

**North Carolina
Division of Marine Fisheries**

2017 Fishery Management Plan Review

August 2018



INTRODUCTION

The Fishery Management Plan Review is a compilation of annual updates about state-managed, federally-managed, and Atlantic States Marine Fisheries Commission-managed species for which there are fishery management plans for North Carolina. The updates are based on data through the previous calendar year and the document is presented to the Marine Fisheries Commission at its annual August business meeting.

The Fishery Management Plan Review is an invaluable reference document and a resource for information about the latest status of fisheries occurring in North Carolina. The document is organized into two primary sections: state-managed species and Atlantic States Marine Fisheries Commission and federally-managed species. The latter section is further divided into species with and without North Carolina indices. If a species has a North Carolina index, it means there is North Carolina data that the federal Councils or Atlantic States Marine Fisheries Commission used in its respective plans.

There are currently 13 state fishery management plans, 12 of which are updated annually and included in this document. The remaining plan is the North Carolina Fishery Management Plan for Interjurisdictional Fisheries. This plan adopts by reference management measures appropriate for North Carolina contained in approved federal Council or Atlantic States Marine Fisheries Commission fishery management plans.

These management measures are implemented by Marine Fisheries Commission rules to provide compliance or consistency with the approved plans and amendments. The goals of these plans, established under the Magnuson-Stevens Fishery Conservation and Management Act (federal Councils plans) and the Atlantic Coastal Fisheries Cooperative Management Act (Atlantic States Marine Fisheries Commission plans), are similar to the goals of the North Carolina Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries. The state interjurisdictional plan reduces duplication of effort while meeting the requirements of North Carolina General Statute 113-182.1, Fishery Management Plans.

Each update in the Fishery Management Plan Review contains information about the:

- History of the plan;
- Management unit;
- Goal and objectives;
- Status of the stock;
- Status of the fishery, including current regulations and commercial and recreational landings;
- Monitoring program data, including dependent and independent monitoring;
- Management strategy;
- Management and research needs; and
- Recommendation on the timing for the next review of state plans.

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STATE-MANAGED SPECIES – BAY SCALLOP

FISHERY MANAGEMENT PLAN UPDATE BAY SCALLOP AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | November 2007 |
| Amendments: | Amendment 1 – November 2010 Amendment 2 – February 2015 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | July 2005 – Began the original FMP a year earlier than planned due to concerns of limited abundance |
| Next Benchmark Review: | July 2020 |

The N.C. Bay Scallop Fishery Management Plan (FMP) was adopted in November 2007. The FMP implemented prohibited take from 2006 to 2008 until an independent sampling indicator was established for re-opening in 2009. Amendment 1 of the Bay Scallop FMP was finalized in November 2010 to provide more flexibility (Adaptive Management) to open the fisheries as the bay scallop population recovers. Target indices were established from fishery independent data collected before a red tide (toxic dinoflagellate) event of late autumn 1987 and early 1988 in Core, Back, and Bogue sounds that decimated the fishery. A separate sampling indicator for re-opening was developed in 2009 for Pamlico Sound. Amendment 2, adopted in February 2015, continues to use the abundance thresholds for opening the harvest season and defining the harvest levels for all areas, except areas south of Bogue Sound. Areas south of Bogue Sound will not be managed with a specific abundance opening level, but will be opened or remain closed based on North Carolina Division of Marine Fisheries (NCDMF) evaluation of sampling results in this region. Expanded sampling is to occur in all areas including areas south of Bogue Sound and improve the reliability of the data for the recreational scallop harvest. For private culture and enhancement, the current management strategy is to modify rules for bottom culture and aquaculture operations to be consistent with rules for other shellfish species. The Shellfish Research Hatchery in Wilmington, N.C. will establish a pilot program to distribute cultured bay scallop seed on private bottom, and depending on the results potentially expand the pilot program to include enhancement for public bottom.

STATE-MANAGED SPECIES – BAY SCALLOP

Life History

Bay scallops (*Argopecten irradians*) are estuarine-dependent, filter feeding shellfish found in seagrass beds. Bay scallops are hermaphroditic (produce both sex cells), and they mature and spawn within their first year. Their lifespan is 12 to 26 months. In North Carolina, bay scallops spawn mostly from August through January and again in March through May. The larvae go through several swimming stages before attaching to a suitable surface such as a blade of seagrass. Upon reaching a size of approximately 1 inch, bay scallops drop to the bottom. Although other structures can be used for attachment, bay scallops use seagrass beds almost exclusively, and are highly dependent on this habitat for successful recruitment. Predators of bay scallops include cownose rays, blue crabs, starfish, whelks and sea birds.

Management Unit

Includes the bay scallop (*Argopecten irradians*) and its fisheries in all waters of coastal North Carolina.

Goal and Objectives

The goal of the North Carolina Bay Scallop Fishery Management Plan (FMP) is to implement a management strategy that restores the stock, maintains sustainable harvest, maximizes the social and economic value, and considers the needs of all user groups. To achieve this goal, it is recommended that the following objectives be met:

1. Develop an objective management program that restores and maintains sustainable harvest.
2. Promote the protection, restoration, and enhancement of habitats and water quality necessary for enhancing the fishery resource.
3. Identify, enhance, and initiate studies to increase our understanding of bay scallop biology, predator/prey relationships, and population dynamics in North Carolina.
4. Investigate methods for protecting and enhancing the spawning stock.
5. Investigate methods and implications of bay scallop aquaculture.
6. Address social and economic concerns of all user groups.
7. Promote public awareness regarding the status and management of the North Carolina bay scallop stock.

STATUS OF THE STOCK

Stock Status

There are insufficient data to conduct a traditional stock assessment for bay scallop in North Carolina. Bay scallop in North Carolina are a species of concern because of population declines, caused by previous red tide events and the additive impacts from environmental factors and predation. Annual commercial landings of bay scallops show large fluctuations through time and are presumed to be driven by changing climate conditions (i.e., winter freezes, high freshwater runoff), predation, and red tide. Bay scallops are vulnerable to overharvest because of the multiple factors affecting their survival.

STATE-MANAGED SPECIES – BAY SCALLOP

Stock Assessment

Independent data on bay scallop have been collected by the NCDMF since 1975, and consistently collected since 1998 to evaluate recruitment into the population and recruitment into the fishery for the current fishing season. Analyses of these data have demonstrated trends between NCDMF independent data and landings data from the following year. The long term landings data (1972-2005) most likely reflected population abundance because harvest was allowed to continue until scallop densities reached levels below those that make the fishing economically viable (Peterson and Summerson 1992). However, during 2006 and after the implementation of the 2007 Bay Scallop FMP, a prohibited take on harvest went into effect to rebuild the stock and until a standardized catch per unit effort measure could be determined (NCDMF 2007). Therefore, using landings data is no longer an effective tool to indicate population size.

Data on scallop abundance from fishery independent sampling are evaluated annually and standardized scallop population level indicators were first established as progressive triggers for opening the harvest season in Amendment 1 of the Bay Scallop FMP in 2010 (NCDMF 2010). These triggers are based on NCDMF sampling that occurred between the pre-red tide months of October and December in 1984 and 1985 for Back, Bogue, and Core sounds and in post-red tide January 2009 in Pamlico Sound (Table 1). This time period for estimating abundance makes the most sense since it is less likely for the two year-classes to be selecting to the sampling gear. Areas south of Bogue Sound will not be managed with a specific abundance opening level, but will be opened or remain closed based on NCDMF evaluation of sampling results in this region (NCDMF 2015). These progressive triggers allow for flexibility to open the fisheries as the bay scallop population recovers and determines harvest limits based on 50 percent, 75 percent, and 125 percent of the natural log of the Catch Per Unit Effort ($\ln\text{CPUE}$) target (Tables 2 and 3).

Fishery independent sampling shows that most tows have small or zero catch, while only a few samples exhibit large catches producing a lognormal distribution, which is usual for most fishery independent data. The natural log (\ln) of the catch per unit effort ($\ln\text{CPUE}$), measured as the number of scallops per minute (using dredges) and number of scallops per meter squared (using a square-meter quadrat), is taken to avoid bias towards occasional large catches. A constant of 0.1 was added to all catches so that tows/quadrats with zero catches can be included in the estimates of the mean since the natural log of zero is undefined. All tows/quadrats taken at a station are averaged to get a single value for each station and are referred to as a sample. This is done to avoid weighting some tows/quadrats to each station more than others because the number of tows/quadrats was not always consistent in duration. Each sample is averaged to get the estimated mean $\ln\text{CPUE}$ and standard deviation for the October-December time period for all areas to produce indices of abundance.

Trends in the past 10 years show bay scallop abundance is very low in all regions, which is also reflected in landings when harvest is opened (Figures 1, 2, and 3). Since the inception of the harvest opening index of abundance, the season has only opened during three years in specific regions, and at the lowest allowed harvest levels. Two of the three open harvest seasons saw very little catch (Figure 4). Expanding the sampling coverage or number of stations in all areas is

STATE-MANAGED SPECIES – BAY SCALLOP

recommended in Amendment 2 of the FMP to improve estimates of bay scallop abundance. As bay scallop abundances expand and retract from year to year, broader sampling coverage of these areas will help identify more precisely what is happening to the population before entering the harvest season.

STATUS OF THE FISHERY

Current Regulations

The North Carolina Marine Fisheries Commission (NCMFC) adopted an adaptive management strategy to open waters to bay scallop harvest with specific progressive triggers for Bogue, Core, Back, and Pamlico sounds (Table 1). Areas south of Bogue Sound will not be managed with a specific abundance opening level, but will be opened or remain closed based on NCDMF evaluation of sampling results in this region. Expanded sampling is to occur in all areas including areas south of Bogue Sound and improve the reliability of the data for the recreational scallop harvest. The triggers allow limited harvest when NCDMF sampling indicates bay scallop abundance in a given region is at 50 percent of the target. Trip limits and fishing days for commercial harvest will progressively increase if sampling showed bay scallop abundance was at 75 percent and 125 percent of the target levels established within each region (Table 2). Recreational daily harvest limits and open days remain the same at all abundance levels (Table 3).

The season can only occur from the last Monday in January through April 1st and there is no minimum size limit for both the commercial and recreational user groups. Specific trip limits, number of days to harvest, and specific gear allowances are implemented within the open season. Both the opening of the season and the harvest restrictions within the open season are based on NCDMF fishery independent sampling abundance levels determining the levels of harvest (NCDMF 2015). There was no open harvest season for bay scallops in 2017 because abundance levels were too low to meet the threshold for opening the season.

Commercial Landings

Bay scallop abundance and harvest have widely fluctuated since landings have been recorded (MacKenzie 2008). Landings are closely linked to weather and other environmental factors. Landings ranged from a peak of approximately 1.4 million pounds of meats in 1928 when North Carolina led the nation in scallop production, to a low of zero landings in 2005 even though there was an open harvest season. Landings have been virtually non-existent since 2005.

The red tide (toxic dinoflagellate) event of late autumn 1987 and early 1988 caused mortality to approximately 21 percent of the adult scallops in Bogue and Back sounds and reduced recruitment of juvenile scallops the following spring to only two percent of normal (the mean of the previous three red tide-free years) (Summerson and Peterson 1990). This event has had lasting impacts to the bay scallop fishery and repopulation of the Bogue, Back, and Core sound regions has not fully occurred. Landings in recent years have been extremely low due to the failure of scallop stocks to recover after the red tide event, fishing pressure, and predation.

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A prohibited take on harvest occurred from 2006 to 2008 through the 2005 FMP (NCDMF 2007). Amendment 1 initiated abundance estimates to determine opening the fishery and at what levels harvest would occur based on the abundance estimates by region (NCDMF 2010). An open harvest commercial and recreational harvest season occurred in Core and Pamlico sounds in 2009, and in Pamlico Sound in 2010 (less than 500 pounds of meat were landed commercially) (Figure 4). Bogue Sound and all areas south of Bogue Sound were opened to harvest to the NC/SC state line in internal waters in 2014 (less than 1,500 pounds of meat were landed commercially) (Figure 4).

Recreational Landings

The recreational harvest of bay scallop in North Carolina does not require a fishing license, and due to this the total amount of recreational landings cannot be estimated and remains unknown.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

There are no fishery dependent sampling programs that collect information on the commercial or recreational fisheries for bay scallops.

Fishery-Independent Monitoring

Independent sampling of bay scallops for fisheries management information has been conducted since 1975, and has varied from monthly examinations at 20 stations to seasonal monitoring at fewer locations.

Currently sampling occurs four times a year in Pamlico, Core, Back, Bogue sounds and areas south of Bogue Sound during the second or third week of the month in January, April, July, and October. Standardized sampling occurs in Pamlico Sound using a meter-square (m^2) quadrat and a bay scallop dredge is towed in Core, Back, and Bogue sounds, and areas south of Bogue Sound. A fixed set of eight stations are towed three times for two minutes with a scallop dredge in Core, Back, and Bogue sounds and additional stations are also sampled three times for two minutes where scallops have historically been found. The fixed stations were selected based on historical information from the sampling program (Program 697) of traditionally abundant areas in Core, Bogue, and Back sounds. A set of three fixed stations, two in New River and one in Topsail Sound, are towed three times for two minutes with a scallop dredge beginning in 2009 in areas south of Bogue Sound. Stations were selected in New River and Topsail Sound based on scouting the areas for scallops and input from fishermen and the public that use the waters regularly. Sampling also occurs at five fixed stations and five non-core stations off Hatteras Island. Scallops are collected with a rake or by hand for 10 m^2 samples within the station in Pamlico Sound. The PVC m^2 quadrat is randomly placed 10 separate times within the area. Catch per unit effort (CPUE) is defined as the number of scallops (juvenile and adult combined) per one-minute tow if a dredge is used or per quadrat. Additional stations (non-fixed) are sampled in most areas dependent on scallop abundance at the given time of year.

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Most tows/quadrats have small or zero catch, while only a few samples exhibit large catches producing a lognormal distribution, which is usual for most fishery independent data. The natural log (ln) of the catch per unit effort (lnCPUE), measured as the number of scallops per minute (dredges) and number of scallops per meter squared (quadrat), is taken to avoid bias towards occasional large catches. A constant of 0.1 was added to all catches so that tows/quadrats with zero catches can be included in the estimates of the mean since the natural log of zero is undefined. All tows/quadrats taken at a station are averaged to get a single value for each station and are referred to as a sample. This is done to avoid weighting some tows/quadrats to each station more than others because the number of tows/quadrats was not always consistent in duration historically. Each sample is averaged to get the estimated mean lnCPUE and standard deviation for the October-December time period for all areas to produce indices of abundance (Figures 1 and 2).

Expanding the sampling coverage or number of stations in all areas is recommended in Amendment 2 of the FMP to improve estimates of bay scallop abundance. As bay scallop abundances expand and retract from year to year, broader sampling coverage of these areas will help identify more precisely what is happening to the population before entering the harvest season. Trends in the past 10 years show bay scallop abundance is very low in all regions which is also a reflection in limited open areas to harvest in the past decade (Table 4; Figure 1).

MANAGEMENT STRATEGY

The current management strategy for the bay scallop fisheries is to allow the NCDMF Director to open a region to limited bay scallop harvest when sampling indicates bay scallop abundance is at 50 percent of the natural logarithm of the Catch Per Unit Effort (lnCPUE) level it was in 1984-1985 in the main harvest areas (Core, Bogue and Back sounds) (Table 1). A separate sampling indicator for re-opening was developed in 2009 for Pamlico Sound (Table 1). Trip limits and fishing days will progressively increase if sampling shows bay scallop abundance is at 75 percent or 125 percent of 1984-85 lnCPUE levels (Tables 2 and 3). The open season may only occur from the last Monday in January through April 1 to ensure spawning is complete and the economic yield is at an optimum for fishermen. Improving data collection on the biology, harvest, environment, enhancement, and socioeconomic aspects relative to bay scallops is recommended throughout Amendment 2 to provide more comprehensive information for assisting in future management decisions. See Table 5 for current management strategies and the status on the implementation of each.

Bay scallop abundance is still quite low (Figure 1, 2, and 3). Harvest openings have only occurred three times since the initiation of the original FMP which was scheduled one year earlier in development due to concern for the stocks.

RESEARCH NEEDS

The list below is presented in order as it appears in Amendment 2 of the Bay Scallop FMP and the section or issue paper they come from is identified. Prioritization of each research recommendation is designated either a HIGH, MEDIUM, or LOW standing. A low ranking does not infer a lack of importance but is either already being addressed by others or provides limited

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information for aiding in management decisions. A high ranking indicates there is a substantial need, which may be time sensitive in nature, to provide information to help with management decisions.

Proper management of the bay scallop resource cannot occur until some of these research needs are met, the research recommendations include:

- Develop better methods to quantify the population including the means to have more precise measures of spatial and temporal variability at both within and between Sound scales – HIGH (Expanded number of stations sampled by region)
- Collect information on larval recruitment and spat settlement – LOW (Incomplete)
- Genetically identify how many separate bay scallop stocks exist in North Carolina – MEDIUM (Ongoing work through UNCW Shellfish Hatchery)
- Examine the effects of scallop culture and oyster cultch on seagrass density – MEDIUM (Incomplete)
- Perform socioeconomic surveys on commercial participants to determine specific business characteristics, the economics of working in the fishery, which issues are important to the participants, attitudes towards management of the fishery and general demographic information – LOW (Incomplete; No open seasons since FMP adopted)
- Determine a method to collect socioeconomic information on processors – LOW (Incomplete; No open seasons since FMP adopted)
- Collect information on the economic impact and value of the recreational bay scallop fishery – MEDIUM (Incomplete; No open seasons since FMP adopted)
- Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to the bay scallop for enhancement or conservation purposes – LOW (Ongoing; Several SAV enhancement projects have been completed or are ongoing)
- Develop techniques to enhance SAV habitat to promote scallop survival – LOW (Ongoing; Several SAV enhancement projects have been completed or are ongoing)
- Conduct research to evaluate the role of shell hash and shell bottom in bay scallop recruitment and survival, particularly where SAV is absent – LOW (Incomplete)
- Determine the concentrations of EDCs in known bay scallop habitats and impacts on bay scallops – LOW (Incomplete)
- Assess the impacts of nutrient loading and algae on SAV and the life history of bay scallops – MEDIUM (Incomplete)
- Determine levels of TSS, turbidity, chlorophyll *a*, and other parameters necessary to achieve desired water clarity and investigate the feasibility of a water quality standard for light attenuation required for SAV growth - LOW (Incomplete)
- Complete a more comprehensive study on treading and impacts of treading on juvenile and adult bay scallops - HIGH (Incomplete)
- Survey fishermen that use a commercial license for personal consumption – LOW (Incomplete; No open seasons since FMP adopted)
- Collect more information on the value of the spring spawn to the population – MEDIUM (Incomplete)

STATE-MANAGED SPECIES – BAY SCALLOP

FISHERY MANAGEMENT PLAN RECOMMENDATION

Recommend maintaining the current timing of the Benchmark Review. Amendment 2 of the N.C. Bay Scallop FMP was adopted in February 2015 with rule changes in effect May 1, 2015. Suggested statute change to G.S. 113-168.4 is also part of Amendment 2 with the intention to take this suggested change to legislators at their next short session, otherwise leaseholders who wish to grow out bay scallops reared in an aquaculture operation cannot acquire them without this change.

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TABLES

Table 1. Target and progressive triggers based on the lnCPUE (natural log of the number of scallops per 1-minute tow) for the October – December 1984-1985 time period for Back, Bogue, and Core sounds. Target and progressive triggers based on the lnCPUE (natural log of the number of scallops per meter squared) for Pamlico Sound based on sampling in January 2009.

| | Pamlico Sound | Core Sound | Back Sound | Bogue Sound |
|-------------------------|---------------|------------|------------|-------------|
| Target lnCPUE | -0.18 | 1.72 | 2.02 | 2.33 |
| Progressive trigger 50% | -0.27 | 0.86 | 1.01 | 1.17 |
| Progressive trigger 75% | -0.23 | 1.29 | 1.52 | 1.75 |
| Progressive trigger | -0.14 | 2.15 | 2.53 | 2.91 |

Table 2. Adaptive management measures for opening the bay scallop commercial fishery as the selected management strategy of the Marine Fisheries Commission. The harvest levels are based on progressive triggers derived from the lnCPUE1984-1985 (Oct-Dec) target indicators for Core, Bogue and Back sounds and the lnCPUEJan 2009 target indicator for Pamlico Sound.

| Progressive triggers and target | Trip limit | Days open in the week | Allowed gears | Season |
|---|--|--------------------------|---|--|
| Less than 50% of target | No allowed harvest | | | |
| 50% or greater of target but less than 75% of target | 5 bushels per person per day not to exceed 10 bushels per fishing operation | Mon and Wed | By hand, hand rakes, hand tongs, dip net, and scoops | Last Monday in January to April 1st |
| 75% or greater of target but less than 125% of target | 10 bushels per person per day not to exceed 20 bushels per fishing operation | Mon, Tues, Wed, and Thur | By hand, hand rakes, hand tongs, dip net, and scoops | Last Monday in January to April 1st |
| | 10 bushels per person per day not to exceed 20 bushels per fishing operation | Mon and Wed | Bay scallop dredges as described by rule 15A NCAC 03K .0503 | Delay opening until first full week in March after hand harvest removes scallops from shallow waters to April 1st |
| 125% or greater of target | 15 bushels per person per day not to exceed 30 bushels per fishing operation | Mon, Tues, Wed, and Thur | By hand, hand rakes, hand tongs, dip net, and scoops | Last Monday in January to April 1st |
| | 15 bushels per person per day not to exceed 30 bushels per fishing operation | Mon and Wed | Bay scallop dredges as described by rule 15A NCAC 03K .0503 | Delay opening until the third full week in February after hand harvest removes scallops from shallow waters to April 1st |

STATE-MANAGED SPECIES – BAY SCALLOP

Table 3. Adaptive management measures for opening the bay scallop recreational fishery as the selected management strategy by the Marine Fisheries Commission. The harvest levels are based on progressive triggers derived from the lnCPUE1984-1985 (Oct-Dec) target indicators for Core, Bogue and Back sounds and the lnCPUEJan 2009 target indicator for Pamlico Sound.

| Progressive triggers and target | Trip limit | Days open in week | Allowed gears | Season |
|---|--|----------------------|---|---|
| Less than 50% of target 50% or greater of target | No allowed harvest 1/2 bushel per person per day not to exceed 1 bushel per recreational fishing operation | Seven days a week | By hand, hand rakes, hand tongs, dip net, and scoops | Last Monday in January to April 1st |

Table 4. Fishery Independent sampling annual lnCPUE and standard error. Pamlico Sound sampling is conducted in January with a m² quadrat, all other areas are sampled in October with a scallop dredge.

| Year | Pamlico Sound | | Core Sound | | Back Sound | | Bogue Sound | | South | |
|------|---------------|----------------|------------|----------------|------------|----------------|-------------|----------------|---------|----------------|
| | LnCPUE | Standard Error | lnCPUE | Standard Error | lnCPUE | Standard Error | lnCPUE | Standard Error | lnCPUE | Standard Error |
| 2006 | | | -2.3026 | 0.0000 | -1.5419 | 0.4975 | -1.0241 | 0.3366 | | |
| 2007 | | | -1.2432 | 0.4958 | -2.0040 | 0.2986 | -1.5685 | 0.3366 | | |
| 2008 | | | 2.9378 | 0.3485 | -1.4067 | 0.4006 | 1.2051 | 0.5700 | | |
| 2009 | -0.1766 | 0.7908 | -1.0071 | 0.4207 | -1.3057 | 0.4549 | 1.3421 | 0.2676 | 0.9372 | 0.7512 |
| 2010 | 0.3238 | 0.6701 | -0.5450 | 0.3887 | -1.1036 | 0.5362 | -1.1168 | 0.5366 | -2.3026 | 0.0000 |
| 2011 | -1.9941 | 0.1273 | -0.6323 | 0.5705 | 0.8260 | 0.2581 | 0.3793 | 0.3429 | -1.7652 | 0.3704 |
| 2012 | -1.6620 | 0.2626 | -1.7053 | 0.3777 | -0.5607 | 0.7793 | 1.1833 | 0.2450 | -0.9060 | 0.3599 |
| 2013 | -1.2115 | 0.1091 | -2.3026 | 0.0000 | -2.3026 | 0.0000 | -0.4116 | 0.7131 | -1.1949 | 0.4186 |
| 2014 | -1.5395 | 0.3130 | -2.0040 | 0.2986 | -1.0071 | 0.4207 | -2.0040 | 0.2013 | -1.6380 | 0.3374 |
| 2015 | -1.8590 | 0.3865 | -2.1427 | 0.1599 | -2.0637 | 0.1628 | -1.7992 | 0.1906 | -1.6885 | 0.1552 |
| 2016 | -2.2946 | 0.0080 | -1.9329 | 0.2519 | -1.9442 | 0.1915 | -1.8681 | 0.1630 | -2.0040 | 0.2013 |
| 2017 | -2.3026 | 0.0000 | -2.1831 | 0.1195 | -1.5455 | 0.2507 | -1.9708 | 0.1365 | -0.7480 | 0.2623 |
| 2018 | -2.2147 | 0.0787 | | | | | | | | |

STATE-MANAGED SPECIES – BAY SCALLOP

Table 5. Summary of the management strategies and their implementation status from Amendment 2 of the Bay Scallop Fishery Management Plan.

| Management Strategy | Implementation Status |
|---|--|
| ENVIRONMENTAL CONCERNS | |
| <i>Status quo</i> (manage fishing gear based on scallop densities) | No action required |
| Continue to support CHPP recommendations that enhance protection of existing bay scallop habitat | No action required; Already support the CHPP |
| Support programs that enhance bay scallop habitat by planting sea grass or other suitable settlement substrate | No action required; Already support the CHPP |
| Identify and designate SHAs that will enhance protection of the bay scallop | Ongoing through CHPP implementation plan |
| Remap and monitor SAV coverage in North Carolina to assess distribution and change over time. | Ongoing through CHPP implementation plan |
| Restore coastal wetlands to compensate for previous losses and enhance water quality conditions for the bay scallop | Ongoing through CHPP implementation plan |
| Work with CRC to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening | Ongoing through CHPP implementation plan |
| Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to SAV and other fish habitats | Ongoing through CHPP implementation plan |
| Evaluate dock criteria siting and construction to determine if existing requirements are adequate for SAV survival and growth, and modify if necessary | Ongoing through CHPP implementation plan |
| Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts | Ongoing through CHPP implementation plan |
| Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary | Ongoing through CHPP implementation plan |
| Accelerate and complete mapping of all shell bottom in coastal North Carolina | Ongoing through CHPP implementation plan |
| Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry | Ongoing through CHPP implementation plan |
| Reduce impervious surfaces and increase on-site infiltration of storm water through voluntary or regulatory measures | Ongoing through CHPP implementation plan |
| Provide more incentives for low-impact development | Ongoing through CHPP implementation plan |
| Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading | Ongoing through CHPP implementation plan |
| Aggressively reduce point and non-point nutrient and sediment loading in estuarine waters, to levels that will sustain SAV habitat, using regulatory and non-regulatory actions | Ongoing through CHPP implementation plan |
| ENVIRONMENTAL CONCERNS | |
| Provide proper disposal of unwanted drugs, reduce insecticide and heavy metal run-off, and develop technologies to treat wastewater for antibiotics and hormones | Ongoing through CHPP implementation plan |
| Discourage use of detergents in coastal waters, especially detergents with antimicrobial components | Ongoing through CHPP implementation plan |
| INSUFFICIENT DATA | |
| Support improving the reliability of the data for the recreational scallop harvest | Incomplete |
| MANAGEMENT | |

STATE-MANAGED SPECIES – BAY SCALLOP

| Management Strategy | Implementation Status |
|---|--|
| Eliminate the August 1 through September 15 season open period in rule | Rule change required to 15A NCAC 03K .0501; Rule change completed on May 1, 2015 |
| Expand sampling in all regions and manage harvest conditionally in areas south of Bogue Sound until adequate sampling can determine a harvest trigger for management. | Existing authority |
| Continue current progressive triggers with adaptive harvest levels in all areas, except areas south of Bogue Sound, and modify harvest management measures as shown in Table 12.7 and Table 12.8 in the issue paper. And continue to improve the statistical rigor of the abundance index. | Existing proclamation authority |
| Keep dredges at the 75% trigger harvest level in Table 12.7 | Existing proclamation authority |
| Modify the daily commercial harvest possession limit in Rule 15A NCAC 03K .0501 to a quantity of no more than 15 standard U.S. bushels per person per day not to exceed 30 standard U.S. bushels in any combined commercial fishing operation per day to be consistent with the adaptive management measures trip limits. | Requires rule change to rule 15A NCAC 03K .0501; Rule change completed on May 1, 2015 |
| Exempt bay scallop harvest from leases from the regular season and harvest limits | Requires rule change to rules 15A NCAC 03K .0111, 03K .0206, 03K .0303, 03K .0501, 03K .0502, 03K .0507, 03K .0508, 03O .0501; Rule changes completed on May 1, 2015 |
| Support an exemption from G.S. 113-168.4 (b) (3) when the sale is to lease or Aquaculture Operations permit holders for further rearing | Requires statutory change to G.S. 113-168.4; NCDMF will take this suggested change to legislators at the next short session. |
| STOCK ENHANCEMENT | |
| Establish a pilot program with the Shellfish Research Hatchery to distribute cultured seed on private bottoms | Will need to start communicating with Shellfish Hatchery staff and interested private culturists interested in establishing this pilot work |
| Contingent on results to distribute seed on private bottom, expand the pilot program to include public bottom | Dependent on results from previous management strategy. |

STATE-MANAGED SPECIES – BAY SCALLOP

FIGURES

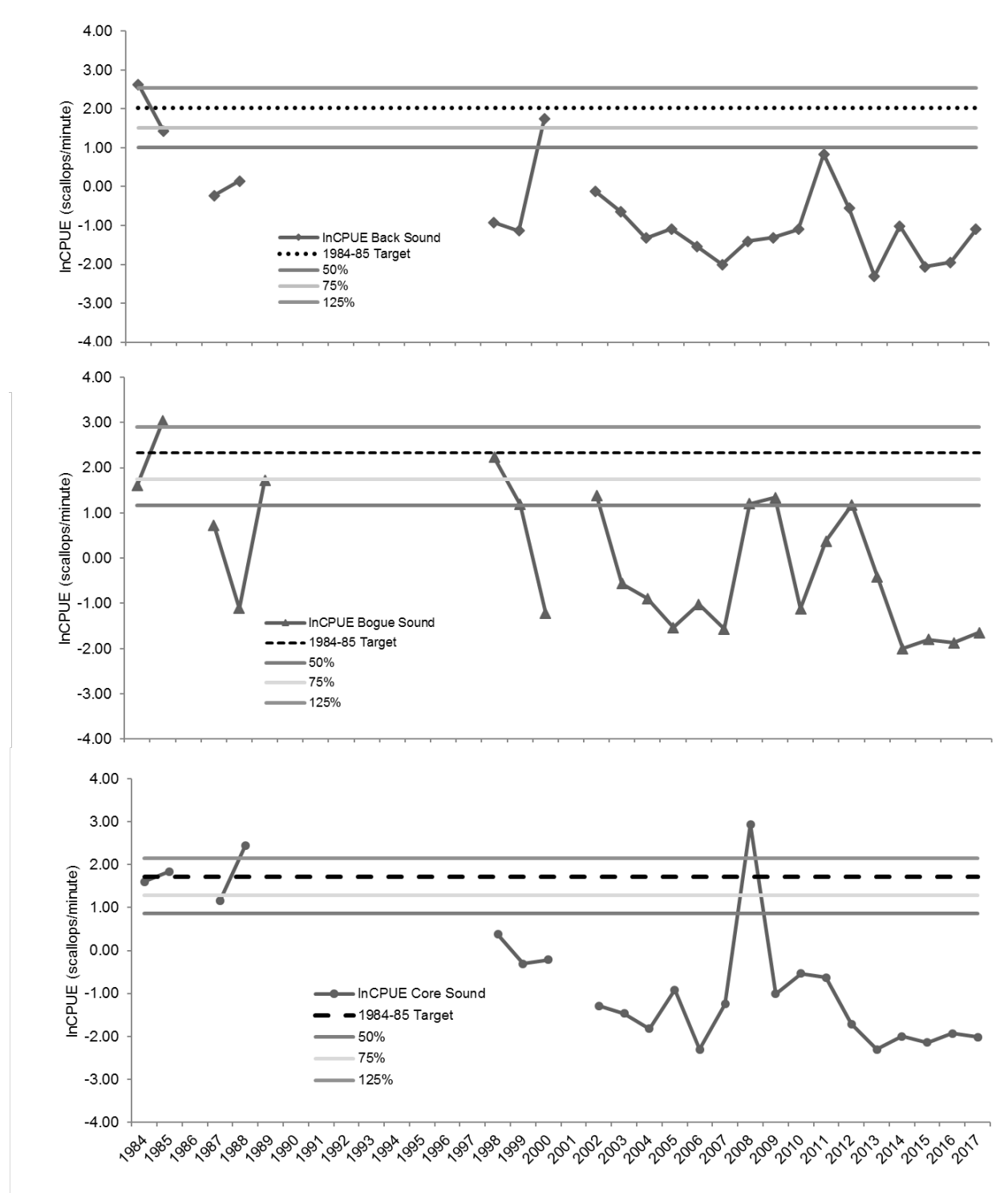


Figure 1. The mean number of scallops (InCPUE)(scallops/minute) for Back, Bogue, and Core sounds during the October-December sampling time period and average InCPUE (target) for the 1984-1985 period showing progressive triggers at 50 percent, 75 percent, and 125 percent of the target. Year indicates the sampling year which is used to determine the harvest season for the next calendar year.

