch (released and/or harvested) of striped bass in the CSMA, 2004-2019. There was a limited recreational season in 2019, lasting from Jan 1 to Mar 19, 2019.

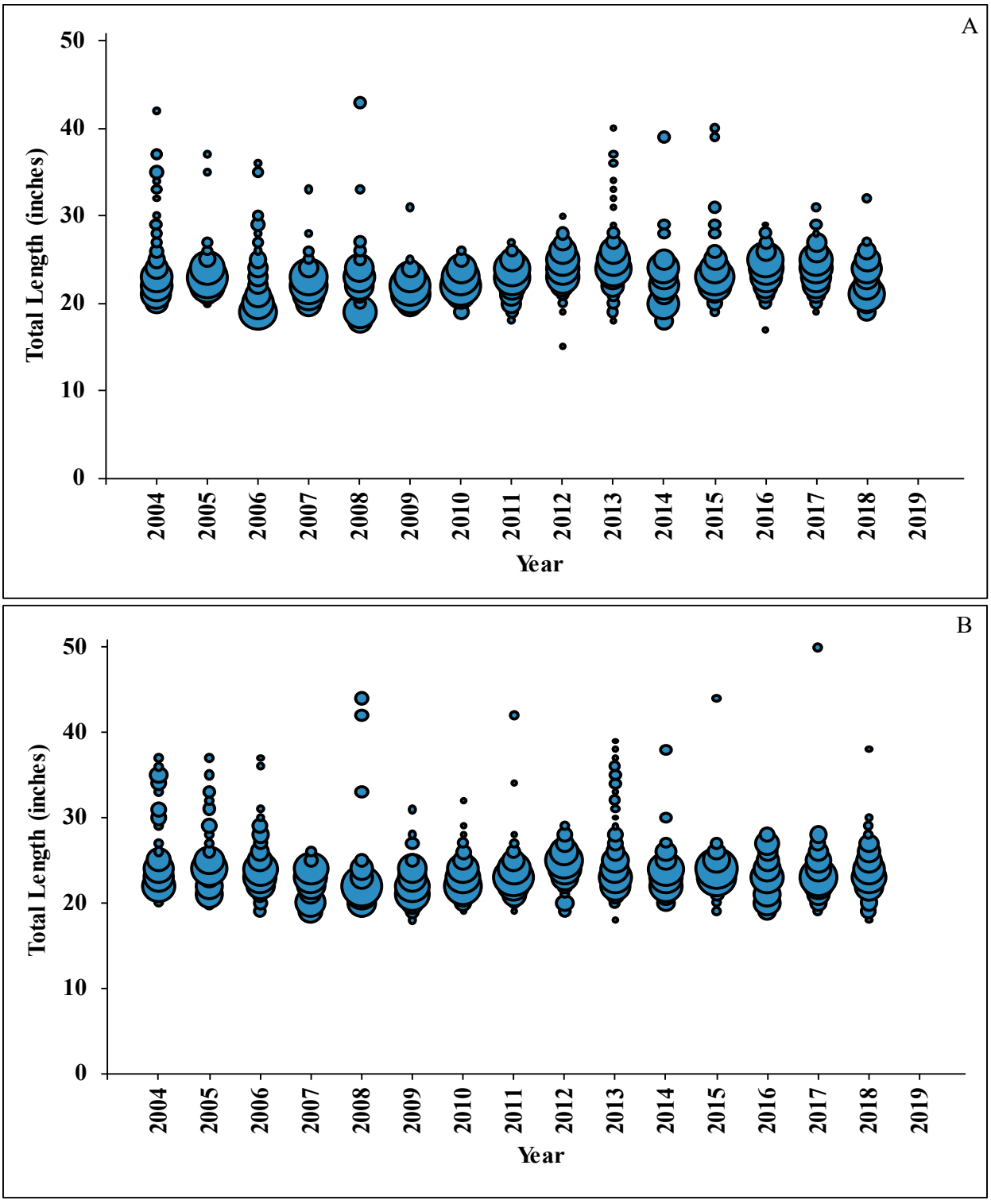


CS_Figure 5. Recreational length frequency of CSMA striped bass harvested in the Tar-Pamlico/Pungo rivers (A), and the Neuse River (B), 2004-2019. Bubble size represents the proportion of fish at length. There was a limited recreational season in 2019, lasting from Jan 1 to Mar 19, 2019.