STATE-MANAGED SPECIES – BAY SCALLOP

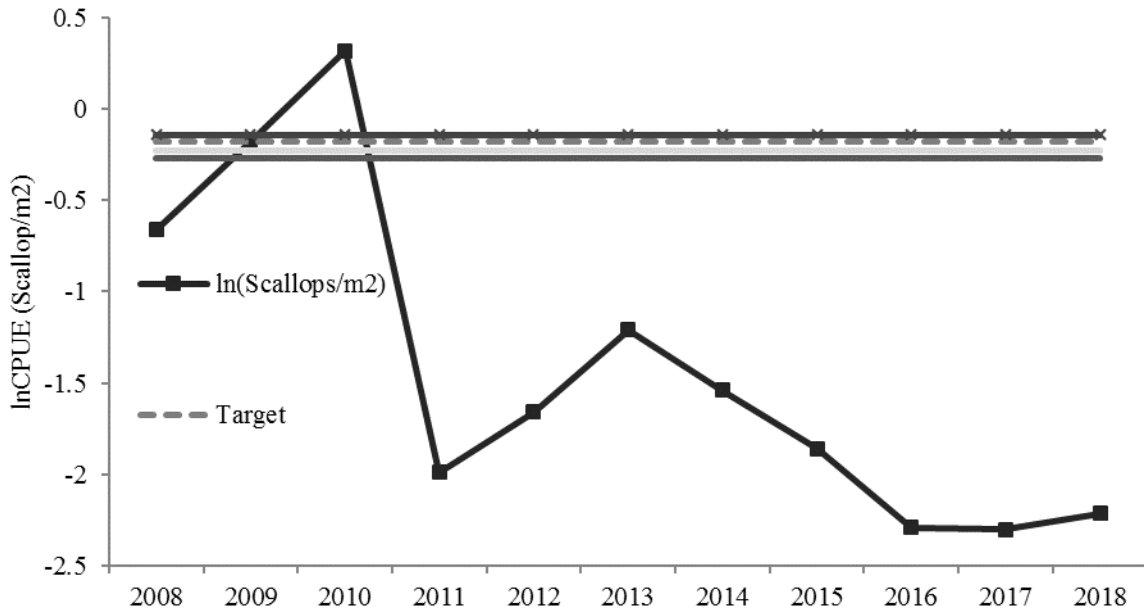


Figure 2. The mean number of bay scallops, lnCPUE ($\ln(\text{scallops}/\text{m}^2)$), for Pamlico Sound during the January sampling time period and target for the January 2009 period showing progressive triggers at 50 percent, 75 percent, and 125 percent of the target. Year indicates the sampling year which is used to determine the harvest season for the same calendar year.

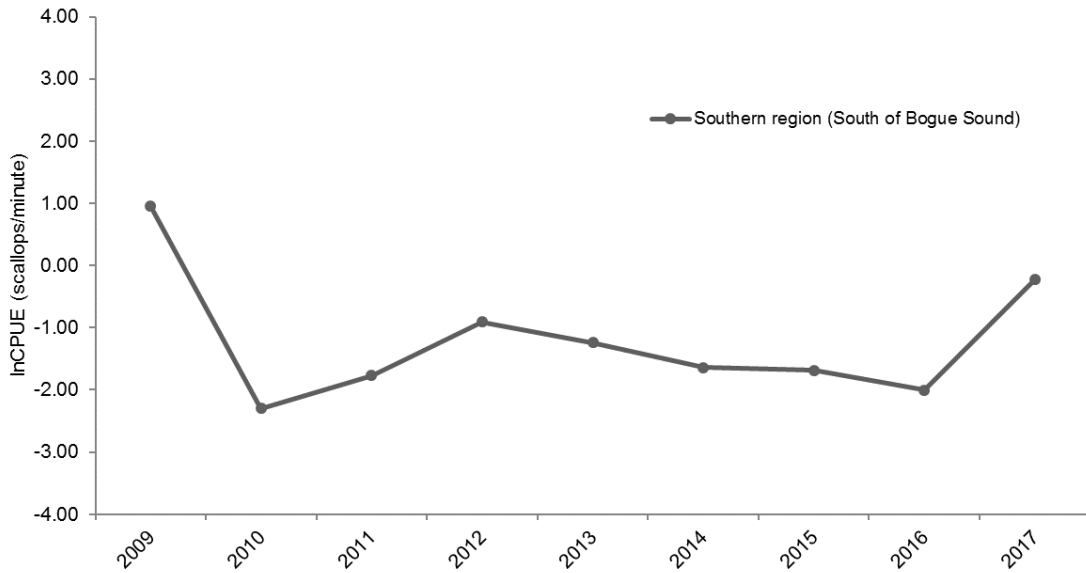


Figure 3. The mean number of scallops (lnCPUE)(scallops/minute) for areas south of Bogue Sound in October, 2009-2017. Target opening estimates and progressive triggers are not defined for this region until sampling is expanded and a longer time series is established.

STATE-MANAGED SPECIES – BAY SCALLOP

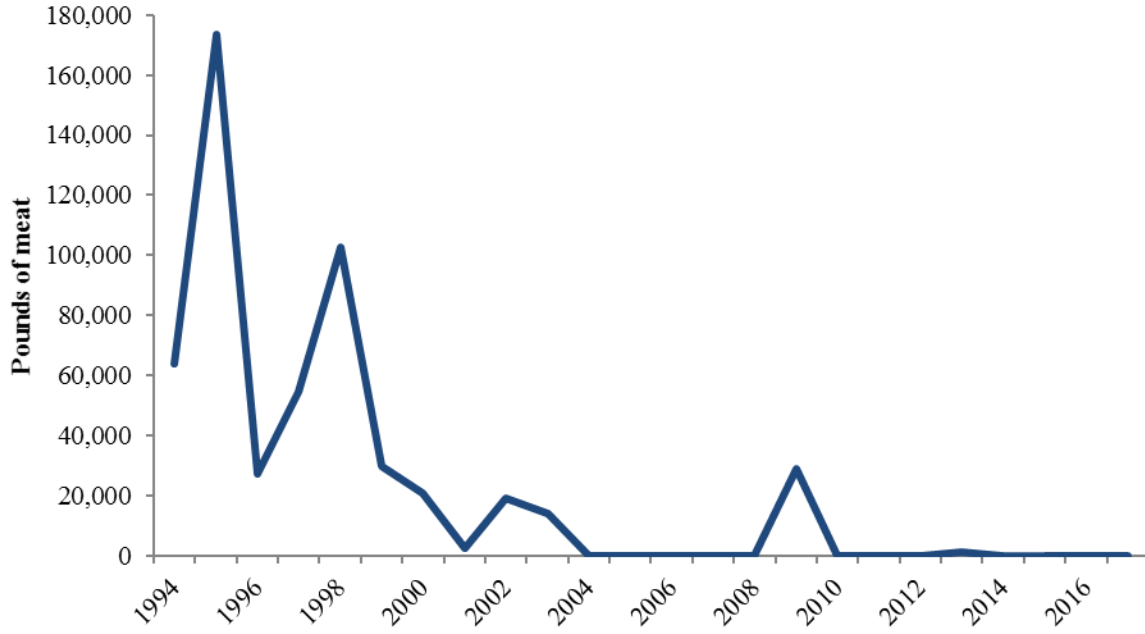


Figure 4. Bay scallop landings (pounds of meat) in North Carolina, 1994-2016. Landings occurred in 2010 and 2013 but are not evident in the figure due to the scale required to show the range of landings for the time series.

STATE-MANAGED SPECIES – BLUE CRAB

**FISHERY MANAGEMENT PLAN UPDATE
BLUE CRAB
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | December 1998 |
| Amendments: | Amendment 1 – December 2004 Amendment 2 – November 2013 |
| Revisions: | May 2016 |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | August 2016 |
| Next Benchmark Review: | August 2016 |

The original North Carolina Blue Crab Fishery Management Plan (FMP) was adopted in December 1998 (NCDMF 1998). The plan adopted several management changes including: 1) requiring sinking lines to be used on all crab pot buoys, 2) prohibited commercial gears (except attended gill nets) in crab spawning sanctuaries from March 1 through August 31, 3) prohibited baiting peeler pots except with live legal-size male blue crabs, 4) repealed the exemption for culling peelers before reaching shore in the hard crab fishery, 5) prohibiting the possession of white line peelers from June 1 through September 30, 6) changed the unattended pot rule from 10 days to seven days, 7) prohibiting setting pots in any navigation channel marked by State or Federal agencies, 8) modified crab pot area regulations to use depth instead of distance from shore, 9) implemented marking requirements for recreational pots, 10) defined collapsible traps as non-commercial gear, and 11) established a permit for shedding operations.

Amendment 1 was adopted in December 2004 (NCDMF 2004). The amendment implemented several management changes including: 1) establishing a 6.75-inch maximum size limit for mature females from September 1 through April 30 if the spawner index fell below the threshold for two consecutive years, 2) establishing a 5.25-inch maximum size limit for female peeler crabs from September 1 through April 30 if the spawner index fell below the threshold for two consecutive years, 3) prohibiting the sale of white-line peelers but allow possession by licensed peeler operations and requiring white-line peelers to be kept separate from pink and red-line peelers, 4) extending the pot cleanup period by nine days, 5) change the unattended pot rule from seven days to five days, 6) requiring a four-inch stretch mesh tail bag for crab trawls in western Pamlico Sound (including the Pamlico, Pungo, Bay, and Neuse rivers), 7) separate hard and

STATE-MANAGED SPECIES – BLUE CRAB

peeler crab trawl landings on trip ticket, 8) modifying channel net rule to incorporate limited blue crab bycatch provisions identical to those for shrimp trawls, 9) modifying user conflict rule to resolve user conflicts on a regional basis, 10) rule change to allow crab pots in all designated long haul areas in the Hyde, Beaufort, and Pamlico counties, 11) modifying the dates for designated crab pot areas from May 1 through October 31 to June 1 through November 30, 12) change designated pot area boundary description to a standardized six foot depth contour in many areas, and 13) prohibit the use of trawls in designated pot areas.

Amendment 2 was adopted in November 2013 (NCDMF 2013). The amendment implemented several management changes including: 1) repealing the spawner index trigger (and associated maximum size limits for mature female and peeler blue crabs) and replacing it with adaptive management framework based on the results of the annual Traffic Light Stock Assessment update, 2) open long haul areas in the Pungo River to pots, 3) add Lower Broad Creek to non-pot areas in rule, 4) modify crab dredging rule to conform to current harvest management, 5) incorporate Pamlico Sound four-inch crab trawl line into rule, 6) redefine criteria for exempting escape rings in crab pots from the 1.5-inch pot mesh size to unbaited pots and pots baited with a male crab, 7) repeal proclamation authority that allowed for the exemption of escape ring requirement to allow harvest of peeler crabs, 8) adopt no trawl line in Pamlico Sound and Newport River boundary in rule as new boundary for areas where closure of escape rings to take small mature female crabs is allowed, 9) modify trawl nets rule to identify Pamlico, Back, and Core sounds as areas that can open to peeler trawling by proclamation, 10) modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for various crab categories, and 11) establish proclamation authority to require terrapin excluders in crab pots and establish a framework for developing criteria and terrapin excluder specifications.

The NCMFC preferred adaptive management strategy for blue crabs (Table 1) relies on the Traffic Light Stock Assessment as the tool to provide information on the relative condition of the stock. The base years (1987 to 2009) for assigning the signals in the Traffic Light Stock Assessment will remain constant until the next amendment of the FMP. The Traffic Light Stock Assessment will be updated annually by July of each year.

Based on the results of the annual Traffic Light update, with 2015 data, management action was required by the North Carolina Marine Fisheries Commission (NCMFC). At their May 19, 2016 business meeting, the NCMFC was presented with several management options identified in the adaptive management framework in Amendment 2 to the N.C. Blue Crab FMP (NCDMF 2016). To improve the condition of the blue crab stock the NCMFC adopted the following management measures: 1) require one additional escape ring in crab pots and one of the three escape rings must be located within one full mesh of the corner of the pot and within one full mesh of the bottom of the apron/stairs (divider) of the upper chamber of the pot; 2) eliminate the harvest of v-apron immature female hard crabs (excluding peeler crabs); and include v-apron immature female hard crabs in the culling tolerance; 3) prohibit the harvest of dark sponge crabs (brown and black) from April 1-April 30 each year; and include dark sponge crabs in the culling tolerance; 4) lower the culling tolerance from 10 percent to five percent for all crabs, except mature females; and 5) prohibit the harvest of crabs with dredges except incidental to lawful oyster dredging as outlined in NCMFC Rule 15A NCAC 03L .0203(a)(2).

STATE-MANAGED SPECIES – BLUE CRAB

All adaptive management measures became effective June 6, 2016 except for the additional escape ring requirement which was postponed until January 15, 2017 (NCDMF 2016). This delay coincided with the annual pot closure period to allow fishermen time to modify pots. The above actions taken by the NCMFC are documented in the May 2016 Revision to Amendment 2 to the N.C. Blue Crab FMP (NCDMF 2016).

The Benchmark Review of the Blue Crab FMP was originally scheduled to begin in July 2018 but at their August 2016 business meeting the NCMFC voted to move the review up on the FMP schedule to begin immediately. Consequently, the review of the Blue Crab FMP for development of Amendment 3 began in August 2016. The stock assessment has been completed and accepted for management use and the division's plan development team is working on development of Amendment 3 in conjunction with the advisory committee.

Management Unit

The management unit includes the blue crab (*Callinectes sapidus*) and its fisheries in all coastal fishing waters of North Carolina.

Goal and Objectives

The goal of the North Carolina Blue Crab FMP is to manage the blue crab fishery in a manner that promotes its ecological and economic value, and the long-term viability of the resource through sustainable harvest. The following objectives will be utilized to achieve this goal.

1. Utilize a management strategy that provides resource protection and sustainable harvest, promotes blue crab ecological and economic value, provides opportunity for resource utilization, and considers the needs of all users.
2. Promote harvesting practices that minimize waste of the resource and environmental damage.
3. Promote the protection, restoration, and enhancement of habitats and environmental quality necessary for the perpetuation of the blue crab resource.
4. Maintain a clear distinction between conservation goals and allocation issues.
5. Minimize conflicts among and within user groups, including non-crabbing user groups.
6. Identify and promote research to improve the understanding and management of the blue crab resource.
7. Promote education and public information to help users understand the causes and nature of problems for blue crabs in North Carolina, its habitats and fisheries, and the rationale for efforts to address resource management.

STATUS OF THE STOCK

Life History

The blue crab is common to all North Carolina coastal waters, but most reside in the Albemarle and Pamlico sounds and their tributaries. Blue crabs mature at approximately 12 to 18 months of age and have an average lifespan of three years with some living as long as eight years (Fischler 1965; Johnson 2004; Rugolo et al. 1997). Mating occurs in brackish areas of the estuary and lower portions of the rivers from late spring to early fall, and spawning occurs in high-salinity waters near the ocean inlets from early summer to fall (Forward et al. 2003; Whitaker 2006). The first larval stage is carried offshore by ocean currents where they undergo several stages of development (Van Engel 1958; Epifanio 1995). Settlement of larval blue crabs occurs in the estuaries after winds and tides transport them through the inlets from the ocean. Once within the estuary, larval blue crabs settle in beds of submerged aquatic vegetation and other complex habitats, like salt marsh and oyster shell, where they become juvenile blue crabs. Juvenile blue crabs gradually migrate to lower salinity waters in the upper estuaries and rivers to grow (molt) and mature (Etherington and Eggleston 2000). Molting is a process of growth in blue crabs that requires shedding the hard exoskeleton. Following each molt, the shell is soft for several hours until it hardens, during this time the crab is more vulnerable to predators. Juvenile and adult blue crabs typically eat what is available to them such as dead and live fish, crabs, shrimp, and shellfish (Laughlin 1982; Williams 1984; Hines et al. 1990; Cordero and Seitz 2014) and serve as food for predator species such as striped bass and red drum (NCSU unpublished data).

Male and female blue crabs are easily identified by the shape of the apron on their abdomen. A mature male crab is called a "jimmy" and is easily recognized by the blue shading on his shell and claws and T-shaped apron on its underside. Female crabs are either called "sooks" as adults or "she-crabs" when immature. The immature female apron is triangular-shaped and held tightly against the abdomen. The mature female's apron becomes rounded and can be easily pulled away from the body after the final molt. The "sponge crab" is a female that has an egg mass on her abdomen.

Stock Status

Results of the 2018 blue crab stock assessment indicate the stock is overfished and overfishing is occurring (NCDMF 2018). The threshold spawner abundance was estimated to be 64 million mature females on average, and the target spawner abundance was estimated to be 73 million mature females on average (Figure 1). The average spawner abundance for 2016 was estimated to be 50 million mature females (< the threshold) with a 95% CI of 37-68 million, which determines the population in 2016 is overfished with a probability of 0.98. The fishing mortality threshold and target were estimated to be 1.46 and 1.22 on average, respectively. The average fishing mortality for 2016 was 1.48 (> *F* threshold) with a 95% CI of 0.86-2.42, which indicates overfishing is occurring in 2016 with a probability of 0.52.

STATE-MANAGED SPECIES – BLUE CRAB

Stock Assessment

The 2018 blue crab stock assessment used a sex-specific two-stage model applied to available data to assess the status of North Carolina's blue crab stock for 1995–2016 (NCDMF 2018). Data were available from commercial fishery monitoring programs and several fishery-independent surveys. Only hard crab landings were incorporated in the model and neither recreational or soft/peeler landings were included primarily due to their minimal contribution to the overall harvest. The two-stage model was developed based on the catch-survey analysis designed for species lacking information on the age structure of the population. The model synthesized information from multiple sources, tracked population dynamics of male and female recruits and fully recruited animals, estimated critical demographic and fishery parameters such as natural and fishing mortality, and thus, provided a comprehensive assessment of blue crab status in North Carolina. The hierarchical Bayesian approach was used to estimate model parameters, which can incorporate uncertainty associated with the data and model assumptions.

The model estimated an overall declining trend in catch, relative abundance indices, population size of both male and female recruits and fully recruited crabs, with a rebound starting in 2007. Females had higher natural mortality estimates than males. The estimated fishing mortality remained high before 2007, and decreased by approximately 50% afterwards.

The status of the blue crab stock was evaluated using biological reference points based on maximum sustainable yield (MSY). The MSY-based biological reference points (BRPs) have been widely used in fishery stock assessments including blue crabs, e.g., Chesapeake Bay 2001 (Miller et al. 2011), Florida 2007 (Murphy et al. 2007) and Gulf of Mexico 2013 assessments (VanderKooy 2013).

The fishing mortality that maximizes the total yield (F_{MSY}) was set to be the threshold for overfishing, and $0.75F_{MSY}$ was set to be the target fishing mortality. The spawner abundance at F_{MSY} (SP_{MSY}) and $0.75 F_{MSY}$ was set to be the threshold and target for overfished population, respectively. In the current stock assessment, the population is determined to be overfished if the average spawner abundance in 2016 falls below SP_{MSY} , and is determined to be undergoing overfishing if the average F in 2016 remains above F_{MSY} .

STATUS OF THE FISHERY

Current Regulations

General Statutes

All management authority for North Carolina's blue crab fishery is vested in the State of North Carolina. Statutes that have been applied to the blue crab fishery include:

- Definitions relating to resources. G.S. 113-129.
- Definitions relating to activities of public. G.S. 113-130.
- Jurisdiction of fisheries agencies. G.S. 113-132.
- It is unlawful for any person without the authority of the owner of the equipment to take fish from said equipment. G.S. 113-268(a).

STATE-MANAGED SPECIES – BLUE CRAB

- It is unlawful for any vessel in the navigable waters of the State to willfully, wantonly, and unnecessarily do injury to any seine, net, or pot. G.S. 113-268(b).
- It is unlawful for any person to willfully destroy or injure any buoys, markers, stakes, nets, pots, or other devices or property lawfully set out in the open waters of the state in connection with any fishing or fishery. G.S. 113-268(c).

Marine Fisheries Commission Rules

The NCMFC has established several rules that directly govern the harvest of blue crabs. Below are rules and excerpts from rules that directly affect the blue crab fishery. The rules below do not cover all gear, area, or other rules which may impact the blue crab fishery. As regulations may change, please contact the North Carolina Division of Marine Fisheries (NCDMF) for the most current regulations.

Definitions

Blue Crab Shedding: The process whereby a blue crab emerges soft from its former hard exoskeleton. A shedding operation is any operation that holds peeler crabs in a controlled environment. A controlled environment provides and maintains throughout the shedding process one or more of the following: (i) food, (ii) predator protection, (iii) salinity, (iv) temperature controls, or (v) water circulation, utilizing technology not found in the natural environment. A shedding operation does not include transporting pink or red-line peeler crabs to a permitted shedding operation. 15A NCAC 03I .0101(2)(c).

Peeler Crab: A blue crab that has a soft shell developing under a hard shell and having a white, pink, or red-line or rim on the outer edge of the back fin or flipper. 15A NCAC 03I .0101(2)(f).

Commercial Fishing Equipment or Gear: All fishing equipment used in coastal fishing waters except: (i) Cast nets; (ii) Collapsible crab traps, a trap used for taking crabs with the largest open dimension no larger than 18 inches and that by design is collapsed at all times when in the water, except when it is being retrieved from or lowered to the bottom; (iii) Dip nets or scoops having a handle not more than eight feet in length and a hoop or frame to which the net is attached not exceeding 60 inches along the perimeter; (iv) Gigs or other pointed implements which are propelled by hand, whether or not the implement remains in the hand; (v) Hand operated rakes no more than 12 inches wide and weighing no more than six pounds and hand operated tongs; (vi) Hook and line and bait and line equipment other than multiple hook or multiple bait trotline; (vii) Landing nets used to assist in taking fish when the initial and primary method of taking is by the use of hook and line; (viii) Minnow traps when no more than two are in use; (ix) Seines less than 30 feet in length; (x) Spears, Hawaiian slings or similar devices, which propel pointed implements by mechanical means, including elastic tubing or bands, pressurized gas or similar means. 15A NCAC 03I .0101(3)(c).

Mesh Length: The diagonal distance from the inside of one knot to the outside of the other knot, when the net is stretched hand-tight. 15A NCAC 03I .0101(3)(k).

Crab Harvest Restrictions

Hard crab minimum size limit of five inches measured from tip of spike to tip of spike for male and immature female hard blue crabs. Soft crabs shall be separated where taken and placed in a

STATE-MANAGED SPECIES – BLUE CRAB

separate container. Peeler crabs shall be separated where taken and placed in a separate container. White-line peeler crabs shall be separated from pink and red-line peeler crabs where taken and placed in a separate container. Male crabs to be used as peeler bait are exempt from the five-inch size limit from March 1 through October 31 and shall be placed in a separate container. A culling tolerance of not more than five percent by number shall be allowed for white-line peelers in the pink and red-line peeler container [suspended by Proclamation M-11-2016]. It is unlawful to: sell white-line peelers, possess white-line peelers unless they are to be used by the harvester in the harvester's permitted blue crab shedding operation, possess male white line peelers from June 1 through September 1. It is unlawful to possess more than 50 crabs per person per day not to exceed 100 blue crabs per vessel per day for recreational purposes. To comply with management measures in the N.C. Blue Crab Fishery Management Plan, the Director, may by proclamation, close the harvest of blue crabs and may impose any or all of the following restrictions on the commercial and recreational blue crab harvest: specify, areas, season; time periods, means and methods, culling tolerance, and limit harvest based on size, quantity, sex, reproductive stage, or peeler stage. 15A NCAC 03L .0201.

Spawning Sanctuaries

It is unlawful to set or use trawls, pots, and mechanical methods for oysters or clams or take crabs with the use of commercial fishing equipment from crab spawning sanctuaries [15A NCAC 03R .0110] from March 1 through August 31. During the remainder of the year the Director may, by proclamation, close these areas and may impose any or all of the following restrictions: areas, time periods, means and methods, and limit harvest based on size, quantity, sex, reproductive stage, or peeler stage. 15A NCAC 03L .0205.

Peeler and Soft Crabs

It is unlawful to possess more than 50 blue crabs in a shedding operation without first obtaining a Blue Crab Shedding Permit from the NCDMF. 15A NCAC 03O .0503(c).

Recreational Harvest

- Blue crabs may be taken without a commercial license if the following gears are used; cast nets, collapsible crab traps with the largest open dimension no larger than 18 inches, a dip net having a handle not more than eight feet in length and a hoop or frame to which the net is attached not exceeding 60 inches along the perimeter; single bait-and-line equipment, or seines less than 30 feet. 15A NCAC 03I .0101(3)(c)(i), (ii), (iii), (vi), and (ix).
- Recreational crab pot buoys must be any shade of hot pink in color, and be no less than five inches in diameter and length and be engraved with the owner's last name and initials. If a vessel is used the buoy must also be engraved with the gear owner's current motorboat registration number or owner's U.S. vessel documentation name. 15A NCAC 03J .0302(a)(1) and (2).
- It is unlawful for a person to use more than one crab pot attached to the shore along privately owned land or to a privately-owned pier without possessing a valid Recreational Commercial Gear License. 15A NCAC 03J .0302(b).
- Up to five crab pots may be used by holders of the Recreational Commercial Gear License. 15A NCAC 03O .0302(a)(3).
- Peeler pots are not permitted to be used by holders of the Recreational Commercial Gear License. 15A NCAC 03O .0302(a)(3).

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- One multiple hook or multiple bait trotline up to 100 feet in length may be used to harvest blue crabs. 15A NCAC 03O .0302(a)(4).
- Trotlines must be marked at both ends with any shade of hot pink in color, and be no less than five inches in diameter and length and be engraved with the owner's last name and initials. If a vessel is used the buoy must also be engraved with the gear owner's current motorboat registration number or owner's U.S. vessel documentation name. 15A NCAC 03J .0302.

Trawls

- It is unlawful to use trawl nets in designated pot areas opened to the use of pots and within an area bound by the shoreline to the depth of six feet. 15A NCAC 03J .0104(b)(6).
- It is unlawful to use shrimp trawls for the taking of blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to commercial shrimp trawling provided that the weight of the crabs shall not exceed; 50 percent of the total weight of the combined crab and shrimp catch; or 300 pounds, whichever is greater. For individuals using shrimp trawls authorized by a Recreational Commercial Gear License, 50 blue crabs, not to exceed 100 blue crabs if two or more Recreational Commercial Gear License holders are on board. The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance with this rule. 15A NCAC 03J .0104(f)(1), (f)(2)(A) and (B), and (g).
- From December 1 through March 31 it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that trawlers working south of Bogue Inlet may keep up to 300 pounds of kingfish, regardless of their shrimp or crab catch weight. 15A NCAC 03J .0202(5).
- It is unlawful to take or possess crabs aboard a vessel in internal waters except in areas and during such times as the Fisheries Director may specify by proclamation. 15A NCAC 03L .0202(a).
- It is unlawful to take crabs with crab trawls with a mesh less than three inches, except in areas of western Pamlico Sound the minimum mesh length is four inches; the Director may, by proclamation, specify other areas for trawl mesh length and increase the minimum mesh length to no more than four inches. 15A NCAC 3L .0202(b)(1) and (2).
- It is unlawful to use trawls with a mesh length less than two inches or with a combined total headrope length exceeding 25 feet for taking soft or peeler crabs. 15A NCAC 03L .0202(c).
- It is unlawful to use trawl nets for any purpose in any of the special secondary nursery areas, except that the Fisheries Director, may, by proclamation, open any or all of the special secondary nursery areas, or any portion thereof to crab trawling from August 16 through May 14. 15A NCAC 03N .0105(b), 03R .0105, 03L .0100 and .0200.
- It is unlawful to use trawl nets in areas listed in 15A NCAC 03R .0106, except that certain areas may be opened to peeler trawling for single-rigged peeler trawls or double-rigged boats whose combined total headrope length does not exceed 25 feet. 15A NCAC 03J .0104(b)(4) and 03R .0106(1).

STATE-MANAGED SPECIES – BLUE CRAB

Crab Pots

- It is unlawful to leave pots in any coastal fishing waters for more than five consecutive days, when such pots are not being employed in fishing operations, except upon a timely and sufficient showing of hardship. 15A NCAC 03I .0105(b)(1), (b)(2)(A) and (B), (b)(3), and (c).
- All pots shall be removed from internal waters from January 15 through February 7. Areas may be reopened, by proclamation, to the use of pots after January 19 if it is determined that such areas are free of pots. 15A NCAC 03J .0301(a)(1).
- From June 1 through November 30 the use of crab pots is restricted in certain areas north and east of the Highway 58 Bridge at Emerald Isle. These areas are described in 15A NCAC 03R .0107(a). To allow for the variable spatial distribution of crustacea and finfish, the Fisheries Director may, by proclamation, specify time periods for or designate the areas described in 15A NCAC 03R .0107(b); or any part thereof, for the use of pots. From May 1 through November 30 in the Atlantic Ocean and west and south of the Highway 58 Bridge at Emerald Isle in areas and during time periods designated by the Fisheries Director by proclamation. 15A NCAC 03J .0301(a)(2)(A) and (B), (a)(3), and 03R .0107(a) and (b).
- It is unlawful to use pots in any navigation channel maintained and marked by State or Federal agencies. 15A NCAC 03J .0301(b)(1).
- It is unlawful to use pots in any turning basin maintained and marked by the North Carolina Ferry Division. 15A NCAC 03J .0301(b)(2).
- It is unlawful to use pots in a commercial fishing operation unless each pot is marked by attaching a floating buoy which shall be of solid foam or other solid buoyant material no less than five inches in diameter and no less than five inches in length. Buoys may be any color except yellow or hot pink or any combination of colors that include yellow or hot pink. The pot owner's N.C. motorboat registration number, or U.S. vessel documentation name, or last name and initials shall be engraved in the buoy, or on a metal or plastic tag attached to the buoy. 15A NCAC 03J .0301(c)(1), (2), and (3).
- It is unlawful to use crab pots in coastal fishing waters unless each pot contains no less than two unobstructed escape rings that are at least 2 and 5/16 inches inside diameter and located in the opposite outside panels of the upper chamber of the pot except: unbaited pots, pots baited with a male crab, and pots set in areas described in 15A NCAC 03R .0118. 15A NCAC 03J .0301(g) [suspended by Proclamation M-11-2016, effective January 15, 2017].
- The Fisheries Director may, by proclamation, exempt the escape ring requirement describe in paragraph (g) in order to allow the harvest of mature female crabs and may impose any or all of the following restrictions: specify time, areas, means and methods, seasons, and quantity. 15A NCAC 03J .0301(h).
- It is unlawful to use more than 150 pots per vessel in the Newport River. 15A NCAC 03J .0301(i).
- It is unlawful to remove crab pots from the water or remove crabs from pots between one hour after sunset and one hour before sunrise. 15A NCAC 03J .0301(j).
- It is unlawful to use pots to take crabs unless the line connecting the pot to the buoy is non-floating. 15A NCAC 03J .0301(k).

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Crab Dredging

- It is unlawful to use any dredge weighing more than 100 pounds except in the Atlantic Ocean. 15A NCAC 03J .0303(a).
- It is unlawful to use more than one dredge per vessel to take crabs or to use any dredges between sunset and sunrise. 15A NCAC 03J .0303(b).
- It is unlawful to take crabs with dredges except from January 1 through March 1 in portions of Pamlico Sound. 15A NCAC 03L .0203(a)(1) [suspended by Proclamation M-11-2016, effective June 6, 2016] and 15A NCAC 03R .0109.
- Crabs may be taken incidental to lawful oyster dredging provided the weight of the crabs shall not exceed 50 percent of the total weight of the combined oyster and crab catch; or 500 pounds, whichever is less. 15A NCAC 03L .0203(a)(2)(A) and (B) [suspended by Proclamation M-11-2016, effective June 6, 2016].
- It is unlawful to take crabs with dredges between sunset and sunrise and between sunset on any Saturday and sunrise on the following Monday, except in the Atlantic Ocean. 15A NCAC 03L .0203(b).

Miscellaneous

- It is unlawful to possess, sell, or purchase fish under four inches in length except for use as bait in the crab pot fishery in North Carolina with the following provision: such crab pot bait shall not be transported west of U.S. Interstate 95 and when transported, shall be accompanied by documentation showing the name and address of the shipper, the name and address of the consignee, and the total weight of the shipment. 15A NCAC 03M .0103(1).

Wildlife Resources Commission Rules

Manner of Taking Nongame Fish Purchase and Sale

- Blue crabs shall have a minimum carapace width of five inches (point to point) and it is unlawful to possess more than 50 crabs per person per day or to exceed 100 crabs per vessel per day. 15A NCAC 10C .0401(a)(1).
- Blue crab taken by hook and line, grabbling or by licensed special devices may not be sold. 15A NCAC 10C .0401(c).

Taking Nongame Fish, Crustaceans, and Mollusks for Bait or Personal Consumption

- A single, multiple bait line for taking crabs not to exceed 100 feet in length that is under the immediate control and attendance of the user and is limited to one line per person and no more than one line per vessel. The line is required to be marked on each end with a solid float no less than five inches in diameter and bearing legible and indelible identification of the user's name and address. 15A NCAC 10C .0402(a)(6).
- A collapsible crab trap with the largest opening not greater than 18 inches and which, by design, collapses at all times when in the water, except when being retrieved or lowered to the bottom. 15A NCAC 10C .0402(a)(7).
- Nongame fishes, crustaceans (crayfish and blue crabs), and mollusks taken for bait or personal consumption may not be sold. 15A NCAC 10C .0402(b).
- No more than 50 crabs per person, per day or 100 per vessel, per day with a minimum carapace width of five inches (point to point) from inland fishing waters or in designated waterfowl impoundments located on game lands. 15A NCAC 10C .0402(d)(3).

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Special Device Fishing

- It is unlawful to use crab pots in inland fishing waters, except by persons owning property adjacent to the inland fishing waters of coastal rivers and their tributaries who are permitted to set two crab pots to be attached to their property and not subject to special device license requirements. 15A NCAC 10C .0404(e).

Commercial Landings

Commercial blue crab landings (hard, soft, and peeler crabs) averaged 40.5 million pounds from 1987 – 2009 (base years used in the traffic light; Figure 2). The majority of blue crab landings are hard blue crabs. Landings for 2017 were 19.3 million pounds, under the base year average. Generally, landings have been declining since 2003, and landings for 2017 were 24 percent lower than 2016. Landings have been below the base year average since 2004. Landings data from 1987 – 1994 were collected under the NCDMF/National Marine Fisheries Service Cooperative Statistics Program which was based on voluntary dealer reporting. Since 1994, landings data have been collected under the NCDMF Trip Ticket Program which instituted mandatory dealer reporting. Landings data should be viewed only as a general indicator of fishing trends since they are influenced by market demand, price, fishing effort, weather, availability of alternate species, regulations, and data collection techniques as well as stock abundance.

Recreational Landings

A survey of Recreational Commercial Gear License (RCGL) holders conducted from 2002 – 2008 by the NCDMF indicated blue crabs were the most abundant species landed (by weight) by RCGL participants. During this time, on average, blue crabs accounted for 20 percent (116,797 pounds) of the total poundage (587,172 pounds) landed by RCGL holders. This survey was discontinued in 2009 so more recent estimates of RCGL harvest are unavailable. The harvest of RCGL exempted shore and pier based pots, as well as other non-commercial gear, is unknown.

The Marine Recreational Information Program is primarily designed to sample anglers who use rod and reel as the mode of capture. Since blue crab are also harvested recreationally throughout coastal North Carolina, primarily by pots, this program does not provide precise estimates of recreational harvest. To address this, the division began a mail survey of Coastal Recreational Fishing License (CRFL) holders in the fall of 2010 to attempt to generate recreational harvest estimates for blue crab. One weakness of the survey is a CRFL is not required to harvest blue crab so the harvest from the recreational sector is likely underestimated. Full year results from this survey are available for 2011-2017 (Table 2). Generally, estimates of recreational blue crab harvest were low, ranging from 71,587 blue crabs (approximately 23,862 pounds, using an average of three crabs per pound) in 2015 to 120,979 blue crabs (approximately 40,326 pounds) in 2012. For 2011 – 2017, the average annual recreational harvest of blue crab was 94,184 blue crabs (approximately 31,395 pounds).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

The Traffic Light, used to monitor the health of the blue crab stock, uses commercial crab sampling data (combined with fishery-independent data) to determine the annual length of 50 percent maturity for female blue crabs. This index is used in the Production characteristic of the Traffic Light. The annual length of 50 percent maturity is compared to the mean length of 50 percent maturity for the base years of 1987 – 2009 (112.1 mm carapace width [CW]). In 2017, the length of 50 percent maturity was 116.3 mm CW and was above the mean for the base years (112.1 mm CW). The length of 50 percent maturity has been above the base years mean since 2005 (Figure 3).

Fishery-Independent Monitoring

The Traffic Light, used to monitor the condition of the blue crab stock, uses several fishery-independent indices for the Adult Abundance, Recruit Abundance, and Production characteristics. The status of each indicator is compared to the mean of that indicator over a set of base years. The base years used for the blue crab traffic light were 1987 – 2009.

Adult Abundance

The adult abundance characteristic uses data from the Juvenile Anadromous Trawl Survey (Program 100), the Estuarine Trawl Survey (Program 120), and the Pamlico Sound Survey (Program 195) to monitor adult blue crab abundance. Indices from Program 120 and Program 195 consist of blue crabs greater than or equal to 100 mm CW; an index of total abundance (no size restrictions) is derived from Program 100. Two indices are derived from Program 120, a Pamlico index using data from tributaries in and around Pamlico Sound and Core Sound and a Southern index using data collected from Back Sound and south (Figure 4).

Adult abundance for Program 100 was above the mean for the base years (0.27 crabs/minute) from 2006 – 2012, both 2013 (0.266 crabs/minute) and 2014 (0.23 crabs/minute) adult abundance estimates were below the base year mean but in 2015 (1.04 crabs/minute), 2016 (0.78 crabs/minute), and 2017 (1.39 crabs/minute) adult abundance estimates were above the base year mean. Adult abundance for Program 120 in the Pamlico region had been below the base year mean (0.62 crabs/tow) since 2013 (2017=0.27 crabs/tow). In the Southern region, adult abundance for Program 120 was below the base year mean (0.15 crabs/tow) from 2011-2014, 2016, and 2017 (0.12 crabs/tow). Adult abundance for Program 195 has been below the base year mean (4.52 crabs/tow) since 2000. In 2017 adult abundance was 0.98 crabs/tow. Figure 5 shows the individual traffic lights for each index as well as the composite adult abundance traffic light.

Recruit Abundance

The recruit abundance characteristic uses data from the Estuarine Trawl Survey (Program 120) and the Pamlico Sound Survey (Program 195) to monitor blue crab recruit abundance. Each index consists of blue crabs less than 100 mm CW and greater than or equal to 30 mm CW. Two indices are derived from Program 120, a Pamlico index using data from tributaries in and around

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Pamlico Sound and Core Sound and a Southern index using data collected from Back Sound and south. Two indices are also derived from Program 195, a summer (June) and a fall (September) index (Figure 6).

Recruit abundance for Program 120 in the Pamlico region has been below the base year mean (1.93 crabs/tow) since 2013 (2017=0.46 crabs/tow). In the Southern region, recruit abundance has been below the base year mean (0.44 crabs/tow) since 2005. In 2017, recruit abundance was 0.23 crabs/tow in the Southern region. Recruit abundance for Program 195 in the summer has been below the base year mean (29.66 crabs/tow) since 2011 and was 23.17 crabs/tow in 2017. In the fall, recruit abundance has been below the base year mean (3.49 crabs/tow) since 1998. In 2017, recruit abundance was 1.16 crabs/tow in the fall. Figure 7 shows the individual traffic lights for each index as well as the composite recruit abundance traffic light.

Production

The production characteristic uses data from the Juvenile Anadromous Trawl Survey (Program 100), the Estuarine Trawl Survey (Program 120), and the Pamlico Sound Survey (Program 195) to monitor the blue crab stock's production potential. The production indicators include measures of median carapace width, pre-recruit abundance (blue crabs less than 30 mm CW), length at 50 percent maturity (see fishery-dependent monitoring section), spawning stock (mature female mm/minute), and frequency of occurrence of mature females (percent of samples with mature female blue crabs).

Three indices are derived from Program 100 including median carapace width, spawning stock, and frequency of occurrence of mature females (Figure 8). Median carapace width was below the base year mean (114.2 mm) from 2009-2017 (2017=103 mm). The spawning stock index was below the base year mean (19.54 mm/minute) from 2012-2014 and 2016. In 2017, the spawning stock index was above the base year mean at 32.44 mm/minute. The frequency of occurrence of mature females was above the base year mean (23.4 percent) from 2005 – 2013 and 2015 – 2017 (2017=60.9 percent).

Three indices are derived from Program 120 including Pamlico and Southern region median carapace width and a statewide pre-recruit abundance index (Figure 9). Median carapace width was above the base year mean (34.3 mm) in 2017 (51.0 mm) in the Pamlico region. In the Southern region, median carapace width was above the base year mean (32.7 mm) in 2017 (41.0 mm). The statewide pre-recruit index has been below the base year mean (1.10 crabs/tow) since 2010; in 2017 the pre-recruit index was 0.33 crabs/tow.

Four indices are derived from Program 195 including summer and fall median carapace width, fall spawning stock, and fall frequency of occurrence of mature female indices (Figure 10). The summer median carapace width index was below the base year mean (72.1 mm) in 2017 (67 mm). The fall median carapace width index was below the base year mean (107.7mm) in 2017 (103 mm). The fall spawning stock index has been below the base year mean (741.7 mm/tow) since 2004; in 2017 the fall spawning index was 193.4 mm/tow. The frequency of occurrence of mature females has been below the base year mean (55.9 percent) since 2004; in 2017 the frequency of occurrence of mature females was 29.6 percent. Figure 11 shows the individual traffic lights for each index as well as the composite production traffic light.

MANAGEMENT STRATEGY

Traffic Light

The NCMFC preferred management strategy under Amendment 2 relies on the Traffic Light analysis to provide information on the relative condition of the stock. The base years (1987 to 2009) for assigning the signals in the Traffic Light analysis will remain constant until the next amendment of the FMP. The adaptive management framework in Amendment 2 will remain in effect until the adoption of Amendment 3. The Traffic Light analysis is updated annually by July of each year to gauge the status of the stock. To trigger management actions, either the adult abundance or production characteristic of the assessment must be at or above the 50 percent red threshold for three consecutive years to trigger the moderate management actions and must be at or above the 75 percent red threshold for two of three consecutive years to trigger the elevated management actions established in the plan (Table 1). The recruit abundance indicator, while not used to trigger initial management action, may be used to supplement any management actions taken if the adult abundance or production triggers are activated.

Based on the results of the Traffic Light update in 2016, management action was required by the NCMFC. At their May 19, 2016 business meeting the NCMFC was presented with several management options identified in the adaptive management framework in Amendment 2 to the N.C. Blue Crab FMP. To improve the condition of the blue crab stock, the NCMFC took the following actions:

1. Required one additional escape ring in crab pots and one of the three escape rings must be located within one full mesh of the corner of the pot and within one full mesh of the bottom of the apron/stairs (divider) of the upper chamber of the pot.
2. Eliminated the harvest of v-apron immature female hard crabs (excluding peeler crabs); and include v-apron immature female hard crabs in the culling tolerance.
3. Prohibited the harvest of dark sponge crabs (brown and black) from April 1-April 30 each year; and include dark sponge crabs in the culling tolerance.
4. Lowered the culling tolerance from 10 percent to five percent for all crabs, except mature females.
5. Prohibited the harvest of crabs with dredges except incidental to lawful oyster dredging as outlined in NCMFC Rule 15A NCAC 03L .0203(a)(2).

All adaptive management measures became effective June 6, 2016 except for the additional escape ring requirement which was not effective until January 15, 2017 (NCDMF 2016). This delay was to allow fishermen time to modify their pots.

For the management measures implemented in May 2016 under the adaptive management framework to be relaxed, the adult abundance characteristic of the traffic light must fall below the 50 percent red threshold for three consecutive years. Currently the adult abundance characteristic is at 67 percent red and has been above the moderate management threshold for five consecutive years. The production characteristic is at 46 percent red and has been above the moderate management threshold for one of the last three years. The recruit abundance characteristic has exceeded the moderate threshold for the seventh consecutive year and has

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exceeded the elevated threshold for five consecutive years. Currently the recruit abundance characteristic is at 80 percent red (Figure 12). The current assessment update indicates that 2017 will not count as the first of three consecutive years required below the 50 percent red threshold for the adult abundance characteristic to allow management measures to be relaxed.

Principal Issues

Several management issues were explored in Amendment 2; Table 3 outlines the specific issues explored and the implementation status of each management strategy.

RESEARCH NEEDS

Several research needs were identified in N.C. Blue Crab Fishery Management Plan Amendment 2; the bulleted list below outlines the specific needs and highlights the progress made towards each management and research need.

- Continue to support research to determine the status of protected species (e.g., migration patterns, habitat utilization) along the North Carolina coast to better anticipate and prevent interactions (needed)
- Support research on blue crab fishery interactions with protected species (e.g., identifying any seasonal or spatial peaks in potential for interactions) (needed)
- Support gear modification research and testing that could reduce protected species interactions (needed)
- Continue socioeconomic surveys of blue crab harvesters and include wholesale and retail benefits, the entire support industry for this fishery including suppliers, picking houses, and restaurants (needed)
- Update Recreational Commercial Gear License (RCGL) survey (needed)
- Continue survey and compile data of recreational crabbers not possessing a RCGL license (ongoing through NCDMF mail survey of CRFL holders)
- Determine the economic effects of imported crabmeat, including the mixture of imported meat with local crabmeat, on processing and demand (needed)
- Determine the costs associated with crab processing. Identify the factors and their relative importance in predicting processor closures (needed)
- Research the changing demographics of the commercial blue crab fishery (needed)
- Continue research on the impacts of endocrine disrupting chemicals (EDCs) on the various life stages of the blue crabs and way to reduce introduction of EDCs into estuarine waters. (needed)
- Assess the impact of winter inlet deepening dredge activities on the overwintering female blue crabs and their habitat (needed)
- Determine the spatial and biological characteristics of SAV beds that maximize their ecological value to the blue crab for restoration or conservation purposes (needed)
- Identify, research, and map shallow detrital areas important to blue crabs (needed)
- Additional research is needed on the extent, causes, and impacts of hypoxia and anoxia on blue crab behavior and population abundance in North Carolina's estuarine waters (needed)
- Conduct research on the water quality impacts of crab pot zincs, bait discard, and alternative crab baits in the pot fishery (needed)

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- Develop methods to expand sampling effort to more accurately assess the status of the blue crab stock and its fisheries (needed)
- Continue research on blue crab discards in the shrimp trawl fishery (ongoing through NCDMF observer studies)
- Expand research state wide on the use of terrapin excluder devices in crab pots (needed)
- Implement outreach programs to inform state agencies, the public, and the commercial and recreational fishing industries about issues relating to protected species and fishery management (needed)
- Continue gear development research to minimize species interactions (needed)
- Continue existing programs that have been used to monitor North Carolina's blue crab stock to maintain baseline data (ongoing through NCDMF fishery-independent sampling)
- Identify key environmental factors that significantly impact North Carolina's blue crab stock and investigate assessment methods that can account for these environmental factors (needed)
- Conduct a study of the selectivity of the gear used in the Juvenile Anadromous Trawl Survey (Program 100) to evaluate the size at which blue crabs are fully-selected to the survey gear; the results of such a study could help determine whether the survey data could be used to develop a reliable index of blue crab recruitment for the Albemarle region; no such index is currently available (needed)
- Expand spatial coverage of the Estuarine Trawl Survey (Program 120) to include shallow-water habitat in Albemarle Sound; sampling in shallow-water habitat is intended to target juvenile blue crabs so that a recruitment index for the Albemarle Sound could be developed (needed)
- Expand temporal coverage of the Estuarine Trawl Survey (Program 120) beyond May and June sampling; additional sampling later in the blue crab's growing season would provide more information on within-year changes in growth, mortality, and abundance; at a minimum, recommend addition of September sampling in order to capture the fall settlement peak (needed)
- Expand spatial coverage of Pamlico Sound Survey (Program 195) to include deep water habitat in Albemarle Sound and the Southern Region; expanding the sampling region of adult blue crab habitat would allow for a more spatially-comprehensive adult index; additionally, there would be increased confidence in comparison of adult abundance trends among regions since all would derive from the same sampling methodology (needed)
- Implement a statewide survey with the primary goal of monitoring the abundance of blue crabs in the entire state; such a survey would need to be stratified by water depth to ensure capture of all stages of the blue crab life cycle and standardized among North Carolina waters (needed)
- Implement monitoring of megalopal settlement near the ocean inlets could potentially add a predictive function to the blue crab stock assessments in the future; Forward et al. (2004) detected a positive, linear relationship between megalopal abundance and commercial landings of hard blue crabs for both the local estuarine area and the entire state of North Carolina when a two-year time lag was implemented (Forward et al. 2004); such monitoring is critical to track larval ingress peaks and the effect of natural forces, such as tropical storms and prevailing winds, on ingress (needed)
- Continue surveys of recreational harvest and effort to improve characterization of the recreational fishery for blue crabs (ongoing through NCDMF mail survey of CRFL holders)

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- Identify programs outside the NCDMF that collect data of potential use to the stock assessment of North Carolina's blue crabs (needed)
- Perform in-depth analysis of available data; consider standardization techniques to account for gear and other effects in development of indices; explore utility of spatial analysis in assessing the blue crab stock

FISHERY MANAGEMENT PLAN RECOMMENDATION

The division will continue developing Amendment 3 in conjunction with the advisory committee. Amendment 3 is slated for adoption 2020.

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TABLES

Table 1. Management measures in N.C. Blue Crab Fishery Management Plan Amendment 2 that may be implemented by proclamation as described in the blue crab adaptive management framework when a stock characteristic exceeds a designated management threshold.

| Characteristic | Moderate management level | Elevated management level |
|-----------------------|---|---|
| Adult abundance | A1. Increase in minimum size limit for male and immature female crabs | A4. Closure of the fishery (season and/or gear) |
| | A2. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 5%) and/or implement gear modifications to reduce sublegal catch | A5. Reduction in tolerance of sub-legal size blue crabs (to a minimum of 1%) and/or implement gear modifications to reduce sublegal catch |
| | A3. Eliminate harvest of v-apron immature hard crab females | A6. Time restrictions |
| Recruit abundance | R1. Establish a seasonal size limit on peeler crabs | R4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots in specific areas |
| | R2. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color) | R5. Expand existing and/or designate new crab spawning sanctuaries |
| | R3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions | R6. Closure of the fishery (season and/or gear) R7. Gear modifications in the crab trawl fishery |
| Production | P1. Restrict trip level harvest of sponge crabs (tolerance, quantity, sponge color) | P4. Prohibit harvest of sponge crabs (all) and/or require sponge crab excluders in pots for specific areas |
| | P2. Minimum and/or maximum size limit for mature female crabs | P5. Reduce peeler harvest (no white line peelers and/or peeler size limit) |
| | P3. Close the crab spawning sanctuaries from September 1 to February 28 and may impose further restrictions | P6. Expand existing and/or designate new crab spawning sanctuaries P7. Closure of the fishery (season and/or gear) |

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Table 2. Recreational blue crab trip, harvest, and discard estimates (number of blue crabs), 2012 – 2017. Percent standard error (PSE) is a measure of precision.

| Year | Number of Trips | PSE for Trips (%) | Harvest | PSE for Harvest (%) | Discards | PSE for Discards (%) | Total Catch | PSE for Total Catch (%) |
|---------|-----------------|-------------------|---------|---------------------|----------|----------------------|-------------|-------------------------|
| 2011 | 24,818 | 8.2 | 114,426 | 12.7 | 81,763 | 11.1 | 196,189 | 10.7 |
| 2012 | 26,863 | 8.9 | 120,979 | 12.0 | 79,072 | 12.5 | 200,051 | 11.5 |
| 2013 | 30,732 | 11.6 | 94,174 | 13.9 | 61,452 | 15.7 | 155,626 | 13.1 |
| 2014 | 23,381 | 11.3 | 100,597 | 19.5 | 67,413 | 15.7 | 168,010 | 16.5 |
| 2015 | 27,963 | 35.8 | 71,587 | 17.2 | 60,135 | 26.5 | 131,690 | 17.9 |
| 2016 | 23,325 | 9.9 | 84,879 | 14.4 | 82,781 | 12.3 | 167,660 | 11.9 |
| 2017 | 17,381 | 10.6 | 72,645 | 17.0 | 67,667 | 12.2 | 140,311 | 13.7 |
| Average | 24,923 | | 94,184 | | 71,469 | | 165,648 | |

Table 3. Summary of management strategies and outcomes from N.C. Blue Crab Fishery Management Plan Amendment 2.

| Management Strategy | Implementation Status |
|--|---|
| STOCK PROTECTION | |
| Repeal the current female stock conservation management trigger. | Rule change to 15A NCAC 03L .0201; Rule change completed on April 1, 2014. |
| Continue existing sampling programs to maintain baseline information for the Traffic Light Stock Assessment method. | No action required. |
| Adopt the adaptive management framework based on the Traffic Light Stock Assessment and the proposed moderate and elevated management levels for recruit abundance, adult abundance, and production characteristics. Initial management action will only be implemented when either the adult abundance or production characteristic reach the management trigger of 50% red or greater for three consecutive years. The recruit abundance characteristic will be used as a supplement to further direct conservation management actions, if deemed necessary. | Rule change to 15A NCAC 03L .0201, 03L .0203, 03L .0204, 03L .0205, 03L .0206, 03L .0209 and 03L .0301; Rule change completed on April 1, 2014. |
| USER CONFLICTS | |
| Status quo, continue with no crab pot limit in southern Bogue Sound. | No action required. |
| Open the non-pot (long haul net) areas all the time by rule in the Pungo River and keep status quo in the Long Point area on the Pamlico River. | Rule change to 15A NCAC 03R .0107; Rule change completed on April 1, 2014. |
| CLARIFICATION OF RULES | |