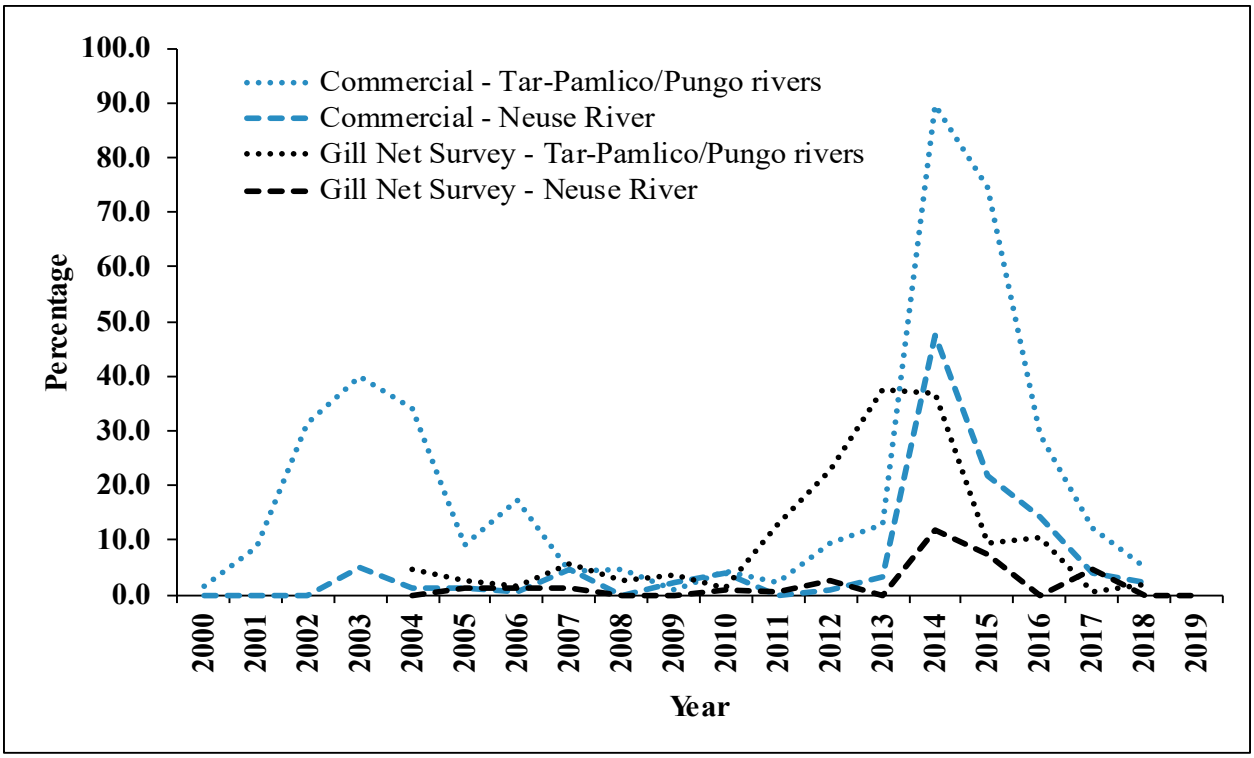




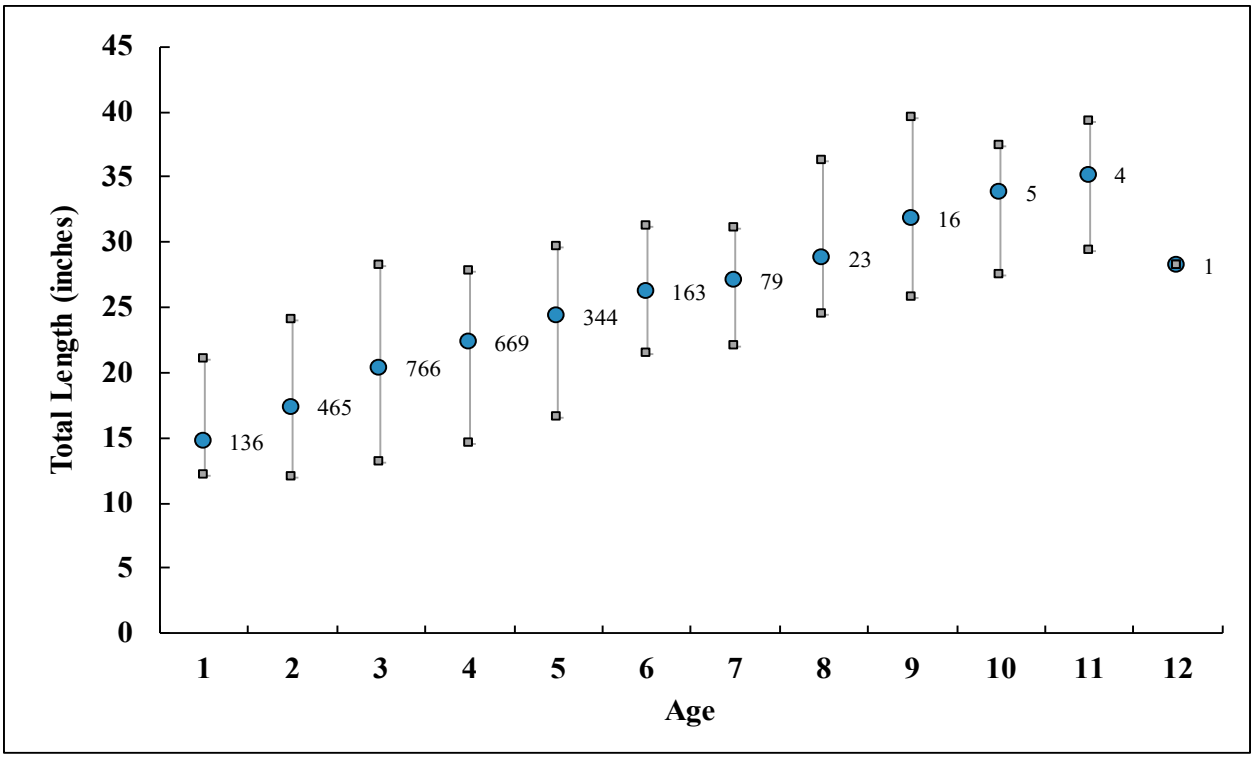
CS_Figure 6. Commercial and recreational length frequency distributions from CSMA striped bass harvested in 2018 from the Tar-Pamlico/Pungo rivers (A) and the Neuse/Bay rivers (B).