STATE-MANAGED SPECIES – BLUE CRAB

| Management Strategy | Implementation Status |
|--|---|
| Modify the rule to include the lower Broad Creek area that is closed to crab pots from June 1 through November 30. | Rule change to 15A NCAC 03R .0107; Rule change completed on April 1, 2014. |
| Amend the rule to match harvest management for crab dredging. | Rule change to 15A NCAC 03L .0203; Rule change completed on April 1, 2014. |
| Modify Rule 15A NCAC 03L .0202 to incorporate the long-standing provisions of Proclamation SH-5-2007 (Pamlico Sound four-inch mesh crab trawl line), and retain the Director’s proclamation authority to restrict crab trawl mesh size. | Rule change to 15A NCAC 03L .0202; Rule change completed on April 1, 2014. |
| Amend the current rule to redefine criteria for exempting escape rings in crab pots from the 1.5-inch pot mesh size to unbaited pots and pots baited with a male crab. | Rule change to 15A NCAC 03J .0301 and 03L .0301; Rule change completed on April 1, 2014. |
| Repeal the proclamation authority that allows for exempting the escape ring requirement in order to allow the harvest of peeler crabs. | Rule change to 15A NCAC 03J .0301; Rule change completed on April 1, 2014. |
| Adopt the no trawl line along the Outer Banks in Pamlico Sound as the new boundary in Pamlico Sound, and the Newport River boundaries as delineated in the proposed rule as new boundaries for the area where closure of escape rings to take small mature females is allowed. | Rule change to 15A NCAC 03J .0301 and add new rule 03R .0118; Rule change completed on April 1, 2014. |
| Modify Rule 15A NCAC 03J .0104(b)(4) TRAWL NETS to correctly reference the Pamlico, Back and Core sounds as the areas in which the Director can open peeler trawling by proclamation. | Rule change to 15A NCAC 03J .0104; Rule change completed on April 1, 2014. |
| Modify rule to clearly state the intent of the exceptions, culling tolerance, and separation requirements for the various categories of crabs. | Rule change to 15A NCAC 03L .0201; Rule change completed on April 1, 2014. |
| HARVEST PRACTICES | |
| Continue with non-floating line on crab pots. | No action required. |
| Establish proclamation authority for requiring terrapin excluder devices in crab pots. | Rule change to 15A NCAC 03L .0204; Rule change completed on April 1, 2014. |
| Establish a framework for developing proclamation use criteria and terrapin excluder specifications which may extend until after adoption of the amendment. | Will be addressed in next fishery management plan amendment. |
| Do not allow multiple pots to a single buoy. | No action required. |
| Encourage crab potters in areas of high pot loss to incorporate methods to reduce pot loss. Develop and provide information on potential methods to reduce pot loss. | Need to develop and provide information on potential methods to reduce pot loss. |

STATE-MANAGED SPECIES – BLUE CRAB

| Management Strategy | Implementation Status |
|---|---|
| Encourage crab potters in areas of high pot loss to incorporate escape panel designs in pots to reduce potential ghost fishing impacts. Develop and provide information on potential methods and materials to reduce ghost fishing impacts. | Need to develop and provide information on potential methods and materials to reduce ghost fishing impacts. |
| ENVIRONMENTAL FACTORS | |
| Identify and designate Strategic Habitat Areas that will enhance protection of the blue crab. | Existing authority through the Coastal Habitat Protection Plan (CHPP). |
| Identify, research, and designate additional areas as Primary Nursery Areas that may be important to blue crabs as well as other fisheries. | Existing authority through the CHPP. |
| Continue to map blue crab spawning areas and evaluate any that need to adjust or expand the boundaries or restrictions of the crab spawning sanctuaries based on recent research. | Existing authority through the CHPP. |
| Remap and monitor submerged aquatic vegetation in North Carolina to assess distribution and change over time. | Existing authority through the CHPP. |
| Restore coastal wetlands to compensate for previous losses and enhance habitat and water quality conditions for the blue crab. | Existing authority through the CHPP. |
| Work with Coastal Resource Commission to revise shoreline stabilization rules to adequately protect riparian wetlands and shallow water habitat and significantly reduce the rate of shoreline hardening. | Existing authority through the CHPP. |
| Develop and implement a comprehensive coastal marina and dock management plan and policy to minimize impacts to submerged aquatic vegetation, wetland edge, and other habitat important to blue crab. | Existing authority through the CHPP. |
| Assess the distribution, concentration, and threat of heavy metals and other toxic contaminants in freshwater and estuarine sediments and identify the areas of greatest concern to focus water quality improvement efforts. | Existing authority through the CHPP. |
| Support oyster shell recycling and oyster sanctuary programs to provide areas of enhanced or restored shell bottom habitat. | Existing authority through the CHPP. |
| Consider if prohibition of crab dredging is advisable. | Existing authority through the CHPP. |
| Protect “recruitment bottlenecks”, like inlets for the blue crab, from trawling or other impacts including natural channel modification using hardened structures like groins and jetties. | Existing authority through the CHPP. |

STATE-MANAGED SPECIES – BLUE CRAB

| Management Strategy | Implementation Status |
|--|--------------------------------------|
| Shallow areas where trawling is currently allowed should be re-examined to determine if additional restrictions are necessary. | Existing authority through the CHPP. |
| Improve methods to reduce sediment and nutrient pollution from construction sites, agriculture, and forestry. | Existing authority through the CHPP. |
| Increase on-site infiltration of storm water through voluntary or regulatory measures. | Existing authority through the CHPP. |
| Provide more incentives for low-impact development. | Existing authority through the CHPP. |
| Aggressively reduce point source pollution from wastewater through improved inspections of wastewater treatment facilities, improved maintenance of collection infrastructure, and establishment of additional incentives to local governments for wastewater treatment plant upgrading. | Existing authority through the CHPP. |
| Provide proper disposal of unwanted drugs, prevent the use of harmful JHA insecticides near-surface waters or in livestock feed, and develop technologies to treat wastewater for antibiotics and hormones. | Existing authority through the CHPP. |

STATE-MANAGED SPECIES – BLUE CRAB

FIGURES

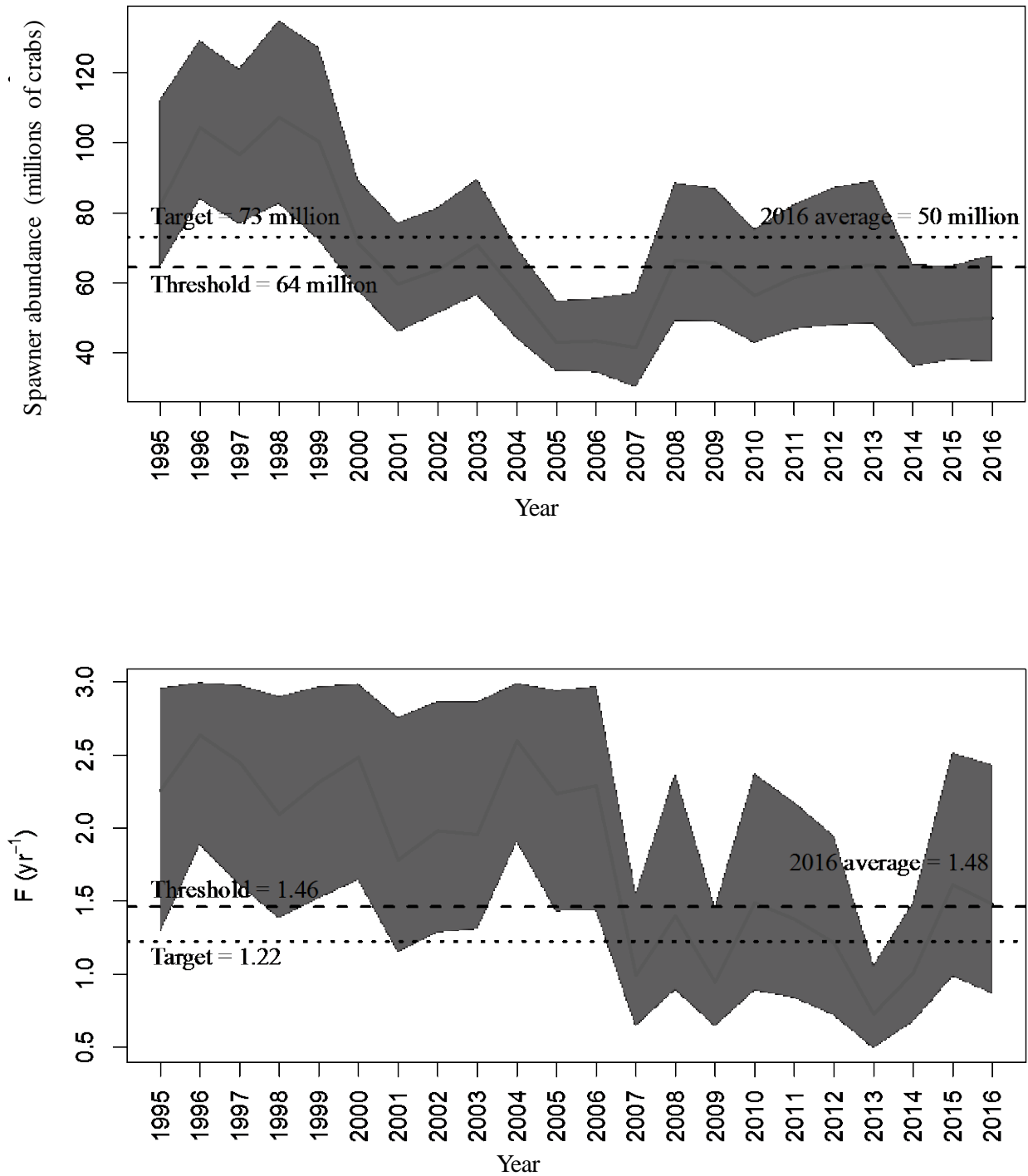


Figure 1. Estimated spawner abundance (mature female blue crabs) and fishing mortality (F) from the 2018 blue crab stock assessment. The solid lines represent the posterior mean and the shaded area represents the 95% credible interval. The threshold and target values are the posterior means (dashed lines).

STATE-MANAGED SPECIES – BLUE CRAB

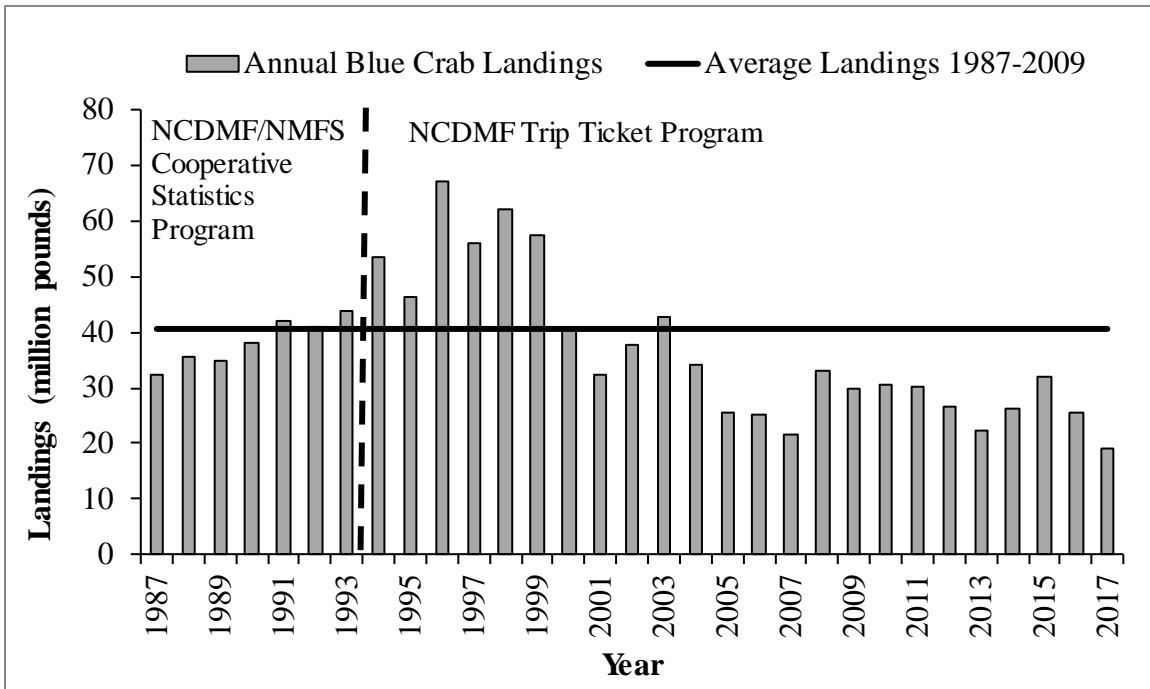


Figure 2. Annual blue crab commercial landings, 1987-2017. Landings include hard, soft, and peeler crabs. The vertical dashed line denotes the change from a voluntary to mandatory commercial landings reporting.

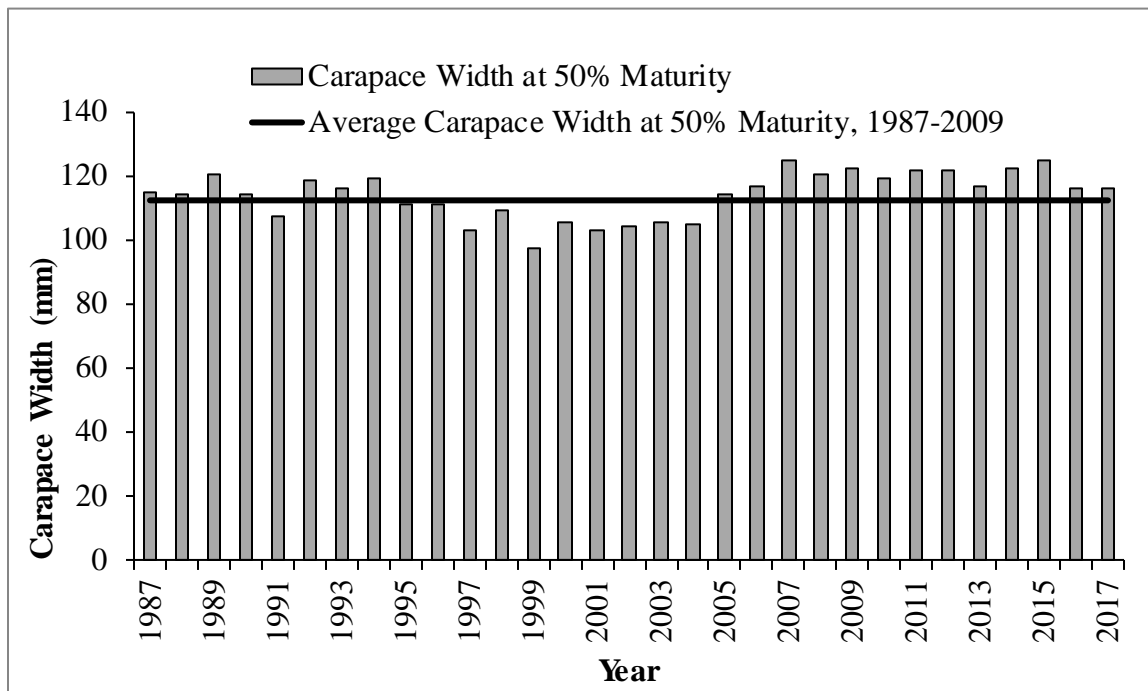


Figure 3. Length at 50% maturity for female blue crabs used in the production characteristic of the Blue Crab Traffic Light, 1987-2017. Fishery-dependent and independent data were included in the analysis.

STATE-MANAGED SPECIES – BLUE CRAB

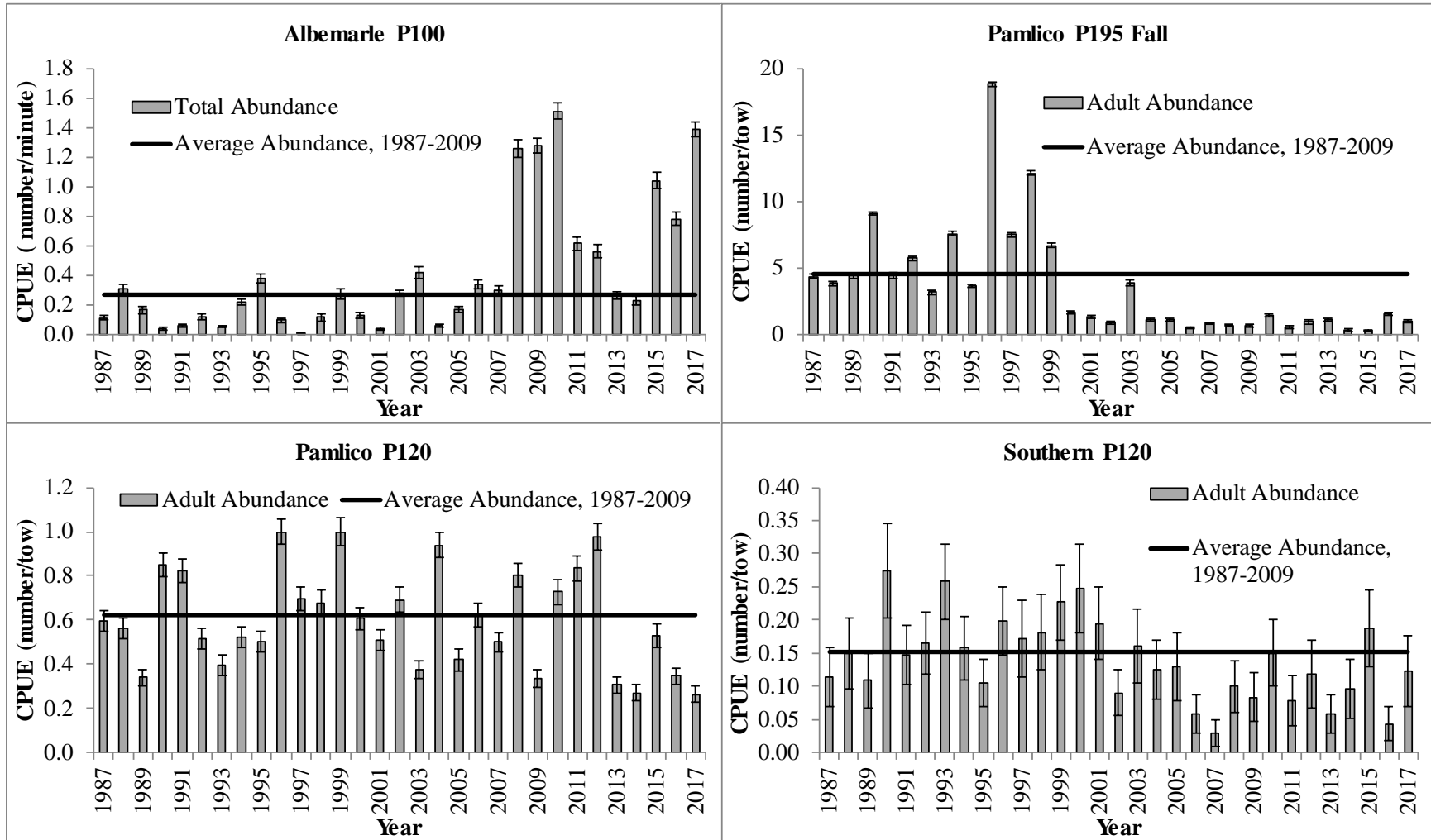


Figure 4. Indices from NCDMF sampling programs 100, 120, and 195 used for the adult abundance characteristic of the Blue Crab Traffic Light, 1987-2017. Error bars represent one standard error of the mean.

STATE-MANAGED SPECIES – BLUE CRAB



Figure 5. Blue Crab Traffic Light individual adult abundance indicators and the integrated summary (bottom figure), 1987-2017.

STATE-MANAGED SPECIES – BLUE CRAB

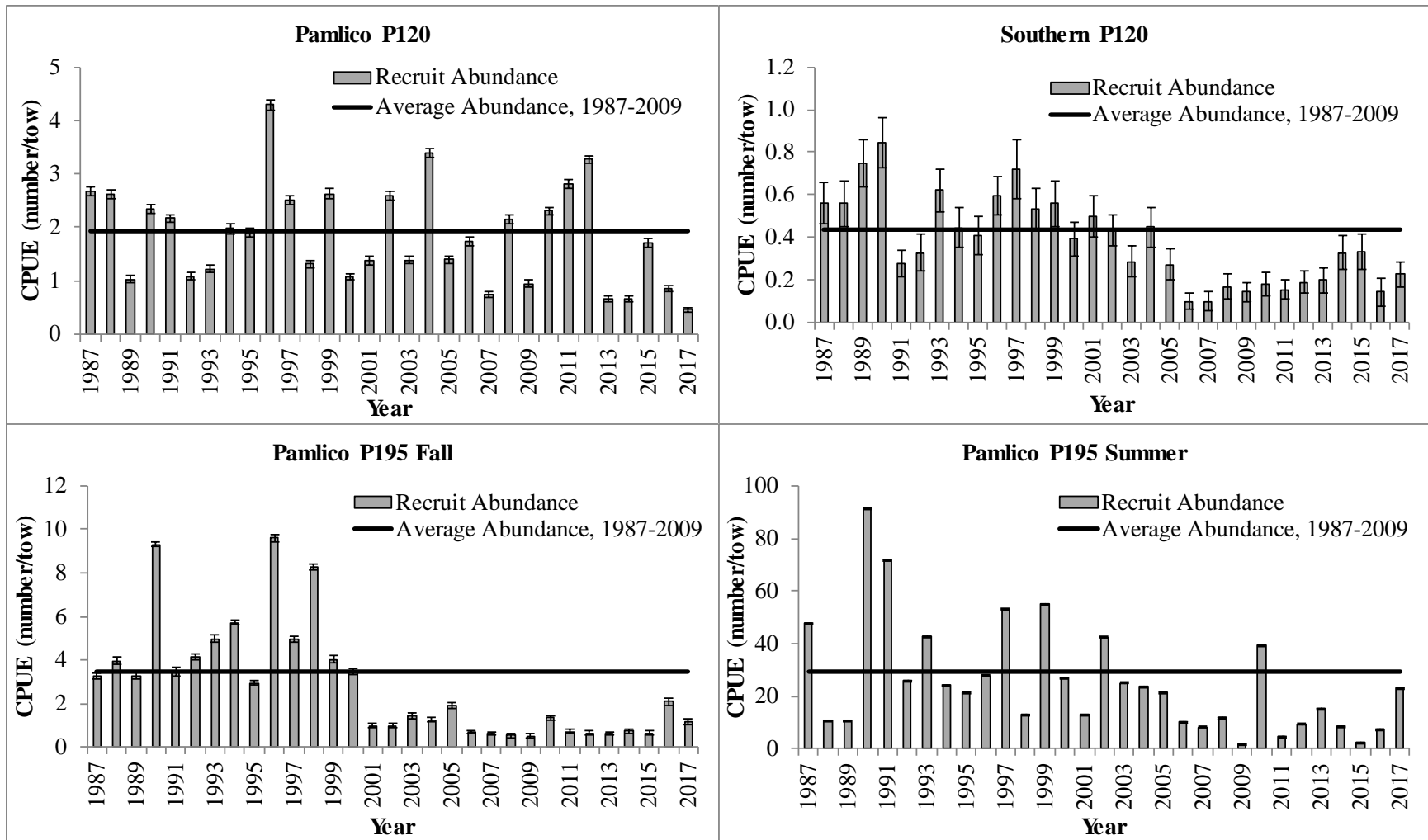


Figure 6. Indices from NCDMF sampling programs 120 and 195 used for the recruit abundance characteristic of the Blue Crab Traffic Light, 1987-2017. Error bars represent one standard error of the mean.

STATE-MANAGED SPECIES – BLUE CRAB



Figure 7. Blue Crab Traffic Light individual recruit abundance indicators and the integrated summary (bottom figure), 1987-2017.

STATE-MANAGED SPECIES – BLUE CRAB

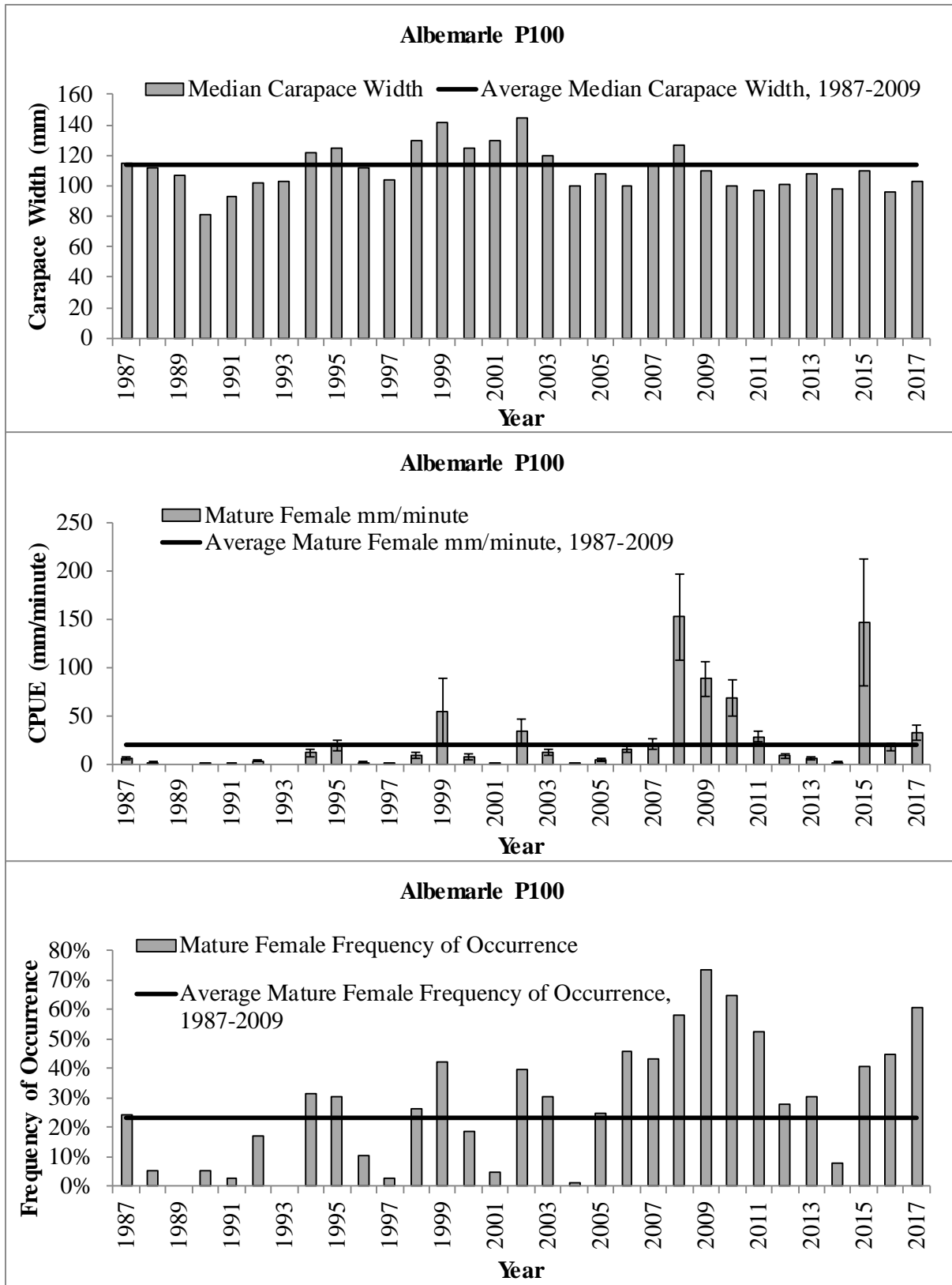


Figure 8. Indices from NCDMF sampling program 100 used for the production characteristic of the Blue Crab Traffic Light, 1987-2017. Error bars represent one standard error of the mean.

STATE-MANAGED SPECIES – BLUE CRAB

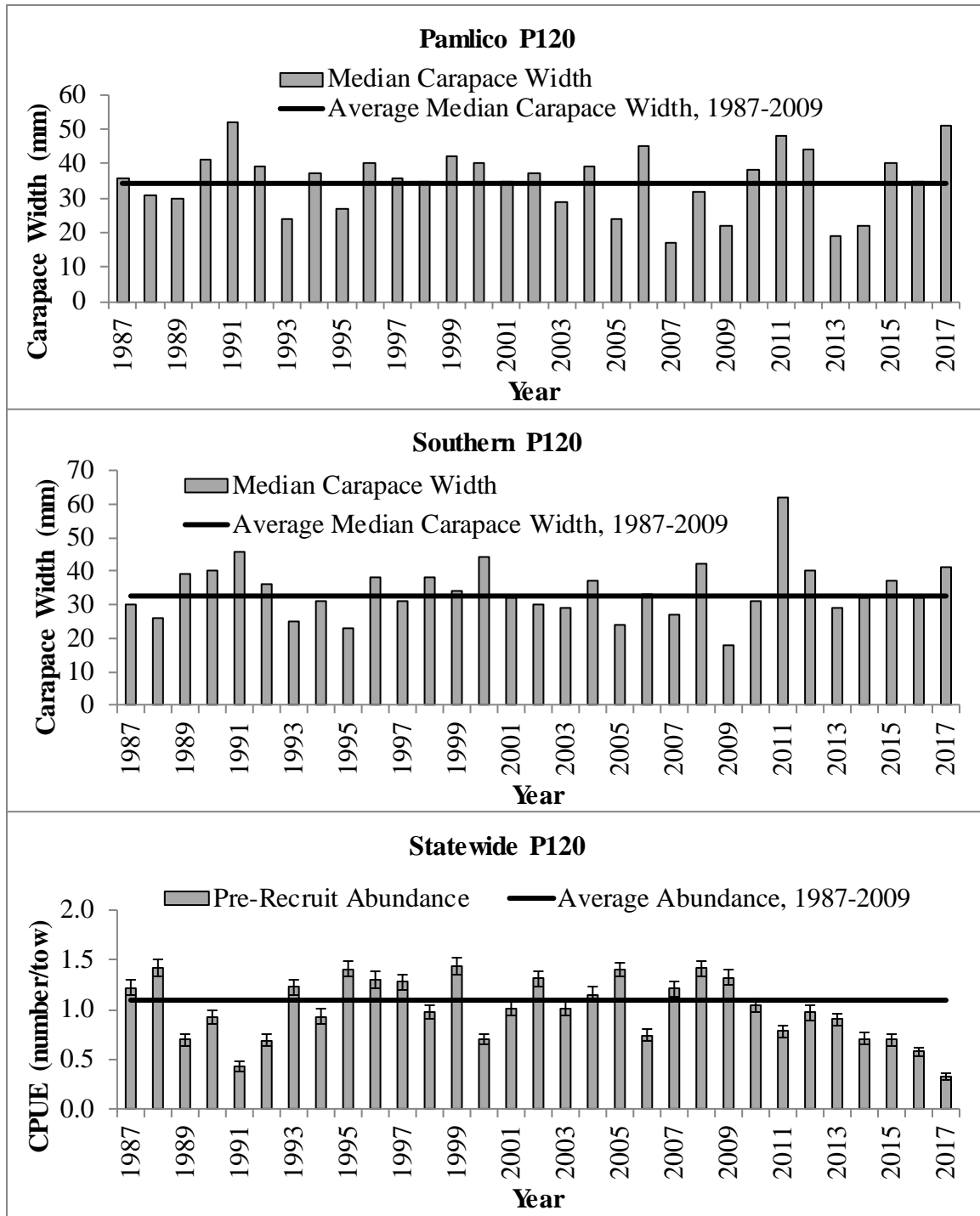


Figure 9. Indices from NCDMF sampling program 120 used for the production characteristic of the Blue Crab Traffic Light, 1987-2017. Error bars represent one standard error of the mean.

STATE-MANAGED SPECIES – BLUE CRAB

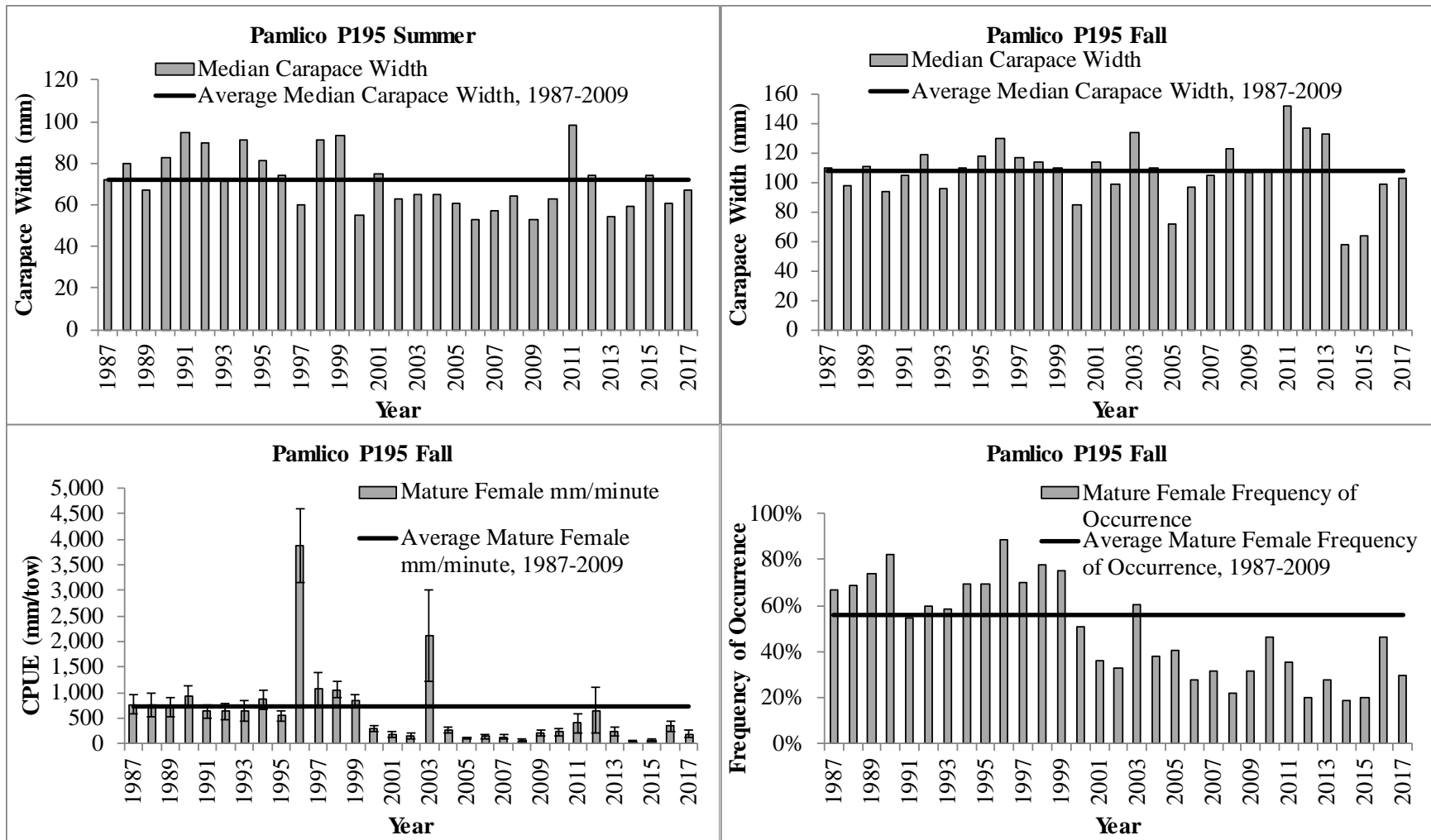


Figure 10. Indices from NCDMF sampling program 195 used for the production characteristic of the Blue Crab Traffic Light, 1987-2017. Error bars represent one standard error of the mean.

STATE-MANAGED SPECIES – BLUE CRAB

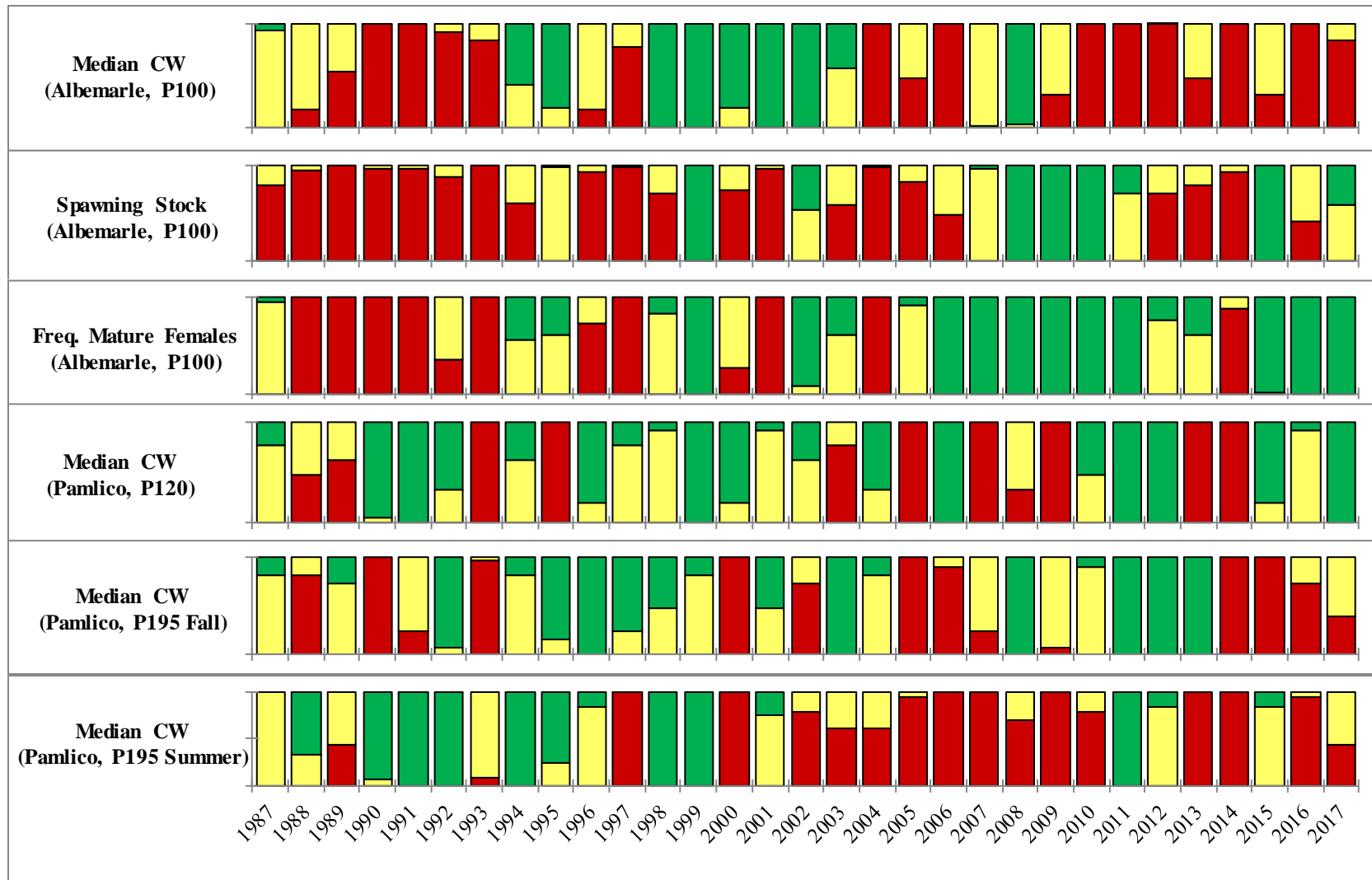


Figure 11. Blue Crab Traffic Light individual production indicators and integrated summary (bottom figure, next page), 1987-2017.

STATE-MANAGED SPECIES – BLUE CRAB

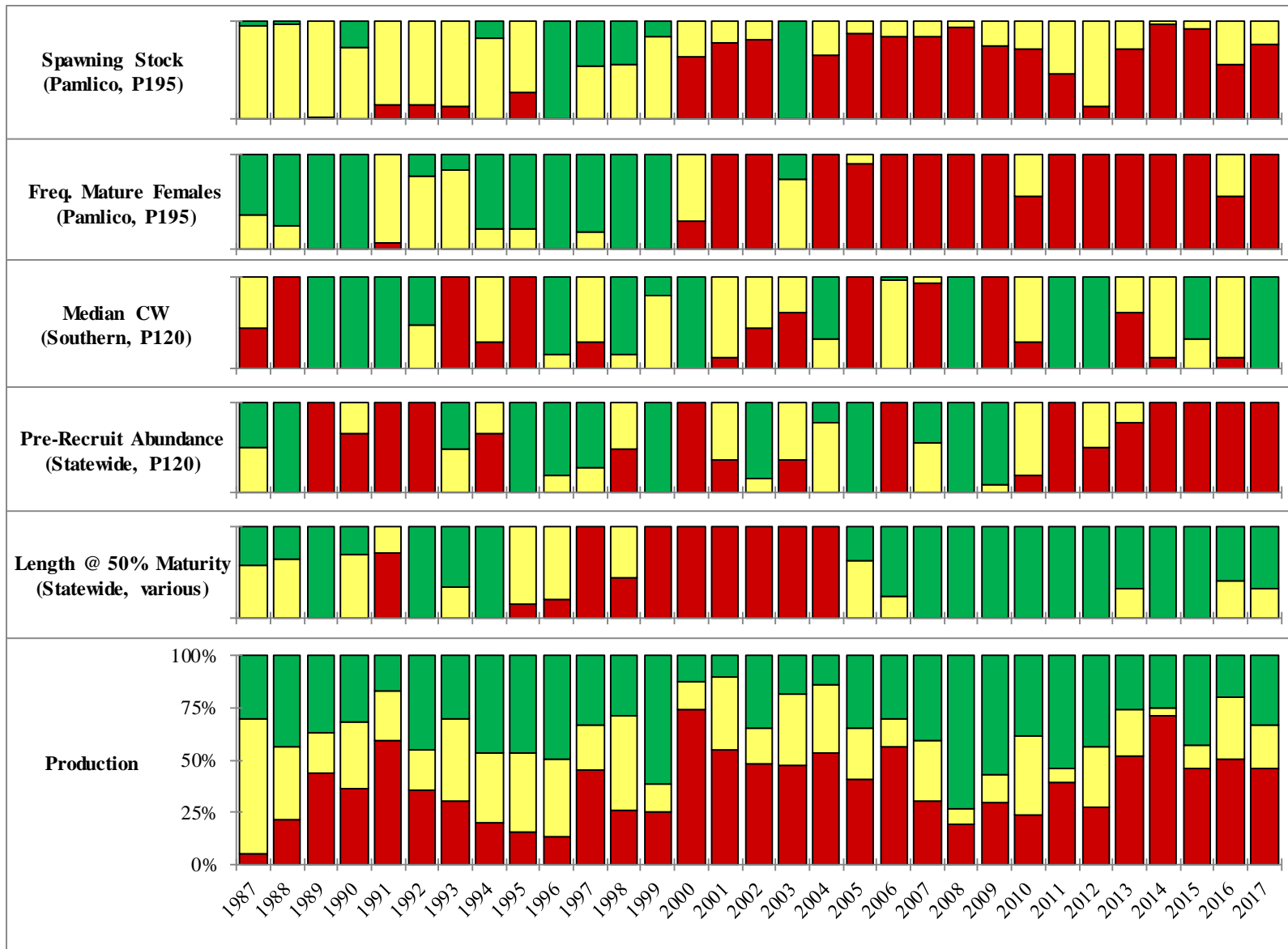


Figure 11 (cont.). Blue Crab Traffic Light individual production indicators and integrated summary (bottom figure), 1987-2017.

STATE-MANAGED SPECIES – BLUE CRAB

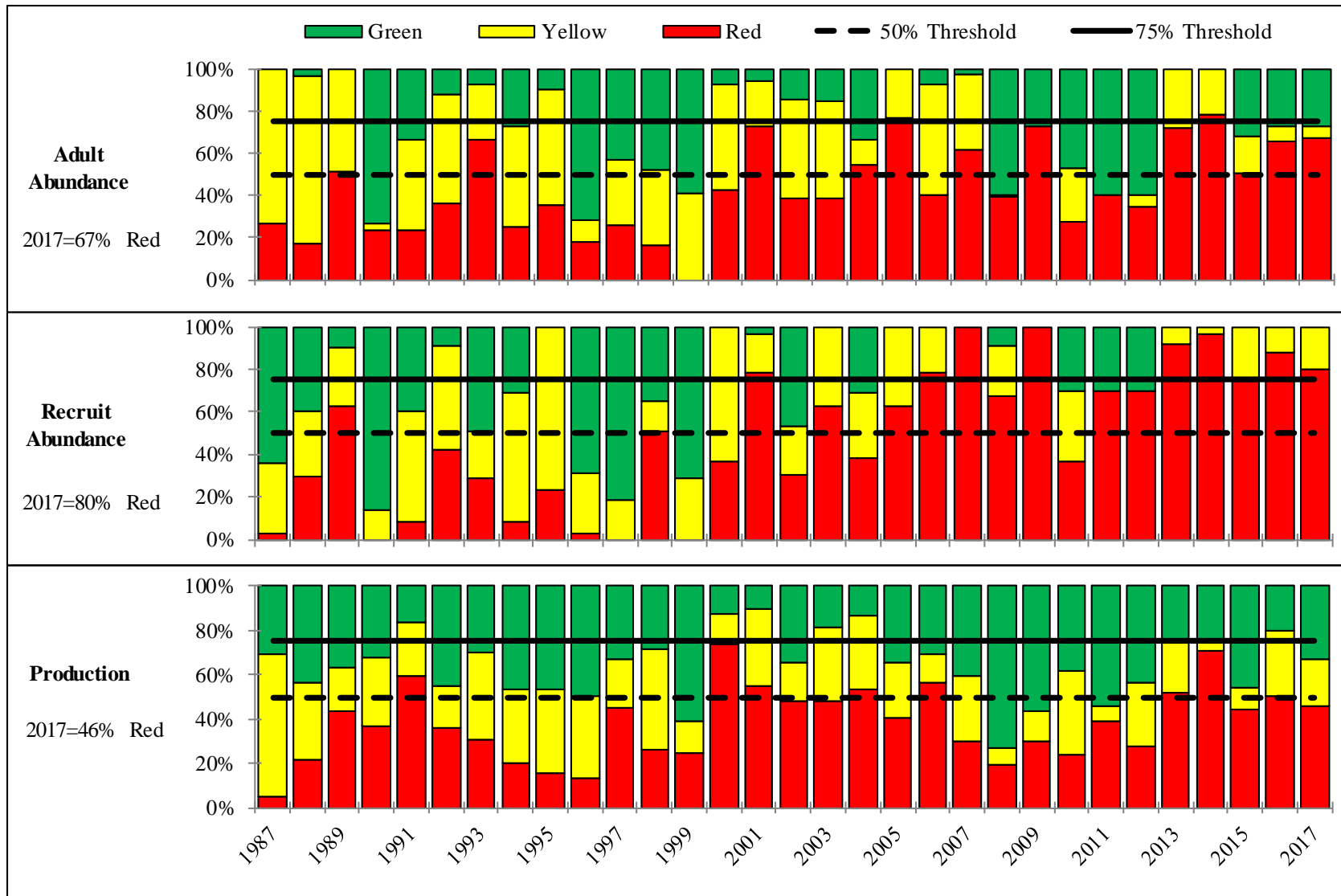


Figure 12. Blue Crab Traffic Light indicators for the adult abundance, recruit abundance, and production characteristics, 1987-2017. The dashed line represents the second quartile (50%) moderate management trigger and the solid line represents the third quartile (75%) elevated management trigger relative to the proportion of red.

STATE-MANAGED SPECIES – EASTERN OYSTER

FISHERY MANAGEMENT PLAN UPDATE EASTERN OYSTER AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | August 2001 |
| Amendments: | Amendment 1 – January 2003 Amendment 2 – June 2008 Amendment 3 – April 2014 Amendment 4 – February 2017 |
| Revisions: | None |
| Supplements: | Supplement A to Amendment 2 – November 2010 |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | July 2022 |

The original N.C. Oyster Fishery Management Plan (FMP) was adopted by the North Carolina Marine Fisheries Commission (NCMFC) in 2001. This FMP set up a process for designation of additional areas limited to hand harvest methods around Pamlico Sound and recommended several statutory changes to the shellfish lease program including higher fees, training requirements, and modified lease production requirements (NCDMF 2001). The N.C. Oyster FMP Amendment 1 simply changed one of the criteria for designation of hand harvest areas from waters generally less than 10 feet deep to waters less than six feet deep (NCDMF 2003). Highlights of the management measures developed in the N.C. Oyster FMP Amendment 2 included adopting a 15-bushel harvest limit in Pamlico Sound and a 10-bushel harvest limit for all gears (hand and mechanical) in designated areas around the sound, reducing the available harvest season, changing the way lease production averages were calculated, limited lease applications to five acres and had a recommendation to expand oyster sanctuary construction efforts (NCDMF 2008). Supplement A raised the potential harvest limit in Pamlico Sound to 20 bushels and created a monitoring system for determining when to close mechanical harvest in that area (NCDMF 2010). The N.C. Oyster FMP Amendment 3 created two seed oyster management areas in Onslow County. Amendment 4 was adopted in February 2017 with selected management measures including: the continuation of the monitoring system for when to close mechanical harvest off public bottom in an area, a reduction of the culling tolerance from 10 to five percent in the commercial fisheries off public bottom, a reduction of the daily harvest limit for holders of the Shellfish License off public bottom to two bushels per person per day

STATE-MANAGED SPECIES – EASTERN OYSTER

maximums four bushels per vessel, the continuation of the six-week open season to mechanical harvest off public bottom in the bays with changes in the timing of the six-week opening, modifications to shellfish lease provisions, and adding convictions of theft on shellfish leases and franchises to the types of violations that could result in license suspension or revocation.

Management Unit

The management unit includes the eastern oyster (*Crassostrea virginica*) and its fisheries in all waters of coastal North Carolina.

Goal and Objectives

The goal of the N.C. Oyster FMP is to manage the state's oyster population so that it achieves sustainable harvest and maximizes its role in providing ecological benefits to North Carolina's estuaries. To achieve this goal, it is recommended that the following objectives be met:

1. Identify, restore, and protect oyster populations as important estuarine habitat.
2. Manage and restore oyster populations to levels capable of maintaining sustained production through judicious use of natural oyster resources, enhancement of oyster habitats, and development and improvement of oyster production on shellfish leases and franchises.
3. Minimize the impacts of oyster parasites and other biological stressors through better understanding of oyster disease, better utilization of affected stocks, and use of disease resistant and biological stress resistant oysters.
4. Consider the socioeconomic concerns of all oyster resource user groups, including market factors.
5. Recommend improvements to coastal water quality to reduce bacteriological-based harvest closures and to limit other pollutants to provide a suitable environment for healthy oyster populations.
6. Identify and encourage research to improve understanding of oyster population ecology and dynamics, habitat restoration needs, and oyster aquaculture practices.
7. Identify, develop, and promote efficient oyster harvesting practices that minimize damage to the habitat.
8. Initiate, enhance, and continue studies to collect and analyze economic, social, and fisheries data needed to effectively monitor and manage the oyster resource.
9. Promote public awareness regarding the ecological value of oysters and encourage public involvement in management and enhancement activities.

STATUS OF THE STOCK

Life History

The eastern oyster (*Crassostrea virginica*) is a non-moving, filter feeding shellfish occurring naturally along the western Atlantic Ocean from the Gulf of St. Lawrence off Quebec, Canada to the Gulf of Mexico and the Caribbean Islands. The eastern oyster has been called the ultimate estuarine animal. It can tolerate a wide range of salinity, temperature, turbidity and dissolved oxygen levels, making it well adapted to the ever-changing conditions of the estuary. The

STATE-MANAGED SPECIES – EASTERN OYSTER

distribution and survival of eastern oysters within habitat types is influenced by abiotic factors such as salinity, tide, oxygen levels and flow, as well as biotic factors such as disease, shell erosion caused by other species and predation. North Carolina's oyster stocks are composed of both intertidal (oysters growing between the mean high and low tide levels) and subtidal (oysters growing below the mean low water level) populations.

Oysters are typically dioecious but can change their sex (hermaphroditic) once each year. Researchers have found that natural oyster populations maintain relatively balanced sex ratios, but exposure to stress, such as food limitation and pollution, results in a higher ratio of males. Gonads may develop in oysters two to three months old. Fully developed oysters entering their first summer season may spawn, but large portions of these young oysters are not sexually mature. Age or size selective mortality from disease and harvest pressure can alter oyster population demographics and result in a shift from male to female. The rate of oyster growth is highest during the first six months after the spat (juvenile oyster) sets and gradually declines throughout the life of the oyster. Seasonally, adult oysters grow most rapidly during spring and fall in North Carolina, reaching market size (3 inches) in about three years. Growth rates in other East Coast and Gulf Coast regions produce market size oysters in time periods ranging from 18 to 24 months in the Gulf of Mexico to four to five years in Long Island Sound.

Stock Status

There are insufficient data to conduct a traditional stock assessment for the eastern oyster in North Carolina, therefore population size and the rate that oysters are removed from the population could not be determined. North Carolina commercial oyster landings have been in decline for most of the past century. This decline was likely initiated by overharvest and compounded by habitat disturbance, pollution, and biological and environmental stressors. Oysters are believed to be more vulnerable to overharvest because these other factors negatively impact their survival.

Stock Assessment

An oyster stock assessment was attempted in 1999, but the necessary data were lacking to determine levels of sustainable harvest (NCDMF 2001). Since there were no significant changes in the types and quantity of data collected, an oyster stock assessment could not be achieved in 2006 and again in 2014 (NCDMF 2008; NCDMF 2017). Collection of appropriate data is needed in order to conduct a stock assessment and determine levels of sustainable harvest (NCDMF 2008).

Data are not available to perform a traditional assessment so it was not possible to estimate population size, demographic rates, or removals from the population in the latest FMP adopted in 2017. The only data representative of the stock were the commercial landings and associated effort. For this reason, the most recent analysis focused on trends in catch rates in the commercial oyster fishery. These catch rates could not be considered an unbiased representation of trends in population size; fisheries-dependent data are often not proportional to population size due to a number of caveats and should be interpreted with caution if the interest is relative to changes in the population. In order for a fisheries-dependent index to be proportional to

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abundance, fishing effort must be random with respect to the distribution of the population and catchability must be constant over space and time (NCDMF 2017). Other factors affecting the proportionality of fishery-dependent indices to stock size include changes in fishing power, gear selectivity, gear saturation and handling time, fishery regulations, gear configuration, fishermen skill, market prices, discarding, vulnerability and availability to the gear, distribution of fishing activity, seasonal and spatial patterns of stock distribution, changes in stock abundance, and environmental variables. Many agencies, such as the NCDMF, do not require fishermen to report records of positive effort with zero catch; lack of these “zero catch” records in the calculation of indices can introduce further bias.

The North Carolina commercial oyster fishery is subject to trip limits, which could bias catch rates (Mike Wilberg, University of Maryland Center for Environmental Science, personal communication; John Walter, National Oceanic and Atmospheric Administration Fisheries, personal communication). The trip limits affect the amount of catch that is observed per unit effort, preventing the true value of this variable from being observed. A censored regression approach was attempted to calculate an index of relative abundance (numbers harvested per transaction) using data collected from a fishery with trip limits.

Data were obtained from the North Carolina Trip Ticket Program for 1994 through 2013. The censored response variable (catch per unit effort) was fit within a Generalized Additive Models for Location Scale and Shape framework using the ‘gamlss.cens’ (Stasinopoulos et al. 2014) and ‘survival’ (Therneau 2014) packages in R (R Core Team 2014). Catch rates were estimated for both hand harvest and mechanical harvest in each of the major water bodies from which eastern oysters are harvested where sufficient data were available. Data were summarized by fishing year (October through March for hand harvest and November through March for mechanical harvest). Only landings from public bottom were examined.

Catch rates were expressed as bushels harvested per transaction. The censored regression approach failed for both hand and mechanical harvest data despite trying three different distributional assumptions (lognormal, gamma, t). This failure was believed to be due to the large number of trips (transactions) that meet or exceed the trip limit in both fisheries. Similar work found that when about 50 percent or more of the trips equaled or exceeded the trip limits, there was not enough information from the uncensored trips to produce a reliable model. Here, 51.4 percent of trips by hand gears equaled (39.3 percent) or exceeded (12.1 percent) the trip limits over all water bodies and fishing years combined; the number of trips equaling or exceeding the trip limits for mechanical gears was 43.5 percent (42.9 percent equaled and < one percent exceeded).

Available data were considered insufficient for estimating reliable fishing mortality rates.

A pilot project is underway over the next three years by The Nature Conservancy and North Carolina State University, with guidance from NCDMF, to develop a subtidal oyster population survey with the potential to become a long-term biological sampling program in NCDMF. Concurrent with these efforts and outside the scope of this pilot project, The Nature Conservancy is collaborating with the NCDMF and commercial oystermen to refine the collection of harvest data to gather more accurate information on harvest levels and effort, as well as discard mortality

STATE-MANAGED SPECIES – EASTERN OYSTER

from dredges. For the southern portion of the state, The Nature Conservancy will also map and illustrate changes from the NCDMF bottom mapping sampling program to delineate oyster reefs and evaluate changes over time as a precursor to a biological sampling program in intertidal oysters in the southern region of the state.

STATUS OF THE FISHERY

Current Regulations

Oysters cannot be taken from any public or private bottom in areas designated as prohibited (polluted) by proclamation except for special instances for: Shellfish Management Areas (NCMFC Rule 15A NCAC 03K .0103), with a permit for planting shellfish from prohibited areas (NCMFC Rule 15A NCAC 03K .0104), and for the depuration of shellfish (NCMFC Rule 15A NCAC 03K .0107). Beginning in April 2014, time and temperature control measures were initiated for oysters to prevent post-harvest growth of naturally-occurring *Vibrio* sp. bacteria that can cause serious illness in humans between April 1 and September 30 of each year. Oysters cannot be taken between the hours of sunset and sunrise of any day. Beginning in the 2017-2018 season the culling tolerance was reduced from 10 percent to five percent off public bottom based on management measures adopted in Amendment 4 of the N.C. Oyster Fishery Management Plan.

Public Bottom

The minimum size limit for oysters from public bottom is three-inch shell length. Both the hand and mechanical oyster harvest season from public bottom are opened annually by proclamation. It is unlawful to sell oysters taken on Saturday and Sunday from public bottom. The hand-harvest season for commercial and recreational harvest begins on October 15 each year with commercial harvest limited to Monday through Friday each week and recreational harvest allowed seven days a week. Hand-harvest methods to take oysters are allowed in all areas found suitable for shellfish harvest by the Shellfish Sanitation and Recreational Water Quality Section of the NCDMF during the open season. Beginning in 2013 through statutory changes, the Shellfish License was restricted to hand harvest only, and harvest by mechanical methods was prohibited. Recreational harvest is only allowed by hand methods. The season typically continues until closed by rule on March 31 although some locations close earlier due to perceived excessive harvest. Brunswick County is the only area frequently closed early due to this concern and it closed prior to March 31 fifteen times between the 1996-1997 and 2017-2018 seasons. The daily hand harvest limit for oysters in Pamlico Sound outside the bays is 15-bushel per day per commercial fishing operation and 10-bushels per day per commercial fishing operation in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound. Areas from Core Sound south have a daily hand harvest limit of five-bushels per person not to exceed 10-bushels in any combined fishing operation regardless of the number of persons, license holders, or boats involved. Recreational daily harvest limits in 2017-2018 were one bushel per person per day not to exceed two bushels per vessel per day.

Beginning in October of the 2017-2018 season, hand harvest for Shellfish License holders was limited to two bushels per person per day not to exceed four bushels per vessel per day if two or

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more Shellfish License holders are onboard the vessel (NCDMF 2017). Hand harvesters with the Standard Commercial Fishing License were allowed to continue landing the higher daily harvest limits in all areas.