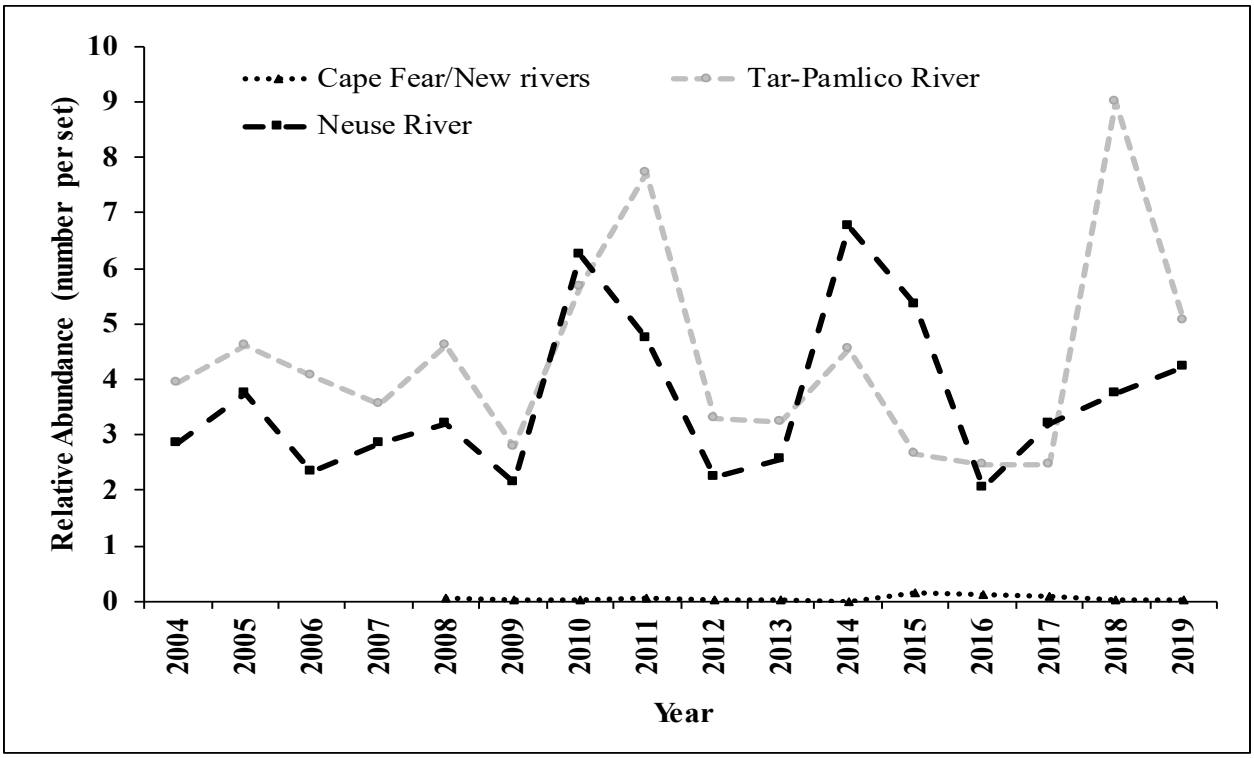
CS_Figure 7. Commercial length frequency of CSMA striped bass landed in the Tar-Pamlico/Pungo rivers (A), and the Neuse/Bay rivers (B) from 2004-2019. Bubble size represents the proportion of fish at length. There was no commercial season in 2019.