The mechanical harvest season for oysters in 2017-2018 was opened November 13, 2017, and areas where mechanical harvest gear was allowed were restricted to deeper portions of the sounds, rivers and bays north of Pamlico Sound. These areas are designated by rule (NCMFC Rule 15A NCAC 03R .0108). Mechanical methods for oysters were only allowed to operate from sunrise to 2:00 p.m. during the 2017-2018 season (November 13 – March 31). Beginning in the 2017-2018 harvest season the six-week open period in the bays was split into two. The first opening in the deep bays began on the Monday of the week prior to Thanksgiving (November 13, 2017) through the Friday after Thanksgiving (November 24, 2017). The second opening of the bays began two weeks before Christmas (December 11, 2017) and ended on January 8, 2018.

Areas outside the bays open to mechanical harvest were limited to a daily harvest limit of 15-bushels of oysters per operation.

The mechanical harvest season can close sooner for areas in Pamlico Sound if sampling by NCDMF indicates that oysters of legal size have been reduced to below 26 percent of the live oysters sampled for two consecutive sampling trips, as directed by Amendment 4 of the Oyster FMP. Mechanical harvest was closed on December 7, 2017 in the Neuse River area, Pamlico River and Northern Dare County areas on December 25, 2017, and Northern Hyde County area on January 29, 2018 (Table 1; Figure 1). All mechanical harvest areas remained closed until the season ended on March 31, 2018.

There are also further restrictions noted in the proclamation for mechanical oyster harvesters to make sure that cultch material and culled oysters are either put back into the water where they were taken or remain on the existing rocks. North Carolina has a rule in place (NCMFC Rule 15A NCAC 03K .0202) requiring culling on site. The following restrictions were put in place beginning with the 2012-2013 oyster season to discourage harvesters from not culling and removing extra cultch material.

It is unlawful to possess more than **five** bushels of unculted catch onboard a vessel. Only material on the culling tray is exempt from culling restrictions.

It is unlawful to possess unculted catch or culled cultch material while underway and not engaged in mechanical harvesting.

Also, some harvesters did not have vessels or dredges rigged for circular dredging patterns which work best with towing points over the side of the vessel or for short tows to allow for culling between pickups. The following restrictions were put in place to encourage circular dredging patterns and shorter tows to keep the cultch and culled oysters on the existing rocks.

It is unlawful for the catch container (bag, cage) attached to a dredge to extend more than **two** feet in any direction from the tooth bar.

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It is unlawful to tow a dredge unless the point where the tow line or cable exits the vessel and goes directly into the water is on the port or starboard side of the vessel forward of the transom.

Private Bottom

The minimum size limit for oysters from private bottom is a three-inch shell length and culling requirements only occur during the open public harvest season, the rest of the year there is no minimum size requirement for oysters taken from private bottom. There is no daily maximum harvest limit applied to the taking of oysters from private bottom in internal waters. Permits are required to use mechanical methods for oysters on a lease or franchise. Public bottom must meet certain criteria in order to be deemed suitable for leasing for shellfish cultivation and there are specific planting, production, and marketing standards for compliance to maintain a shellfish lease or franchise. There are also management practices that must be adhered to while the lease is in operation, such as: marking poles and signs, spacing or markers, and removal of markers when the lease is discontinued.

Possession and sale of oysters by a hatchery or aquaculture operation and purchase and possession of oysters from a hatchery or aquaculture operation are exempt from the daily harvest limit and minimum size restrictions. The possession, sale, purchase and transport of such oysters must be in compliance with the Aquaculture Operation Permit. Leases that use the water column must also meet certain standards as outlined in G.S. 113-202.1 in order to be deemed suitable for leasing and aquaculture purposes.

There is a specific application process to obtain a lease and a public comment process that is required before a shellfish lease is granted if anyone wishes to protest the issuance of a lease. Owners of shellfish leases and franchises must provide annual production reports to the Division. Failure to furnish production reports can constitute grounds for termination. Cancellation proceedings will begin for failure to meet production requirements and interfering with public trust rights. Corrective action and appeal information is given. And there are also requirements for the transfer of a lease before the contract term ends.

Commercial Landings

Data on landings from public bottom by gear indicate that, prior to 1960, most of the oysters were taken by dredge when compared to all hand methods. Chestnut (1955) reported that 90 percent of the oysters landed in North Carolina came from Pamlico Sound. The Pamlico Sound area is largely dependent on dredging. The resurgence of the dredge landings in 1987 was due, in part, to increased oyster populations and in part to increased effort, as displaced mechanical clam harvesters turned to oyster dredging due to closure of southern clam areas by a red tide. The red tide was a dinoflagellate bloom that caused closure of over 361,000 acres of public bottoms to shellfish harvest from November 1987 to May 1988. The dinoflagellate (*Karenia brevis*) produced a neurotoxin, which was concentrated in shellfish, making them unfit for consumption. These closures affected 98 percent of the clam harvesting areas and had its greatest impact on the clam fishermen. Hand harvest landings of oysters failed to reach their potential that same year due to the fact that the majority of the hand-harvest-only areas were also closed because of the

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red tide. Hand harvest landings are the most consistent contributor to the state's oyster fishery. Hand harvest landings exceeded the dredge landings for significant periods between 1961 and 1970 and between 1989 and 2008 (NCDMF 2017).

The oyster parasite *Perkinsus marinus*, also known as Dermo disease, has been responsible for major oyster mortalities in North Carolina during the late 1980s to mid-1990s. Dermo, a protist, similar to dinoflagellates, causes degradation of oyster tissue. Once infected, oysters suffer reduced growth, poor condition, diminished reproductive capacity and ultimately mortality resulting from tissue lysis and occlusion of hemolymph vessels (Ford and Figueras 1988; Ford and Tripp 1996; Haskin et al. 1966; Ray and Chandler 1955). Chestnut (1955) may have been the first to report its occurrence in North Carolina. However, no extensive assessments were attempted until large-scale oyster mortalities prompted investigations during the fall of 1988. Oyster samples from 11 sites were sent to the Virginia Institute of Marine Science (VIMS) and the Cooperative Oxford Laboratory. Results showed that Dermo infection was the major cause of mortalities (NCDMF 2008).

Staff observed in the southern estuaries, while the Dermo infections were on the rise, that during late summer, moderate and high Dermo infection levels did not reduce oyster populations. Hand harvest landings in the south from 1991 through 2002 did not decline in the same manner as landings from Pamlico Sound during the same time. It is suspected that the small, high salinity estuaries may inhibit mortality by flushing out parasites at a higher rate or by exceeding the salinity tolerance of the Dermo parasite, allowing for a higher survival rate compared to Pamlico Sound. The link between low dissolved oxygen, increased availability of iron and increased parasite activity may also be a factor in the different mortality rates as the smaller, high salinity estuaries are less prone to low dissolved oxygen events than the Pamlico Sound (Leffler et al. 1998). Dermo infection intensity levels since 2005 have remained low; however, prevalence appears to be increasing (NCDMF unpublished data; Colosimo 2007). Dermo infection intensity has remained low and mechanical harvest landings in Pamlico Sound continued to recover from the extremely high Dermo mortality levels and hurricane impacts of the mid-1990s until additional environmental impacts (i.e., low dissolved oxygen) began affecting the fishery in 2011 (Figure 2).

Bioeroders (other species that tunnel into the oyster's shell), in particular boring sponge (*Cliona* sp.), are also of concern to researchers for their impacts to oyster reefs in North Carolina. These sponges can chemically etch out canal systems within oyster reefs, as well as encrust and smother them. Boring sponges range in color from yellow to dark brown or black and can cause mortality by weakening the shell. As the shell becomes weak, the oyster is unable to protect itself from predators. Once the oyster reef has been compromised, there is a loss of material for spat attachment and eventually a reduction in the vertical height of the reef. Boring sponges are linked to salinity gradients with some species found in high salinity waters while other species are found in the low to mid-range salinities but typically are not found in waters with less than 10 parts per thousand. Intertidal oysters have some refuge from boring sponge. Dunn et al. (2014) examined the distribution and abundance of oyster reef bioerosion by *Cliona* sp. in North Carolina. The study examined levels of boring sponge infestations across salinity gradients in multiple oyster habitats from New River through the southern portions of Pamlico Sound. The study found boring sponge infestations in all oyster communities sampled, with the exception of

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those found in the upper reaches of some tidal creeks in the Newport and North rivers in Carteret County. Low salinity areas had mean salinity levels of 15 parts per thousand while the higher salinity areas had a mean salinity of 20 parts per thousand or greater. High salinity areas were infested by the high salinity tolerant boring sponge *Cliona celata*. The study found that as salinities increased, infestations increased.

Overall commercial oyster landings from private bottom have been increasing while landings off public bottom have been much more variable in the last 10 years (Figure 2). Hand harvest landings exceeded the mechanical landings from public bottom in 2007 to 2008, 2012 to 2013, and 2015 to 2017 (Figure 3). The most significant increase in oyster landings from public bottom in the past ten years occurred in the mechanical harvest fishery in Pamlico Sound during the 2009-2010 and 2010-2011 seasons (Figures 2 and 3). There was a high abundance of oysters in some areas in Pamlico Sound that had not been seen in over 20 years, high market demand, and an increase in new participants in the fishery likely influenced these higher landings. In 2013 General Statute 113-169.2 limited the use of the Shellfish License to hand harvest methods only, this license is available to all residents of North Carolina for a lower fee than the Standard Commercial Fishing License. Hand harvest has shown a slight increasing trend in landings for the past 10 years. In 2017, hand harvest commercial landings off public bottom were five times higher than mechanical harvest landings off public bottom (Figure 3).

Mechanical Harvest Fishery Off Public Bottom

During the early 2009-2010 mechanical harvest oyster season, the Narrows area between Great Island and the mainland in Hyde County in Pamlico Sound experienced intensive oyster harvest (Figures 1, 2 and 3). Some of the operations were harvesting the 15-bushel limit, offloading, returning to the area with a new crew and harvesting another limit the same day. The 2010-2011 season began with a 2:00 pm time limit on dredging to stop the two-trips-per-day loophole but it probably had little impact on mechanical harvest since experienced dredgers could take their limit in a few hours and there appeared to be many new entrants into the fishery. The traditionally harvested oyster rocks in the deeper waters of western Pamlico Sound contributed greatly to the increased landings in the 2009-2010 and 2010-2011 seasons but the Middle Ground area in 2010-2011 provided another unexpected source of significant oyster production similar to the Great Island Narrows in 2009 (Figures 2 and 3). Also, interest in taking advantage of expected high market demand caused by closure of oyster harvest areas in the Gulf of Mexico due to the Deepwater Horizon oil spill lengthened the season slightly with a November 1 mechanical harvest season opening in the fall of 2010.

Hurricane Irene hit the North Carolina coast on August 27, 2011 and had major impacts on the mechanical harvest area for oysters. The oyster resources on the Middle Ground could not be located after the storm probably due to sedimentation or physical relocation caused by waves or currents. Many of the deeper water oyster resources located near Brant Island Shoal were also significantly damaged (Figure 4). Oyster resources in the Neuse and Pamlico rivers did not appear to suffer much damage but also did not show any of the typical growth characteristics during the following fall and winter months. These factors had a pronounced effect on the mechanical harvest oyster season in 2011-2012 and the mechanical harvest area in western Pamlico Sound was closed in January. Mechanical harvest landings declined to near 2008-2009

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levels during the 2011-2012 season (Figure 3). Regular sampling of oyster sizes to fulfill the requirements of Amendment 4 to the N.C. Oyster FMP has made it clear that oyster growth during the harvest season is essential to sustain acceptable harvest levels.

In the summer prior to the 2012-2013 mechanical harvest season, an apparent, severe low dissolved oxygen event occurred in the Neuse River that caused virtually a 100 percent mortality of the oyster resources at 18 feet or greater depths. The Pamlico River area also had not recovered from the effects of Hurricane Irene at this time. There still was little evidence of any recovery of the Neuse River oyster resources prior to the 2013-2014 season but the Pamlico River area appeared to be recovering and growth indicators were good during the season. The Northern Dare area in Pamlico Sound also supported some significant mechanical harvest activity throughout the 2013-2014 season.

During the 2014-2015 mechanical harvest season effort was still consistently low in the Neuse River, with effort peaking in all areas in mid-December. Closures of the Northern Hyde and Dare areas resulted in declines in harvest in January and foul weather increased these declines in February. Staff continued to sample and Northern Dare was re-opened in early March and closed by rule on March 31, 2015. The fleet encountered what was described as a “crust” covering much of the oyster rocks fished on re-opening day and took several days to break up this “crust”. Effort was high for the re-opening with approximately 50 boats fishing on the first day and dropping off to around 20 boats after a few days.

Water temperatures were quite warm throughout the 2015-2016 season and not a lot of new growth was observed until January on the oysters. Some areas in Northern Hyde were covered in tunicates the previous year and little spat was seen in these locations during this season. Planting sites in the Northern Dare area samples showed a lot of dredge damage from the previous year and effort was low the entire season because the warm water temperatures kept most fishermen potting for crabs up until the pot closure period in January. The Neuse River area was limited in locations to harvest oysters and closed early this season. Effort was highest in the Pamlico River at the beginning of the season and then after Christmas effort shifted to areas off Northern Hyde. The area that was dredged by most of the fleet in January 2016 was an old clam bed with little bottom relief. The oysters were large and showed good growth. By late January the new area was depleted and fishermen were seen working offshore Juniper Bay Point near the sanctuary, off Great Island, and Royal Shoal in the deeper areas of Pamlico Sound. By mid-February many oyster fishermen working in Northern Hyde and the Pamlico River quit harvesting oysters because they could not reach their daily harvest limit and were gearing up for other fisheries (i.e. crab pots and shad fishing). The Northern Dare area closed in late February.

Like the previous season, water temperatures were quite warm and little growth was observed in the oysters until January in the 2016-2017 season. In the Neuse River live oysters were present in only a few locations. A confirmed low dissolved oxygen event occurred earlier that summer over a prolonged period near the mouth of the Neuse River which may have had an impact on oysters in this area. Within a few weeks of the season opening, only a few oyster harvesters were working in the Neuse River area, and most live oysters were found in shallow water (less than 20 feet deep). At the beginning of the season most of the effort was concentrated in an old clam bed west of Bluff Shoal in the Northern Hyde area, which showed good numbers of legal-sized

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oysters with hardly any spat. Oyster harvesters continued to work in this area all season without much movement. In mid-November, reports from Northern Hyde and the Pamlico River areas indicated only a few fishermen were harvesting oysters. By late December the few oyster harvesters seen on the water were having to move around a lot to find oysters. In January, dealers indicated fishermen had moved on to other fisheries (shrimping in the ocean or small mesh gill netting in estuarine waters). January 2017 samples showed better growth on the oysters and spat on the cultch. Mechanical harvest was closed within a few weeks apart starting in mid-January in the Neuse River and Northern Dare areas for the remainder of the season. The Pamlico River and Northern Hyde areas remained open for the entire 2016-2017 season, but only a few fishermen remained harvesting oysters in early February and by mid-February no effort was seen in the open areas while sampling.

Pre-season sampling in October-November 2017 showed a lot of spat and small oysters in all areas, and two areas (Neuse River and Northern Dare) came in below the threshold (<26 percent) of legal-sized oysters in the samples. The 2017-2018 mechanical harvest season began Monday, November 13, 2017, and the six-week open period in the bays was split into two. The culling tolerance was also reduced from 10 to 5 percent following the latest management strategies. Oysters were small according to the dealers at the beginning of the season and showed little growth. The Neuse River only had a few areas with live oysters available and closed on December 7, 2017 after reaching the legal-sized threshold for closure. Small oysters that would not grow into legal-size this season were also pre-dominant in the Pamlico River and Northern Dare areas sampled early in the season. By early December both areas had one sampling event that came in below the legal-size threshold. As legal-sized oysters became harder to find in the Northern Hyde and Pamlico River areas, effort started to move to the Northern Dare area and by mid-December the majority of the fishermen were working in the main oyster areas in Northern Dare. Both Pamlico River and Northern Dare areas were closed to mechanical oyster harvest on December 25, 2017. Only Northern Hyde County remained open into 2018, but eventually met the threshold as the other areas and closed to mechanical harvest by late January. All mechanical harvest areas for oysters remained closed for the rest of the season. In addition, starting the first week of January 2018 and for the next two weeks, coastal North Carolina experienced record low temperatures, with at least one consecutive 72-hour period where air temperatures were below freezing. Most inshore areas and some of the deeper water areas had ice. Some areas maintained ice for two weeks. In mid-January reports were coming in that some of the subtidal oysters in Pamlico Sound had been impacted by the freezing. Particularly in shallow water areas where oysters are exposed to the air for a period of time caused by wind-driven tides.

Hand Harvest Fishery Off Public Bottom

Hand harvest gear accounts for the majority of the landings and has been the dominant harvest gear for oysters in North Carolina since the 1960s. Hand harvest oyster landings are also less variable than landings from mechanical gears (Figure 3). These higher, more consistent landings come from Core Sound south to the state line. The hand harvest areas in the northern region of the state are exclusively subtidal reefs with depths of 2 to 6 feet in which hand tongs are used. Hand harvest gear has not been extensively used in the northern area since oyster dredging was allowed in 1887. In Amendment 2 to the N.C. Oyster FMP in 2008, the MFC adopted the

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strategy to promote a more habitat friendly fishery by increasing the hand harvest limits to match dredging limits in the Pamlico Sound bay areas. Amendment 2 put in place a 15 bushel per day hand/mechanical harvest limit per commercial fishing operation in Pamlico Sound mechanical harvest areas outside the bays, a 10 bushel per day hand/mechanical harvest limit per commercial fishing operation in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound. This management option raised the limits of hand harvest to encourage less destructive harvest methods in those particular bays and open waters.

These management measures for hand harvest in Pamlico Sound area will continue through Amendment 4 of the N.C. Oyster FMP adopted in February 2017, but only to holders of the Standard Commercial Fishing License after October 2017. Beginning in the 2017-2018 season, hand harvest limits will remain five bushels per person, not exceeding 10 bushels per commercial fishing operation from Core Sound south to the North Carolina-South Carolina border for holders of the Standard Commercial Fishing License. Harvesters holding a Shellfish License statewide will be limited to two bushels of oysters per person per day no more than four bushels per vessel beginning in October 2017 to maintain the selected management strategy adopted by the NCMFC in Amendment 4 of the N.C. Oyster FMP. Areas in the southern region from Core Sound south are closed to mechanical harvest of oysters.

Other factors affecting the hand harvest fishery are the loss of harvest area due to pollution closures. Many shellfish waters in North Carolina are permanently or conditionally closed due to bacterial contamination associated with urban development (Table 2). The greatest proportion of closed shellfish waters occur in the southern district (Onslow, Pender, New Hanover, and Brunswick counties) where over half of the waters are closed and can be attributed to small, narrow waterbodies and more developed watersheds. The area north of Core Sound with the higher hand harvest limits does not have the same problem with large percentages of the available harvest area closed by pollution so oyster harvest is not impacted.

Hand-harvest oyster landings have generally increased in recent years (Figure 3). Oyster harvest south of the Highway 58 Bridge generates significant landings even though the area only encompasses five percent of the total area open to shellfishing in the state.

The 2017-2018 open oyster harvest season off public bottom from Core Sound and areas south started slow because of rain and temporary closures, and high tides during the middle of the day making it difficult to access the oysters. Staff did look at oysters in Pender and Onslow counties, and the oysters showed good growth. No complaints were received from the public or dealers from the southern region on oyster harvest until January. As in the Pamlico Sound, the intertidal oysters in the southern region of the state were impacted by record low temperatures that lasted over two weeks in early January. Reports were received that the cold temperatures and low tides during this period caused the oysters to die. Staff also saw directly dead spat and legal-sized oysters with meat still intact. The oyster season was closed 15 days early in Brunswick County due to public comment and management's concerns of excess harvest pressure on an ever-decreasing area open to shellfishing. Brunswick County continues to be closed more often during the season because of temporary shellfish closures after rainfall events, compressing harvest into small areas and decreasing the amount of legal-sized oysters available to harvesters much quicker than in most other areas.

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Permanent and Temporary Shellfish Closures

Microbial contamination from fecal matter is important to NCDMF because it affects the opening and closing of waters to shellfish harvest. Fecal coliform bacteria occur in the digestive tract of, and are excreted in the solid waste from, warm-blooded animals including humans, wildlife and domesticated livestock (Mallin 2009). Because consumption of shellfish containing high levels of fecal coliform bacteria and associated pathogens can cause serious illness in humans, shellfish growing waters must be closed to shellfish harvest when fecal coliform counts increase above the geometric mean standard of 14 MPN/100mL [NCMFC Rules 15A NCAC 18A Section .0900 Classification of Shellfish Waters], where MPN denotes “most probable number.” The NCDMF closes waters where a high potential for bacterial contamination exists, such as around marinas and point source discharges. Shellfish harvest closures have continued to occur over time, which has led to a reduction in available shellfish harvest areas. Long term shellfish closures due to bacterial contamination remove available harvest area for shellfish and concentrate those activities on remaining resources compounding harvest related impacts on the oyster habitat in those areas.

Between 2007 and 2014, there were 1,427 additional acres of water permanently closed to shellfish harvesting in North Carolina, while between 2015 and early 2018, 3,729 additional acres were closed (Table 2). In March 2017, about 180 acres of additional shellfishing waters were permanently closed in the Lockwoods Folly River and Spring Creek, which made almost the entire river unavailable to shellfish harvest. About 90 acres of this closure was reopened in late 2017 after improvements in bacteriological water quality were seen. Throughout 2017 and early 2018, an additional 1,882 acres were closed to shellfishing activities in Pamlico County and areas north. On February 4, 2015, approximately 314,710 acres were closed administratively in lower resource areas as a result of the inability to sample due to budget constraints. The areas closed to shellfish harvest because of the inability to meet federal sampling requirements caused by funding cuts were approximately 11,834 acres in the Neuse River, approximately 3,042 acres in the Pungo River, and approximately 299,107 acres in Albemarle Sound.

In addition to the areas that are permanently closed to shellfishing, other areas are temporarily closed during periods of high rainfall due to runoff. The rainfall closure threshold varies by growing area as detailed in each management plan, and can vary from 1 inch to 2.5 inches of rain in a 24-hour period. Closures last from several days to more than a month, and reopen when bacteriological water sample results show the area has returned to normal conditions. Large storms, such as hurricanes, result in harvest closures covering much larger areas, sometimes including all of North Carolina's estuarine waters. The conditionally approved areas are concentrated in the Core-Bogue, New-White Oak, and Southern Estuaries management units. Within these watersheds, permanent closures are most common in the upper reaches of tidal creeks and rivers, with conditionally approved areas occurring downstream of those areas or in the upper portions of less degraded creeks. As temporary closures have increased in frequency and duration, they have become an issue of great concern to the public, particularly in the southern area of the coast.

2017 was an average year for rainfall amounts throughout the North Carolina coast, and temporary closures during oyster season were not as significant as those seen in 2015 or 2016.

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Portions of the Newport River area were closed to harvest for 20 percent of the harvest season (compared to 63 percent in 2016), while portions of the Lockwoods Folly River area were closed for 31 percent of the season (compared to 51 percent in 2016), and portions of Stump Sound for 13 percent of the season (compared to 43 percent in 2016).

Private Culture

Statutory authority to lease bottomlands for shellfish cultivation can be traced back to a statute adopted in 1909. Today some shellfish leases are held by commercial fishermen to supplement their income from public harvest areas. Other shellfish leases are held by individuals and corporations looking to augment other sources of income; to be engaged in a sustainable business opportunity; or to maintain an attachment to cultural maritime heritage and way of life. Since 2012 administrative and process changes have been made to allow for better customer service, communication and ongoing support of the North Carolina Shellfish Lease and Franchise Program. Process operations and customer support were reviewed; actions were undertaken and implementation steps were completed to improve process operations and to provide a higher level of customer service.

The NCDMF administers the shellfish lease program whereby state residents may apply to lease estuarine bottom and water columns for the commercial production of shellfish. The NCDMF does not differentiate between clam, oyster, bay scallop, and mussel leases; therefore, allowing shellfish growers to grow out multiple species simultaneously or as their efforts and individual management strategy allows. For the period of 2003-2013, roughly 40 percent of all private culture operations harvested only oysters (NCDMF 2017).

Since 1994 there has been an overall increase in oyster harvest from private culture operations. Oyster harvest from private culture operations in the period from 1994 to 2013 account for 12 percent of all oyster landings (NCDMF 2017). Due to increase interest in private culture of oysters and lower landings off public bottom, private culture harvest accounted for 53 percent of the total oyster landings in 2017 (Figure 2). As of 2017, the lease program had 325 leases, and 50 bottom lease and 46 water columns amendment applications during the year. Currently shellfish leases take up about 1,960.7 acres of bottom (M. Graven; Lease Program Coordinator, NCDMF; May 2018).

Recreational Landings

Recreational landings for oysters in North Carolina are unavailable because there are no license requirements to take shellfish for personal consumption and therefore no way to fully determine the user group to collect their harvest information. Since 2011, the division has collected effort and catch data from the recreational oyster harvesters by surveying those individuals that indicate participation when purchasing a recreational fishing license. This survey does not include recreational oyster harvesters that do not purchase a recreational fishing license. Effort continues to produce state wide estimates of recreational oyster harvest.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Currently, the only data available for the stock in all areas are the commercial landings and associated effort from the Trip Ticket Program. No fishery dependent monitoring programs occur for oysters.

Fishery-Independent Monitoring

There are two independent programs for oysters. One is an indicator for habitat disturbance and damage of the commercial dredge fishery on public bottom to determine closure of the season for habitat protection of oyster rocks (Program 627). The second program is a long-term spatfall sampling program conducted by the Habitat and Enhancement section to estimate recruitment of spat (Program 610).

Public Bottom Mechanical Harvest Area Oyster Sampling

Supplement A to Amendment 2 established the trigger for closing areas to mechanical harvest to protect the resource and habitat, which was approved to continue under Amendment 4 of the Oyster FMP. The management trigger was established and defined as when the sampling indicates the number of legal-sized (three-inch) oysters in the area has declined to 26 percent of the live oysters sampled. The management areas are divided geographically into four areas; the Neuse River Area, Pamlico River Area, Northern Hyde Area, and Northern Dare Area (Figure 1). Sampling targets areas and oyster rocks being worked by commercial oystermen, directly before the opening of and throughout the mechanical harvest oyster season. The sampling sites are selected based on the presence/absence of commercial oystermen working in the area. Only areas where commercial oystermen are working are sampled to determine localized depletion and address habitat protection. From each sample, the first 100 live oysters, including spat and any boxes, are collected for workup. Each oyster, up to a maximum of 100, is measured to the nearest mm and inspected for any damage. Shell damage is denoted as none, minor, or substantial for further evaluation.

Sampling began on September 23, 2009 with preseason oyster sampling, in four management areas, using mechanical harvesting methods. Sampling has consistently continued with a target of 10 sites per management area, throughout the four management areas. All sampling is conducted using NCDMF vessels and standard oyster dredges with comparable construction to those used by commercial oystermen. Samples are collected at least bi-monthly in each management area (weather permitting) before, during, and after the open mechanical oyster harvest season. More intensive sampling is conducted if samples are near the trigger percentage. Sampling continues after an area is closed to assess the possibility of reopening. Sampling is discontinued when it is apparent that reopening is not likely to occur. Mean oyster shell height (commonly referred to as length) is calculated for each 100-oyster sample. The number of legal-sized (≥ 76 mm; ≥ 3 inches) and undersized (< 76 mm; < 3 inches) oysters is determined for each sample. The total legal-sized oysters for all the samples taken in a management area on a sampling trip is divided by the total of all oysters sampled on that trip to calculate the percentage

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used to assess compliance with the harvest closure trigger. Oyster sizes are also sorted into five-mm size bins and the size distribution for the area is presented as a bar graph. Sampling results are reported to interested dealers/fishermen and staff after each sampling event.

This sampling is not intended for use as a species abundance index, but instead to reflect the conditions of the habitat during the open oyster mechanical harvest season to determine closure of an area as a protection measure. For this update, only the 2017-2018 open mechanical harvest season data will be provided with a brief overview of the season.

Pre-season samples from the Pamlico River and Northern Hyde areas exceeded, while the Neuse River and Northern Dare areas fell below the 26 percent legal-sized threshold, before the 2017-2018 mechanical harvest season opened. Table 1 shows the percentages of legal-sized oysters taken by area throughout the 2017-2018 mechanical harvest season and the number of commercial oyster vessels operating in the area while sampling occurred in parentheses. Effort was down this harvest season in all areas. By January the long duration of low temperatures had frozen some of the oysters and dealers did not want to buy them in case the oysters would die while on the shelf. Like the 2016-2017 season little growth was observed in the oysters until January. A lot of spat and small oysters were present in the Pamlico Sound harvest areas that would not grow into legal size that season. Mechanical harvest was closed on December 7, 2017 in the Neuse River area and in the Northern Dare and Pamlico River areas on December 25, 2017 (Table 1; Figure 4). Northern Hyde closed on January 29, 2018 and all mechanical harvest areas remained closed until the season ended on March 31, 2018.

Spatfall Evaluation

Division staff conduct spatfall sampling annually (Program 610), on cultch planting sites from the previous three years during January, but samples may be collected through April if required. Subtidal sites are sampled by towing a standard oyster dredge over the planting site until, at a minimum, 30 pieces of cultch are collected. Normally a 75-pound, 36-inch toothed bar dredge is used; however, various other dredges may be used. On rare occasions, patent tongs and hand tongs may be used to obtain planting samples. Intertidal sites are sampled by hand at low tide in all applicable intertidal areas of the Southern District and hand tongs are used in the more northerly subtidal areas of Stump Sound and New River. Three tong grabs per location are usually taken to obtain the minimum amounts of cultch required. Gear type and any other valuable gear parameters are recorded. Prior to 2005, data was not collected south of New River.

Thirty pieces of cultch are randomly selected from each sample and the type of cultch (oyster, calico scallop, surf clam, marl, or sea scallop) is noted. The total number of spat on each piece of cultch is enumerated, with each spat being measured to nearest millimeter shell length. The average number of spat per piece of cultch is calculated by summing the number of spat per cultch piece, divided by the total number of cultch pieces sampled. Annual Juvenile Abundance Index (JAI) is calculated as the average number of spat per site and then averaged across all sites within that year. The 10-year average is calculated by averaging the annual JAI over the last 10 years.

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The Juvenile Abundance Index has been somewhat variable from year to year in the early years in the time series, but overall showing a declining trend for the past 10 years (Table 3; Figure 5). The 2017 and 2018 indices were the lowest and below the average (Annual average number of spat across all sampling sites) in the 10-year time series (Table 3).

MANAGEMENT STRATEGY

There are no management triggers or methods to track stock abundance, fishing mortality, or recruitment between benchmark reviews in the current FMP.

Amendment 4 was adopted in February 2017 and implementing rule changes became effective May 1, 2017. The selected management strategies of the NCMFC in Amendment 4 for oysters taken from public bottom include:

- the continuation of the monitoring system to determine when to close mechanical oyster harvest in an area;
- aligning the maximum daily harvest limit for oysters with current management;
- continuing the six-week open mechanical harvest in the bays, but close the bays to mechanical harvest for two weeks after Thanksgiving and then re-open two weeks before Christmas for the remainder of the six-week open mechanical harvest in the bays;
- a reduction of the culling tolerance from 10 percent to five percent for the possession of sublegal oysters; and
- a reduction of the daily harvest limit for Shellfish License holders to two bushels per person not to exceed four bushels per vessel.

For private culture of oysters, the selected management strategies in Amendment 4 include:

- adding convictions for theft of shellfish from leases or franchises to the list of convictions that may result in revocation of fishing licenses to implement stronger deterrents to shellfish theft and intentional aquaculture gear damage;
- clarifying how production and marketing rates are calculated for shellfish leases and franchises to meet minimum production requirements;
- expanding the maximum proposed lease size to 10 acres in all areas; and
- specifying criteria that allow a single extension period for shellfish leases of no more than two years per contract period to meet production and marketing requirements in the case of unforeseen circumstances, and reorganize the rules for improved clarity.

Amendment 4 also included the expansion of oyster enhancement activities.

The selected management recommendations and implementation status can be found in Table 4 in Amendment 4 of the FMP adopted by the NCMFC in February 2017.

2017 Legislative Long Session

Session Law (S.L.) 2017-57, the Appropriations Act of 2017, allocated both non-recurring and recurring funds in the budget to support oyster sanctuaries, oyster rehabilitation or cultch planting, and positions within NCDMF to provide services to accelerate shellfish industry

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growth. Section 13.12 required that the NCDMF and the University of North Carolina at Wilmington report annually to the chairs of the Senate and the House of Representatives appropriations committees with jurisdiction over natural and economic resources and the Fiscal Research Division regarding the funding for oyster research and restoration activities provided by this act. The report shall include details regarding the use of the funds, including activities completed and additional personnel supported by the funds.

Session Law 2017-57 also amended S.L. 2016-94, which had already made several changes to General Statutes 113-202, 113-202.1, and 113-202.2 that are part of the shellfish lease and franchise program. Section 13.13(a) identified the North Carolina Policy Collaboratory (known as the Collaboratory) as the lead to convene a stakeholder group to study and advance efforts to ecologically restore and achieve economic stability of the shellfish industry. This clarified the focus on both native oyster populations and aquaculture-grown oysters in North Carolina and identified how to populate the stakeholder group.

In S.L. 2017-57, Section 13.13(b) the Collaboratory was also tasked to prepare and deliver a Shellfish Mariculture Plan by Dec. 31, 2018 to the Joint Legislative Oversight Committee on Agriculture and Natural and Economic Resources, the chairs of the House of Representatives Appropriations Committee on Agriculture and Natural and Economic Resources, the chairs of the Senate Appropriations Committee on Agriculture, Natural, and Economic Resources, and the Fiscal Research Division with specific details on what information the Plan shall consider. These considerations include an examination of existing shellfish mariculture operations within the State and from other states and countries, siting strategies, enforcement needs, opportunities for local traditional fishermen, environmental policies that protect or enhance operations, appropriate substrate for cultch planting, strategies to mitigate or eliminate shellfish pests, and any other issues deemed relevant by the Collaboratory. Section 13.13(d) requires the Collaboratory to consult with several stakeholder groups and develop conceptual plans and recommendations for economic development related to promotion of the State's shellfish harvesting heritage, including recommendations of locations, oversight, governmental support, cost, and timing of initiatives. The Collaboratory's recommendations shall be provided no later than March 1, 2018 to the same groups as required for the Shellfish Mariculture Plan. These economic development plans and recommendations shall be included as an appendix to the Shellfish Mariculture Plan.

2016 Legislative Short Session

During the 2016 legislative short session, both non-recurring and recurring funds were part of the budget to support oyster sanctuaries (non-recurring), oyster rehabilitation or cultch planting (non-recurring), and positions within NCDMF to provide services to accelerate shellfish industry growth (recurring funds).

Session Law 2016-94, Section 14.11: Promote the Shellfish Industry

Session Law 2016-94, Section 14.11 made several changes to General Statutes 113-202, 113-202.1, and 113-202.2 that are part of the shellfish lease and franchise program. The lease rental due date was modified [G.S. 113-202 (j)], clarifications were made for water column and bottom

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lease transfers [G.S. 113-202.1(a)], the time frame for water column leases to perpetual franchises was changed from five to 10 years [G.S. 113-202.2(d)], and there were changes to the terms for transfers of water column leases to perpetual franchises [G.S. 113-202.2(f)]. Changes were also made to the time frame for demonstration or research aquaculture development projects from two to five years [G.S. 113-202.2(i)]. And a study on shellfish aquaculture is to be conducted by the University of North Carolina's Chief Sustainability office. The study is to include a stakeholder group with representatives from the commercial and recreational oyster harvesting industries as well as staff from the NCDMF and members of the NCMFC, nature conservation groups, and experts in the fields of marine biology and marine ecology. A report is expected from this study with recommendations and suggested legislation needed to implement the recommendations to the Fiscal Research Division, Environmental Review Commission, and the Joint Legislative Oversight Committee on Agriculture and Natural Resources by Dec. 31, 2018.

2015 Legislative Long Session

Session Law 2015-241, Section 14.9: Senator Jean Preston Oyster Sanctuary Network

Session Law 2015-241, Section 14.9 required the NCDMF to develop a 10-year plan to enhance shellfish habitat within the Albemarle and Pamlico sounds and their tributaries to benefit fisheries, water quality, and the economy. In this 10-year plan, the Oyster Sanctuary Program and the Cultch Planting Program will continue the development of a network of oyster sanctuaries and cultch planting sites within the Pamlico Sound and its tributaries. The 10-year plan calls for NCDMF to design two new sampling programs which will help guide the future oyster rehabilitation projects. These future sites will also be constructed in a way that will provide complex fish habitat to promote hook and line fishing while minimizing the impact to commercial trawling. Through the use of sampling programs and alternative materials, the NCDMF aims to construct oyster sanctuaries and cultch planting sites in a manner so the highest benefit-cost ratio is achieved.

A joint Public Private Partnership was initiated in late 2016 between the NCDMF and the North Carolina Coastal Federation to develop a 40-acre oyster sanctuary near Swan Island near West Bay in eastern Carteret County. The NCDMF purchased and stockpiled materials and obtained necessary permits for the project. The Coastal Federation contracted the deployment of the material. Deployment started in May 2017 and will continue into the summer. This project leveraged approximately one million dollars in state funding and will result in a doubling of funding for this sanctuary over a two-year period.

A comprehensive sampling program has been developed to assess and sample oyster sanctuary sites. A Subtidal Estuarine Reef Sampling Program (Program 941) was developed for estuarine artificial reef and oyster sanctuary sampling. This program looks at different material types in three salinity regimes. Additionally, meter square oyster sampling is conducted on these sites. The existing spatfall monitoring program (Program 610) will be modified to include more quantitative data on spatfall in the future as time and staffing permits.

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Session Law 2015-241, sections 14.10D and 14.8: Shellfish Aquaculture and Core Sound Shellfish Aquaculture Leasing

Session Law 2015-241, Section 14.10D, requires the NCDMF to develop recommendations covering nine topics for shellfish aquaculture. Section 14.8 requires the NCDMF to create a proposal to open shellfish cultivation leasing certain areas of Core Sound that are currently subject to a moratorium

The NCDMF provided a report which addresses these topics ranging from shellfish aquaculture to oyster restoration. It identifies existing bottlenecks, deficiencies and inefficiencies, and recommends ways to improve existing programs. The recommendations on new ways to develop the shellfish industry will benefit the state shellfish aquaculture industry and the overall shellfish resource. Some of the recommendations in this study are also included in the Senator Jean Preston Marine Oyster Sanctuary Program Plan, which was mandated by S.L. 2015-241, Section 14.9. That law required the NCDMF to develop a 10-year plan that includes recommendations for oyster sanctuary construction, cultch planting, funding and any other resources needed.

To develop this plan, NCDMF staff, including its own shellfish experts, met with shellfish and aquaculture experts from North Carolina and Virginia, shellfish growers, and non-governmental organizations. This included meeting with the existing steering committee of stakeholders that oversees the implementation of the N.C. Oyster Restoration and Protection Plan: Blueprint for Action that covers 2015 to 2020 (N.C. Coastal Federation 2015 <https://ncoysters.org/>). Cumulatively, the recommendations listed in this report create a holistic approach to shellfish aquaculture and resource enhancement by linking research, permitting, outreach and extension and support services of several state agencies with private shellfish aquaculture organizations and interests as well as to non-governmental organizations.

The success of aquaculture operations goes beyond permitting and site selection functions that have traditionally been the role of the NCDMF. Achieving and sustaining a successful shellfish aquaculture industry will depend on use of sound scientific principles, solid business planning, marketing, training and assistance from other groups.

Section 14.8 of S.L. 2015-241 requires the NCDMF to create a proposal to open shellfish cultivation leasing to certain areas of Core Sound that are currently subject to a moratorium. NCDMF staff met with the Carteret County Fisheries Association, which represents commercial fishing interests, the president of the N.C. Shellfish Growers Association, and aquaculture experts from the National Oceanic and Atmospheric Administration. The report provides a conservative, methodical approach to re-opening limited areas of Core Sound to shellfish leasing (N.C. Coastal Federation 2015). A proposal was developed to open portions of western Core Sound to shellfish leasing in a controlled manner with oversight from the NCMFC through the Shellfish and Crustacean Advisory Committee. The eastern side of Core Sound was not considered in the proposal because of high densities of submerged aquatic vegetation, it is part of the Cape Lookout National Seashore, has an existing pound net fishery, and other commercial and recreational uses that make this area unsuitable for considering shellfish cultivation. An action plan is also provided in the report to allow limited shellfish leases in Core Sound.

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The Shellfish Aquaculture Recommendations report along with other interests and support resulted in the North Carolina General Assembly providing dedicated funding of \$149,000 (re-occurring) including permanent Biologist I and Technician II positions. No changes were made in the Core Sound moratorium statute. NCDMF is currently participating with the University of North Carolina Collaboratory to identify requirements to develop a statewide shellfish aquaculture plan.

RESEARCH NEEDS

Table 4 provides the NCMFC selected management strategies from Amendment 4 adopted in February 2017. The specific research recommendations from Amendment 4, with its priority ranking are provided below. The prioritization of each research recommendation is designated either a HIGH, MEDIUM, or LOW standing. A low ranking does not infer a lack of importance but is either already being addressed by others or provides limited information for aiding in management decisions. A high ranking indicates there is a substantial need, which may be time sensitive in nature, to provide information to help with management decisions.

Amendment 4

Many environmental considerations are applied throughout the Coastal Habitat Protection Plan (CHPP) and are not part of this list but are still considered very important to oysters. Specifically, the proposed implementation actions on sedimentation within the CHPP are considered a high priority.

Proper management of the oyster resource cannot occur until some of these research needs are met, the research recommendations include:

- Support all proposed implementation actions under the priority habitat issue on sedimentation in the CHPP – HIGH (Ongoing through the CHPP)
- Improve the reliability for estimating recreational shellfish harvest – HIGH (Ongoing)
- Survey commercial shellfish license holders without a record of landings to estimate oyster harvest from this group – HIGH (Needed)
- Develop regional juvenile and adult abundance indices (fisheries-independent) – HIGH (Pilot study in progress with the Nature Conservancy and NC State University)
- Complete socioeconomic surveys of recreational oyster harvesters – MEDIUM (Needed)
- Continue to complete socioeconomic surveys of commercial oyster fishermen – LOW (Needed)
- Determine alternative substrates for reef development and monitoring of intertidal and subtidal reefs (cost-benefit analysis for reefs and cultch planting) – HIGH (Ongoing)
- Identify number and size of sanctuaries needed – LOW (Ongoing)
- Identification of larval settlement cues which influence recruitment to restored reefs (i.e. sound, light, current, etc.) – LOW (Ongoing)
- Support collaborative research to more efficiently track bacterial sources for land-based protection and restoration efforts - MEDIUM (Ongoing)
- Quantify the impact of current fishing practices on oyster habitat suitability in North Carolina – HIGH (Needed)

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- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units (e.g., docks, bulkhead sections) - MEDIUM (Needed)
- Develop peer reviewed, standardized monitoring metrics and methodologies for oyster restoration and stock status assessments – MEDIUM (Needed)
- Further studies on the effects of dredge weight and size on habitat disturbance and oyster catches – LOW (Needed)
- Develop a program to monitor oyster reef height, area and condition – HIGH (Ongoing)
- Estimate oyster mortality associated with relay - LOW (Needed)
- Estimate longevity and yield of oysters on cultch planting sites - HIGH (Needed)
- Develop methods to monitor abundance of the oyster population – HIGH (Pilot study in progress with the Nature Conservancy and NC State University)

FISHERY MANAGEMENT PLAN RECOMMENDATION

Recommend maintain the current timing of the Benchmark Review. Amendment 4 of the N.C. Oyster FMP was adopted by the NCMFC in February 2017 with rule changes in effect May 1, 2017.

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TABLES

Table 1. Percentage of legal-sized oysters by area for the 2017 portion of the 2016-2017 season and the 2017-2018 season in the mechanical fishery. Number of boats seen while out sampling is in parentheses.

2016-2017 season:

*Neuse River closed on Jan. 16, 2017 (Proclamation SF-1-2017)

+Northern Dare County closed on Feb. 6, 2017 (Proclamation SF-2-2017)

2017-2018 season:

*Neuse River closed on Dec. 7, 2017 (Proclamation SF-8-2017)

+Pamlico River and Northern Dare County closed on Dec. 25, 2017 (Proclamation SF-10-2017)

**Northern Hyde County closed on Jan. 29, 2018 (Proclamation SF-2-2018)

| Neuse River* | | Pamlico River+ | | Northern Hyde County** | | Northern Dare County+ | |
|--------------|-------------|----------------|-------------|------------------------|-------------|-----------------------|-------------|
| Date | Percent | Date | Percent | Date | Percent | Date | Percent |
| 1/10/2017 | 23.5 (0) | 2/15/2017 | 29.5 (2) | 1/17/2017 | 47.6 (5) | 1/10/2017 | 26.1 (4) |
| 1/25/2017* | Closed 17.0 | 2/28/2017 | 29.1 (0) | 2/6/2017 | 36.5 (0) | 1/25/2017 | 21.8 (4) |
| 2/14/2017* | Closed 22.8 | | | 2/22/2017 | 43.1 (0) | 2/1/2017 | 15.3 (4) |
| 2/27/2017* | Closed 19.7 | | | 3/9/2017 | 35.1 (0) | 2/21/2017+ | Closed 11.1 |
| | Pre-season | | Pre-season | | Pre-season | | Pre-season |
| 10/27/2017 | 16.4 | 10/25/2017 | 26.2 | 11/2/2017 | 46.3 | 10/25/2017 | 25.6 |
| 11/28/2017 | 9.5 (5) | 12/7/2017 | 18.3 (3) | 11/29/2017 | 34.6 (9) | 11/27/2017 | 30.4 (11) |
| 1/10/2018* | Closed 9.5 | 12/19/2017 | 11.2 (1) | 12/15/2017 | 27.5 (11) | 12/11/2017 | 17.1 (12) |
| 2/1/2018* | Closed 4.1 | 1/22/2018+ | Closed 12.8 | 1/11/2018 | 16.5 (5) | 12/18/2017 | 15.7 (21) |
| 3/19/2018* | Closed 10.6 | 2/23/2018+ | Closed 17.3 | 1/22/2018 | 16.8 (2) | 1/25/2018+ | Closed 13.0 |
| | | | | 2/20/2018** | Closed 19.0 | | |

Table 2. Status of shellfish waters in acreage from 2007-2018 From NCDMF Shellfish Sanitation & Recreational Water Quality Section.

| Year | Open | Closed | Approved | Conditionally Approved Open | Conditionally Approved Closed | Prohibited |
|--------|-----------|---------|-----------|-----------------------------|-------------------------------|------------|
| 2007* | 1,777,523 | 441,448 | 1,734,339 | 43,184 | 12,512 | 428,936 |
| 2008 | 1,777,473 | 441,527 | 1,734,192 | 43,281 | 12,788 | 428,739 |
| 2009 | 1,777,777 | 441,276 | 1,734,246 | 43,531 | 12,552 | 428,724 |
| 2010 | 1,777,992 | 440,966 | 1,734,938 | 43,054 | 12,552 | 428,414 |
| 2011 | 1,777,992 | 440,966 | 1,734,938 | 43,054 | 12,552 | 428,414 |
| 2012 | 1,777,534 | 441,498 | 1,732,902 | 44,632 | 11,834 | 429,664 |
| 2013 | 1,777,349 | 441,684 | 1,733,067 | 44,282 | 11,832 | 429,852 |
| 2014 | 1,776,967 | 442,102 | 1,733,118 | 43,849 | 11,739 | 430,363 |
| 2015** | 1,462,222 | 756,908 | 1,418,373 | 43,849 | 11,739 | 745,169 |
| 2016 | 1,461,745 | 757,605 | 1,416,960 | 44,784 | 12,008 | 745,597 |
| 2017 | 1,459,134 | 759,968 | 1,414,709 | 44,425 | 12,209 | 747,759 |
| 2018 | 1,458,552 | 760,637 | 1,414,626 | 43,926 | 12,031 | 748,606 |

*In 2007 the NC Division of Environmental Health – Shellfish Sanitation Section started calculating acreage from GIS, whereas prior figures were hand-tallied by planimeter on NOAA Charts. Data will be slightly higher than previous data calculated by hand beginning in 2007.

**314,710 acres administratively closed on 2/4/15 due to budget cuts and office closures

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Table 3. The annual average number of oyster spat across all sampling sites, 2008-2018 (NCDMF Habitat and Enhancement Section).

| Year | Number of sites sampled | Annual average number of spat across all sampling sites | Standard error |
|------|-------------------------|---|----------------|
| 2008 | 107 | 2.38 | 0.16 |
| 2009 | 111 | 3.15 | 0.19 |
| 2010 | 112 | 2.77 | 0.20 |
| 2011 | 99 | 2.10 | 0.22 |
| 2012 | 89 | 3.04 | 0.31 |
| 2013 | 82 | 1.90 | 0.19 |
| 2014 | 76 | 2.92 | 0.25 |
| 2015 | 92 | 1.75 | 0.15 |
| 2016 | 92 | 1.86 | 0.17 |
| 2017 | 93 | 1.79 | 0.27 |
| 2018 | 69 | 1.45 | 0.16 |

Table 4. Summary of the NCMFC management strategies and their implementation status for Amendment 4 of the N.C. Oyster FMP adopted February 2017.

| Management Strategy | Implementation Status |
|--|--|
| OYSTER MANAGEMENT | |
| Maintain the cost of the Shellfish License, establish a daily limit of two bushels of oysters per person with a maximum of four bushels of oysters per vessel off public bottom with the Shellfish License. | Existing proclamation authority |
| Increase efforts to plant and monitor cultch material. | Ongoing |
| Implement a five percent cull tolerance for oysters | Rule change to 15A NCAC 03K .0202 in effect on May 1, 2017 |
| Pursue elimination of the Shellfish License for oysters only and require all oyster harvesters to have a Standard or Retired Commercial Fishing License with a shellfish endorsement to harvest commercially. | Amend G. S. 113-169.2 |
| Allow Shellfish License holders to be eligible to acquire a Standard Commercial Fishing License after they show a history of sale of shellfish. Continue to allow commercial harvest of all other shellfish as currently allowed. | No action required; Process already in place |
| Status quo (Maintain the shallow bays (less than 6 feet) as defined in 15A NCAC 03R .0108) | No action required |
| Recommend a six-week opening timeframe for deep bays to begin on the Monday of the week prior to Thanksgiving week through the Friday after Thanksgiving. Reopen two weeks before Christmas for the remainder of the six-week season. | Existing proclamation authority; Completed in 2017-2018 season |
| Status quo (Maintain the 15-bushel hand/mechanical harvest limit in Pamlico Sound mechanical harvest areas outside the bays, 10-bushel hand/mechanical harvest limit in the bays and in the Mechanical Methods Prohibited area along the Outer Banks of Pamlico Sound) | Existing proclamation authority |
| Adopt the provisions of Supplement A – a flexible harvest limit up to 20 bushels, a trigger of 26 percent legal-sized oysters for closing an area to mechanical harvest and set the upper harvest limit of 20 bushels in rule (rule change required). | Existing proclamation authority and rule change to 15A NCAC 03K .0201 on May 1, 2017 |
| Attempt to develop and ground-truth a fishery dependent metric of effort to better inform management decisions in the future | Additive to NCDMF monitoring; Working with the Nature Conservancy |
| PRIVATE CULTURE | |

STATE-MANAGED SPECIES – EASTERN OYSTER

| Management Strategy | Implementation Status |
|--|---|
| Support modification of G.S. 113-208 and G.S. 113-269 to add minimum fines for violations on shellfish leases and franchises. With minimum fines set at \$500 for the first violation and \$1,000 for the second violation | Amend G.S. 113-208 and G.S. 113-269 |
| Support modification of G.S. 113-269 to include protection to all shellfish leases and franchises, not just those with water column amendments | Amend G.S. 113-269 |
| Modify Rule 15A NCAC 03O .0114, regardless whether statute changes occur, so that a first conviction under G.S. 113-208 or G.S. 113-269 the Fisheries Director shall revoke all licenses issued to the licensee | Rule change to 15A NCAC 03O .0114 in effect on May 1, 2017 |
| Status quo (Adhere to Regional Conditions of U.S. Army Corps of Engineers Nationwide Permit 48 with no adverse effect to submerged aquatic vegetation from shellfish leases and following measure identified in the interim) | No action required |
| Continue the moratorium of shellfish leases in Brunswick County | No action required |
| Establish a rule to support extensions for where “Acts of God” prevent lease holder from making production, with a two-year extension and only one extension allowed per term | Rule change to 15A NCAC 03O .0201 in effect on May 1, 2017 |
| Allow leases returned to the state to remain delineated for a period of one year to allow the pre-existing leased bottom to be re-issued to other shellfish growers | Amend G.S. 113-202 |
| Improve public notice of proposed lease applications on the physical lease, at fish houses, and/or through electronic notices | Ongoing |
| Allow a maximum of 10 acres in both mechanical methods prohibited areas and mechanical methods allowed areas | Rule change 15A NCAC 03O .0201(a)(3) in effect on May 1, 2017 |

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FIGURES

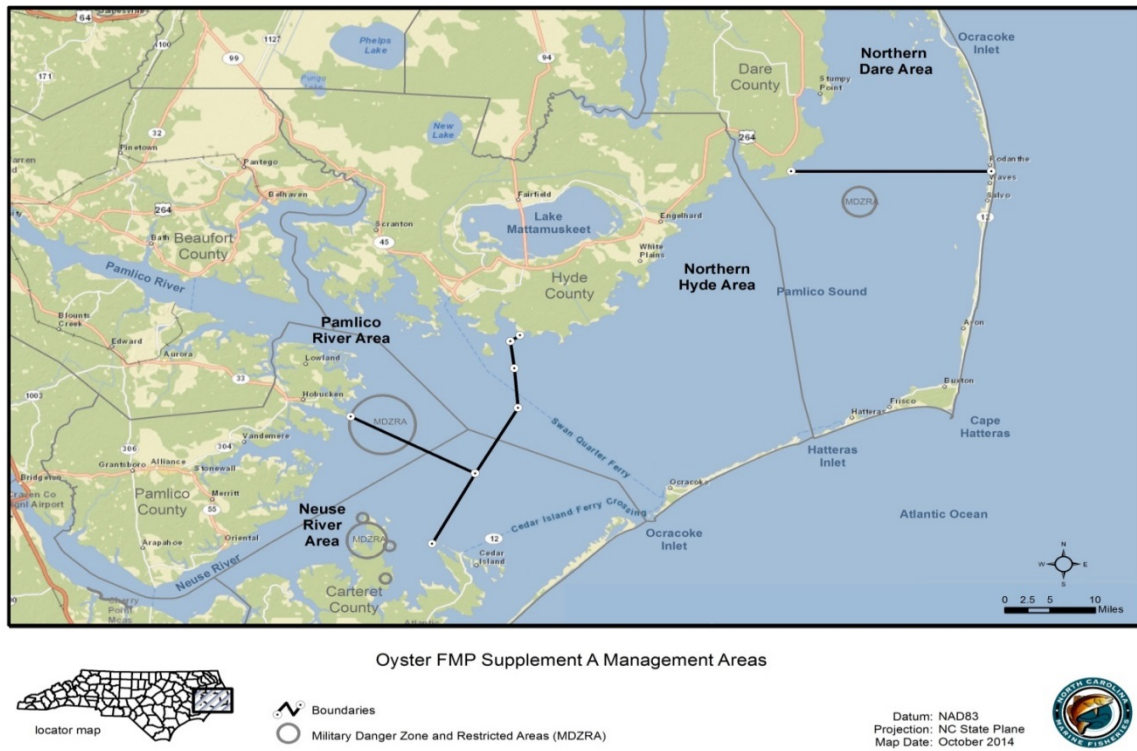


Figure 1. Mechanical harvest management areas from Amendment 4 of the Oyster Fishery Management Plan.

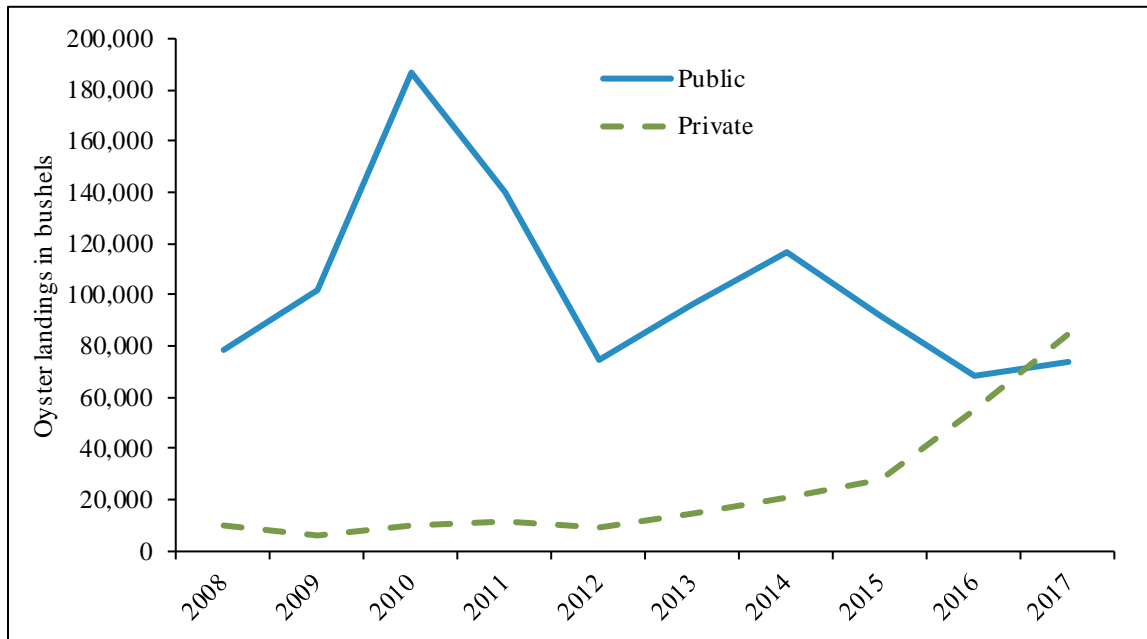


Figure 2. Annual commercial oyster landings (bushels) from private and public bottom in North Carolina, 2008-2017 (NCDMF Trip Ticket Program).