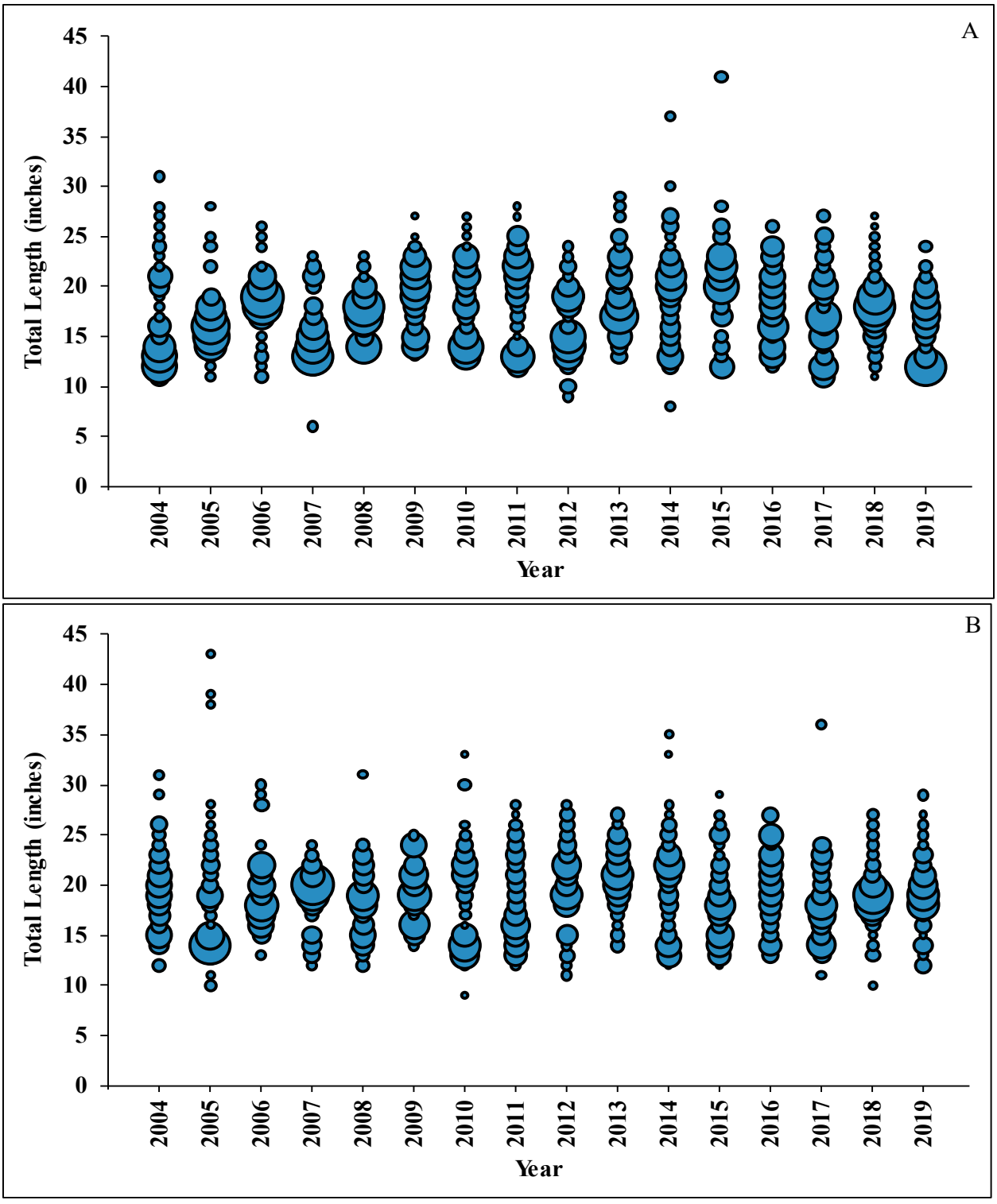
CS_Figure 8. Percentage of CSMA hybrid striped bass in commercial fish house samples (Tar-Pamlico/Pungo and Neuse/Bay rivers, 2000-2018; no commercial season in 2019) and in the Fisheries Independent Gill Net Survey (Tar-Pamlico and Neuse rivers, 2004-2019).



CS_Figure 9. CSMA striped bass length at age based on otolith and genetic age samples collected from 2004 to 2019. Blue circles represent the mean size at a given age with the number of samples. The grey squares represent the minimum and maximum observed size for each age. Otolith age data from 2019 are considered preliminary, genetic ages from 2019 are not currently available.



CS_Figure 10. Annual indices of adult abundance of CSMA striped bass in the Fisheries Independent Gill Net Survey (P915) for the Tar-Pamlico and Neuse rivers during April, and October-November, in shallow water sets (2004-2019) and the Cape Fear/New rivers (2008-2019).



CS_Figure 11. Length frequency of CSMA striped bass captured in the Fisheries Independent Gill Net Survey (P915) in the Tar-Pamlico River (A), and the Neuse River (B) during April, and October-November, in shallow water sets (2004-2019). Bubble size represents the proportion of fish at length.