STATE-MANAGED SPECIES – EASTERN OYSTER

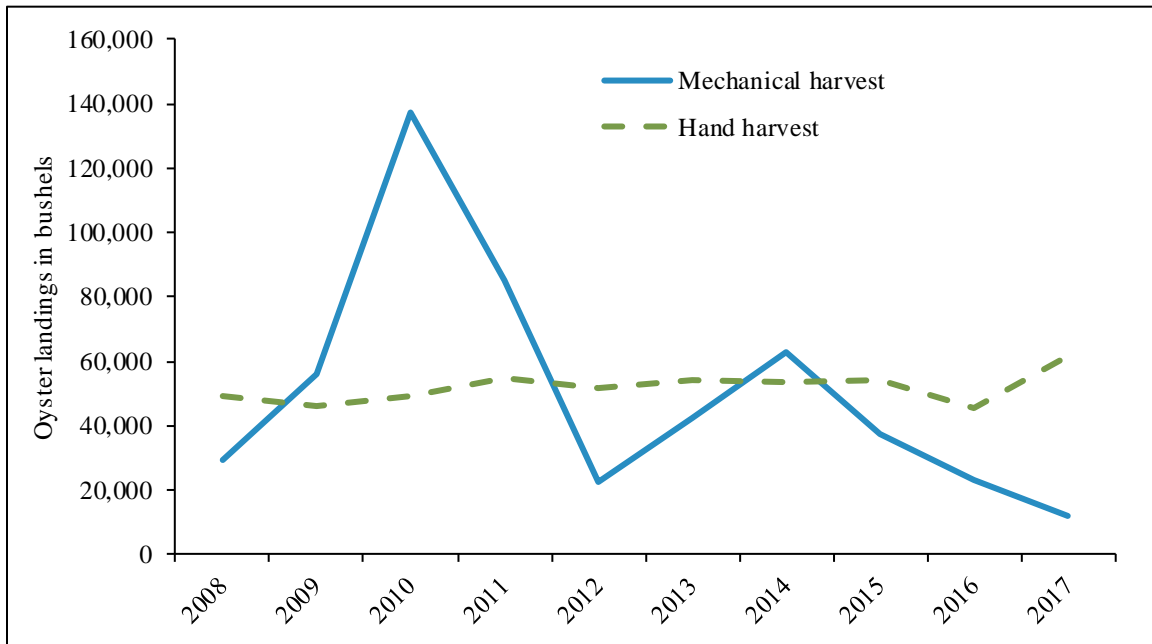


Figure 3. Annual commercial oyster landings (bushels) from public bottom in the mechanical and hand harvest oyster fisheries, 2008-2017 (NCDMF Trip Ticket Program).

STATE-MANAGED SPECIES – EASTERN OYSTER

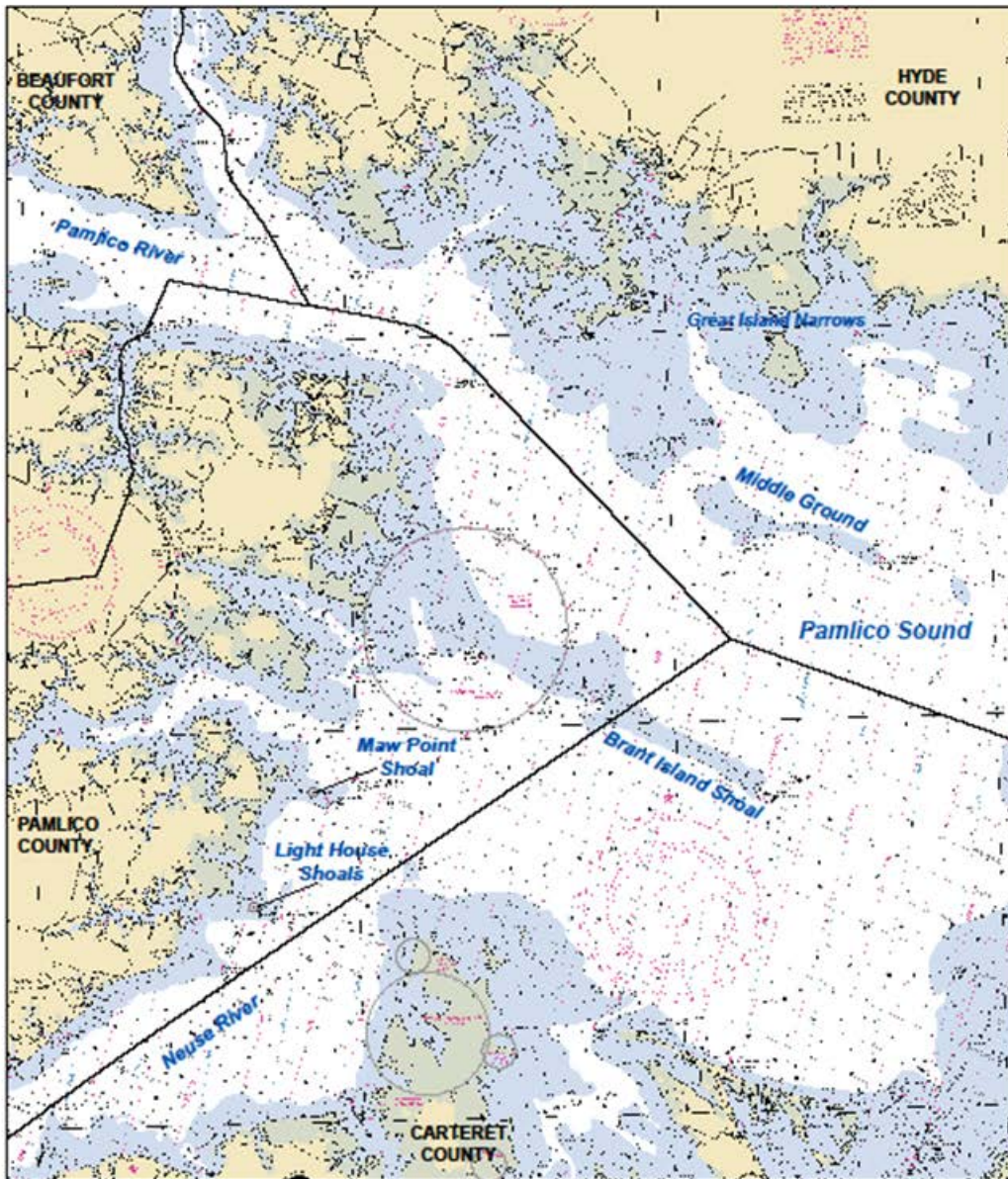


Figure 4. Map of areas referenced in the commercial landings section NCDMF Geographical Information System database).

STATE-MANAGED SPECIES – EASTERN OYSTER

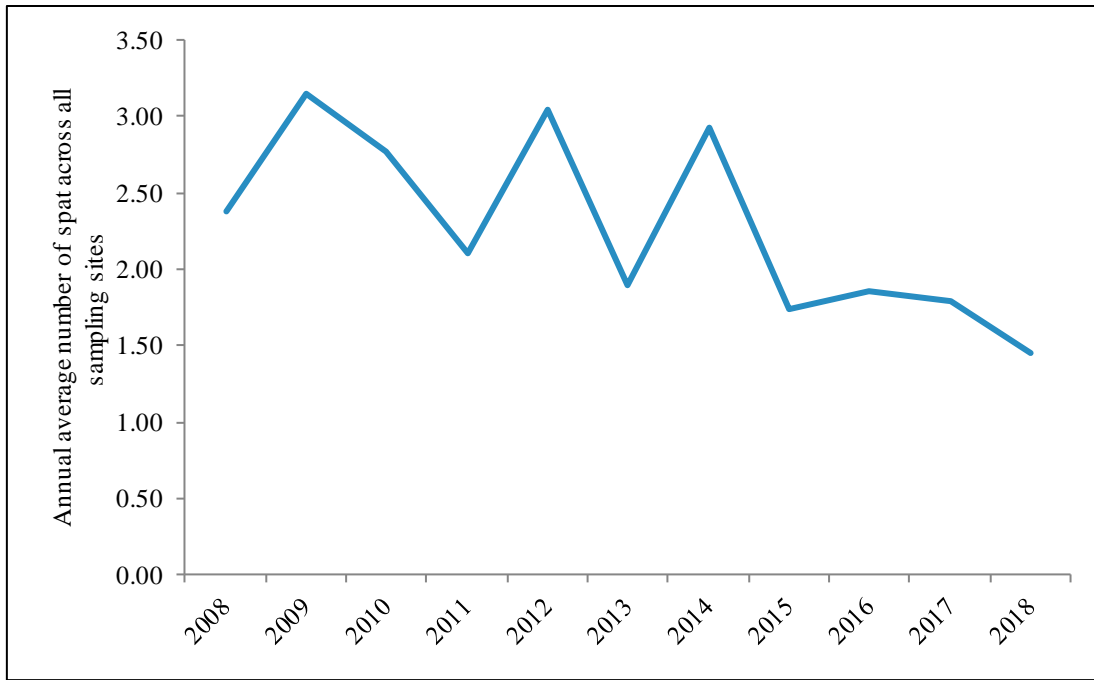


Figure 5. The annual average number of oyster spat across all sampling sites, 2008-2018 (NCDMF Habitat and Enhancement Section).

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

FISHERY MANAGEMENT PLAN UPDATE ESTUARINE STRIPED BASS AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

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

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

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

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

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

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

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

Management Unit

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

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

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

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

Goals and Objectives

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

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

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

STATUS OF THE STOCK

Life History

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

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

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

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

Stock Status

A/R Stock

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

CSMA Stocks

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

Stock Assessment

A/R Stock

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

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

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

CSMA Stocks

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

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

STATUS OF THE FISHERY

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

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

Current Regulations

ASMA

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

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

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

RRMA

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

CSMA

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

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

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

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

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

Commercial Landings

ASMA

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

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

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

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

CSMA

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

Recreational Landings

ASMA

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

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

RRMA

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

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

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

CSMA

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

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

A/R Stock

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

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

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

CSMA Stocks

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

Fishery-Independent Monitoring

A/R Stock

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

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

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

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

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

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

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

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

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

CSMA Stocks

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

MANAGEMENT STRATEGY

A/R Stock

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

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CSMA Stocks

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

RESEARCH NEEDS

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

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

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

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

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

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

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

FISHERY MANAGEMENT PLAN RECOMMENDATION

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

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TABLES

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

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

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

| Management Area | Year | Striped Bass Fishing Angler Trips | Striped Bass Effort Angler Hours | Number Harvested | Pounds Harvested | Striped Bass Discard (#over-creel) | Striped Bass Discard (#under-sized) | Striped Bass Discard (#legal-sized) | Striped Bass Discard (# slot-sized) | Total Discards |
|-----------------|--------------|-----------------------------------|----------------------------------|------------------|------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|------------------|
| ASMA | 2008 | 11,793 | 72,673 | 10,048 | 31,628 | 391 | 36,324 | 260 | N/A | 36,975 |
| | 2009 | 11,326 | 72,021 | 12,069 | 37,313 | 20 | 38,683 | 1,860 | N/A | 40,563 |
| | 2010 | 9,660 | 66,893 | 3,504 | 11,470 | 569 | 15,398 | 233 | N/A | 16,200 |
| | 2011 | 13,114 | 85,325 | 13,341 | 42,536 | 317 | 20,114 | 1,141 | N/A | 21,572 |
| | 2012 | 14,490 | 102,787 | 22,345 | 71,456 | 1,024 | 19,977 | 3,970 | N/A | 24,971 |
| | 2013 | 7,053 | 50,643 | 4,299 | 14,897 | 31 | 16,034 | 316 | N/A | 16,381 |
| | 2014 | 7,264 | 40,478 | 5,529 | 16,867 | 18 | 22,558 | 510 | N/A | 23,086 |
| | 2015 | 11,132 | 75,009 | 23,240 | 70,008 | 1,573 | 45,559 | 2,402 | N/A | 49,534 |
| | 2016 | 7,023 | 42,276 | 4,794 | 14,486 | 252 | 8,822 | 1,278 | N/A | 10,352 |
| | 2017 | 8,822 | 41,371 | 4,214 | 15,479 | 55 | 24,003 | 599 | N/A | 24,659 |
| | Total | 101,677 | 649,476 | 103,383 | 326,140 | 4,250 | 247,472 | 12,569 | | 264,293 |
| RRMA | 2007 | 31,816 | 151,128 | 19,305 | 62,492 | | | | | 52,501 |
| | 2008 | 27,026 | 128,372 | 10,541 | 32,725 | | | | | 189,638 |
| | 2009* | 25,405 | 120,675 | 23,248 | 69,581 | | | | | 135,964 |
| | 2010 | 29,458 | 156,776 | 22,445 | 72,037 | | | | | 123,910 |
| | 2011 | 30,018 | 137,986 | 22,102 | 71,561 | | | | | 107,693 |
| | 2012 | 29,032 | 119,917 | 28,847 | 88,271 | | | | | 63,018 |
| | 2013 | 21,785 | 112,814 | 7,718 | 25,197 | | | | | 74,221 |
| | 2014 | 18,932 | 97,798 | 11,058 | 33,717 | | | | | 165,539 |
| | 2015 | 25,034 | 123,648 | 20,031 | 58,962 | | | | | 108,240 |
| | 2016 | 27,123 | 140,423 | 21,260 | 65,218 | | | | | 52,644 |
| 2017 | 21,004 | 109,011 | 9,899 | 32,569 | | | | | 78,566 | |
| | Total | 254,817 | 1,247,420 | 177,149 | 550,106 | | | | | 1,099,433 |
| CSMA | 2007 | 10,974 | 37,088 | 3,600 | 10,795 | 147 | 21,673 | 1,707 | 0 | 23,527 |
| | 2008 | 6,621 | 21,296 | 842 | 2,990 | 2,838 | 11,719 | 3,316 | 91 | 17,964 |
| | 2009 | 5,642 | 20,695 | 896 | 3,062 | 7 | 4,472 | 1,768 | 719 | 6,966 |
| | 2010 | 6,558 | 16,060 | 1,758 | 5,536 | 28 | 5,201 | 2,402 | 361 | 7,992 |
| | 2011 | 12,608 | 33,353 | 2,727 | 9,475 | 9 | 16,661 | 5,397 | 2,128 | 24,195 |
| | 2012 | 18,340 | 71,899 | 3,871 | 15,198 | 351 | 26,250 | 13,614 | 2,986 | 43,201 |
| | 2013 | 20,143 | 86,090 | 5,452 | 20,076 | 438 | 19,329 | 10,368 | 2,324 | 32,459 |
| | 2014 | 15,657 | 69,616 | 3,302 | 13,354 | 765 | 18,885 | 7,175 | 1,622 | 28,447 |
| 2015 | 18,443 | 80,590 | 3,904 | 14,152 | 40 | 22,896 | 8,193 | 825 | 31,954 | |

Disposition of discards not available for all years.

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

Biological Reference Points

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

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

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

Maintain current TAC² of 550,000 lb.

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

ASMA commercial TAC² = 275,000 lb.

ASMA recreational TAC² = 137,500 lb.

RRMA recreational TAC² = 137,500 lb.

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

18 in TL minimum size limit (ASMFC compliance requirement)

Continue to operate as a bycatch fishery

Spring season, anytime between Jan 1 – Apr 30

Fall Season, anytime between Oct 1 – Dec 31

Daily trip limits for striped bass

Maintain gill net mesh size and yardage restrictions

Maintain seasonal and area closures

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

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

18 in TL minimum size limit

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

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

Spring season, anytime between Jan 1 – Apr 30

Fall season, anytime between Oct 1 – Dec 31

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

18 in TL minimum size limit

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

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

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

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

FIGURES

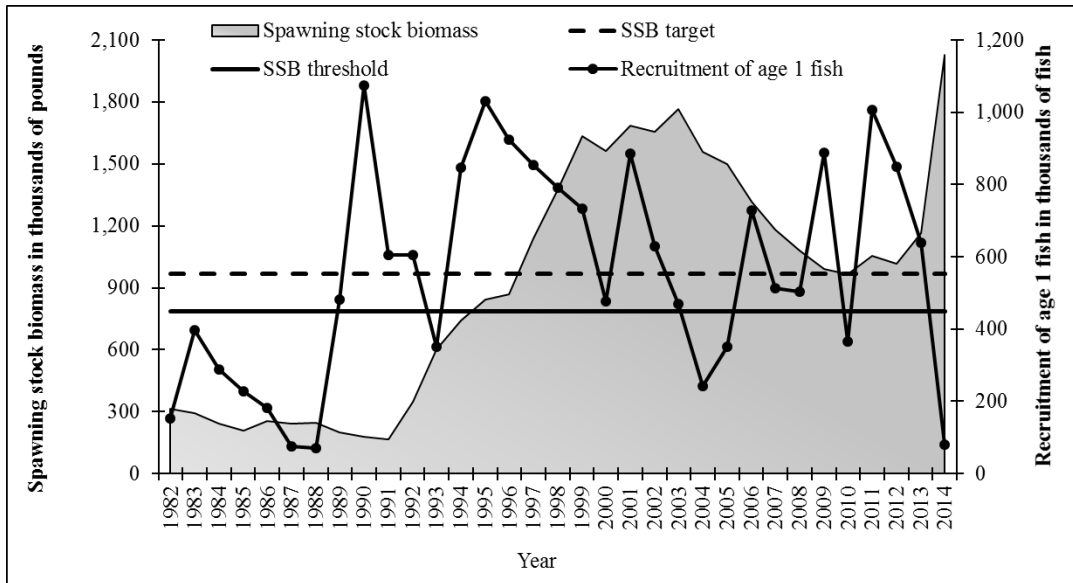


Figure 1. Albemarle/Roanoke striped bass female spawning stock biomass and recruitment (abundance of age-1), 1982-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

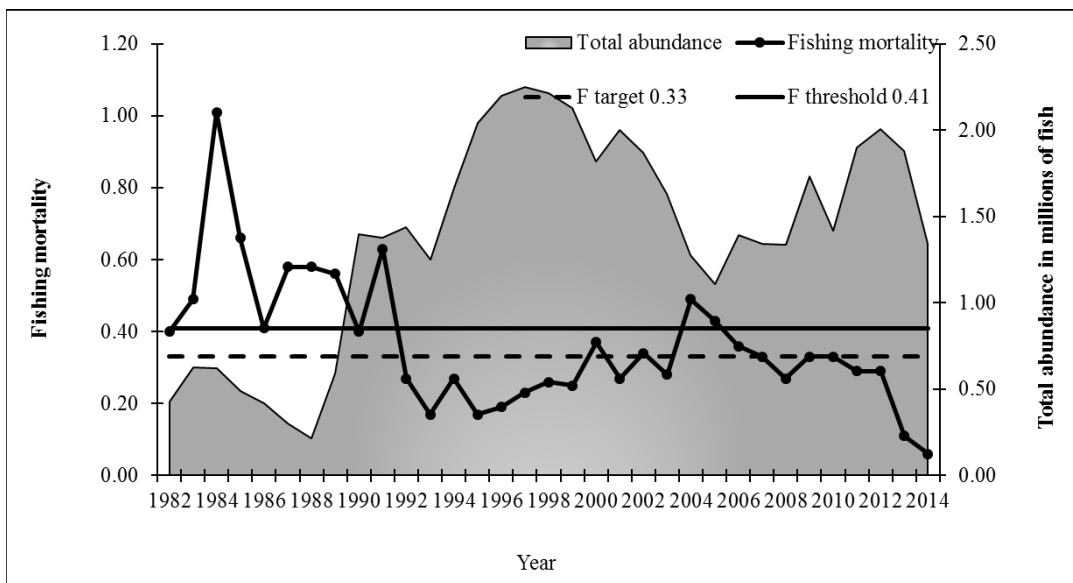


Figure 2. Albemarle/Roanoke striped bass total stock abundance and fishing mortality, 1982-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

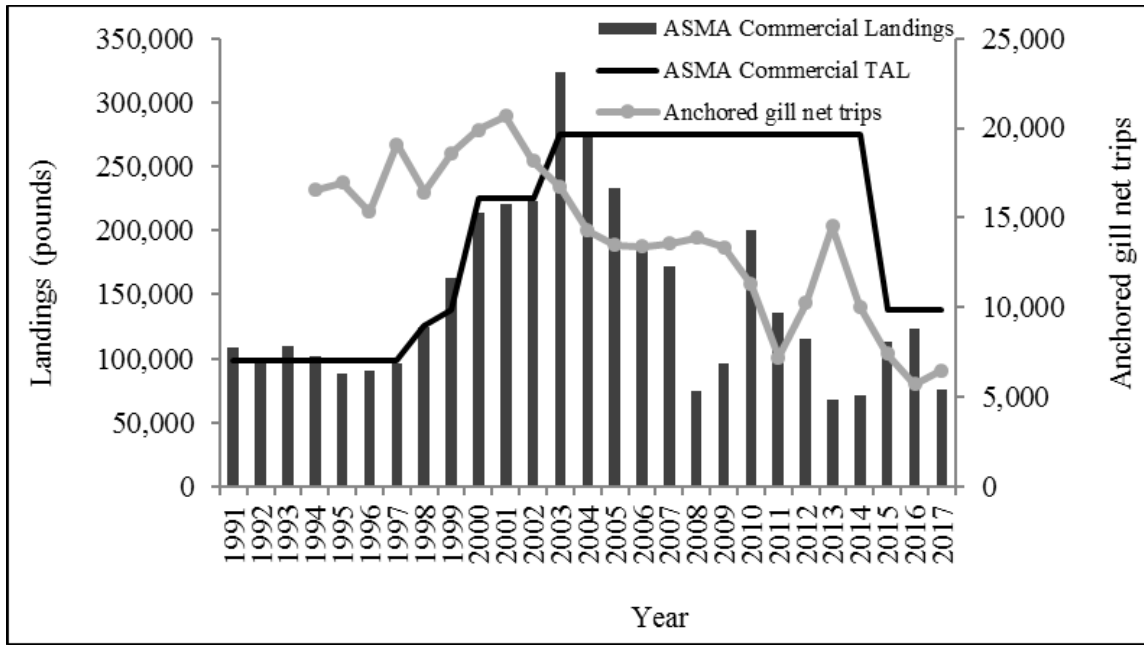


Figure 3. Commercial striped bass landings, TAL, and anchored gill net trips in the ASMA, NC, 1991-2017.

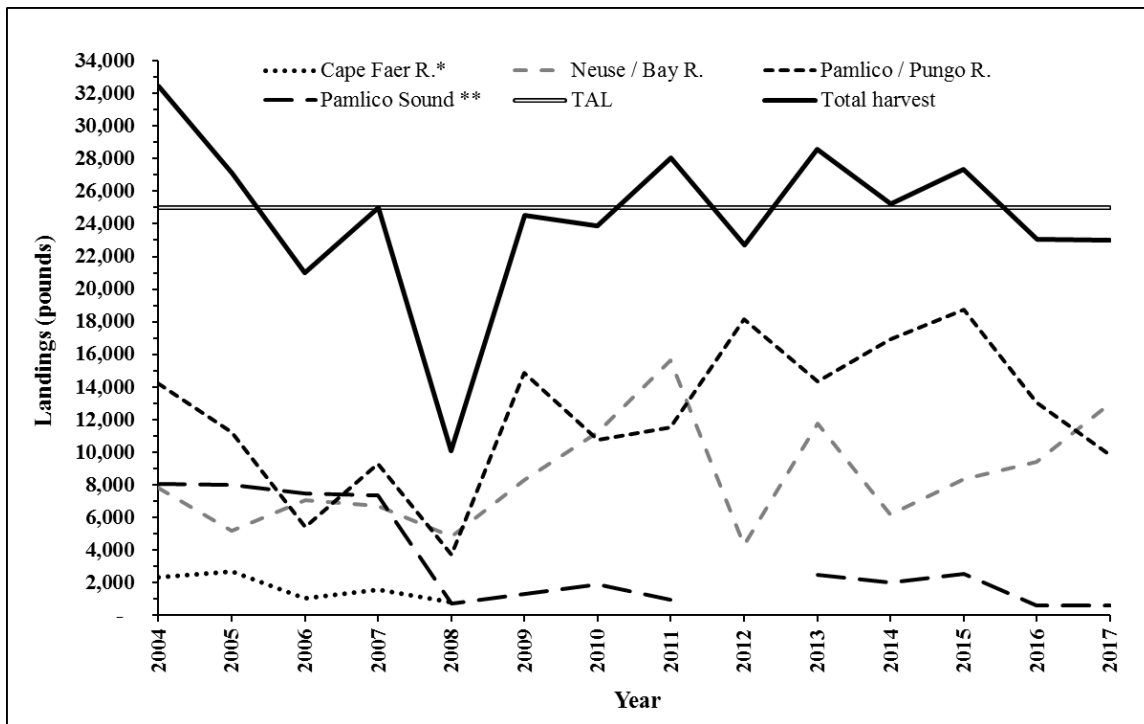


Figure 4. Commercial striped bass landings by system, and the TAL in the CSMA, NC, 2004-2017. *There has been a moratorium on harvest in the Cape Fear River since 2009. **Landings data for the Pamlico Sound in 2012 are confidential.

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

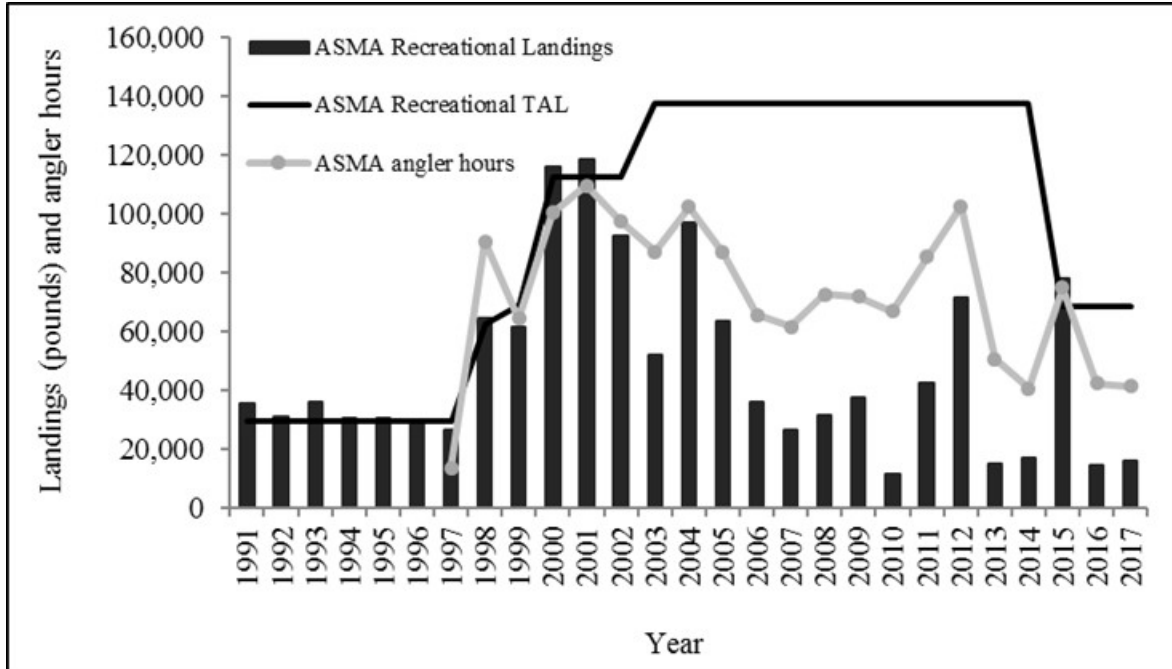


Figure 5. Recreational striped bass landings, TAL, and angler hours in the ASMA, NC, 1991-2017.

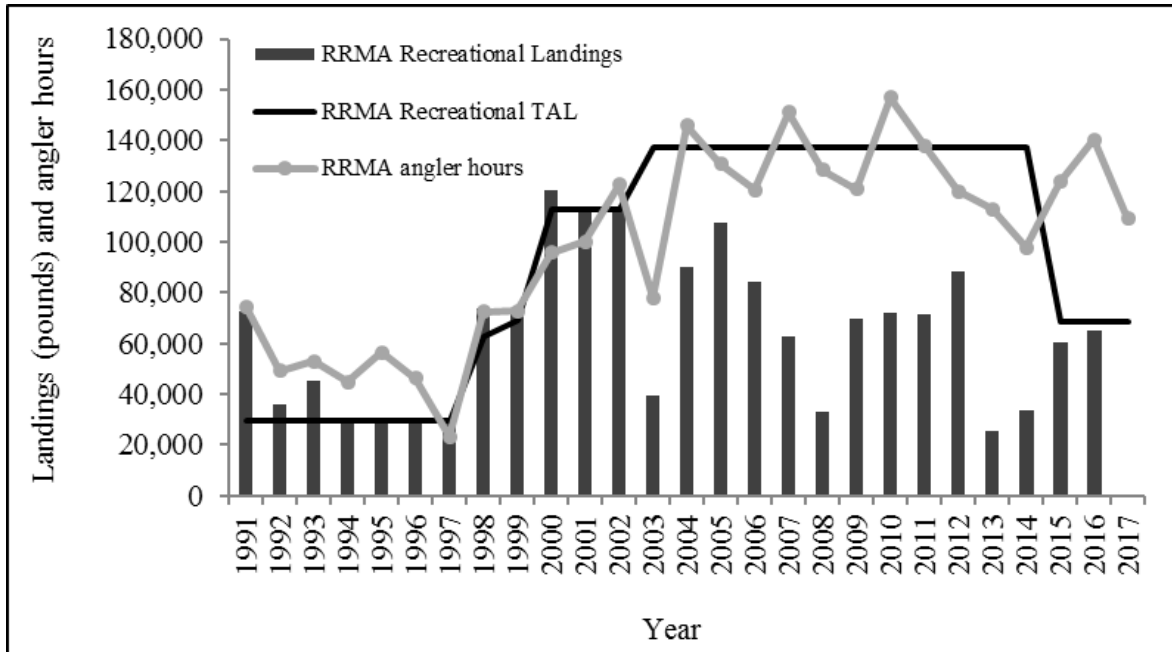


Figure 6. Recreational striped bass landings, TAL, and angler hours in the RRMA, NC, 1991-2017.

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

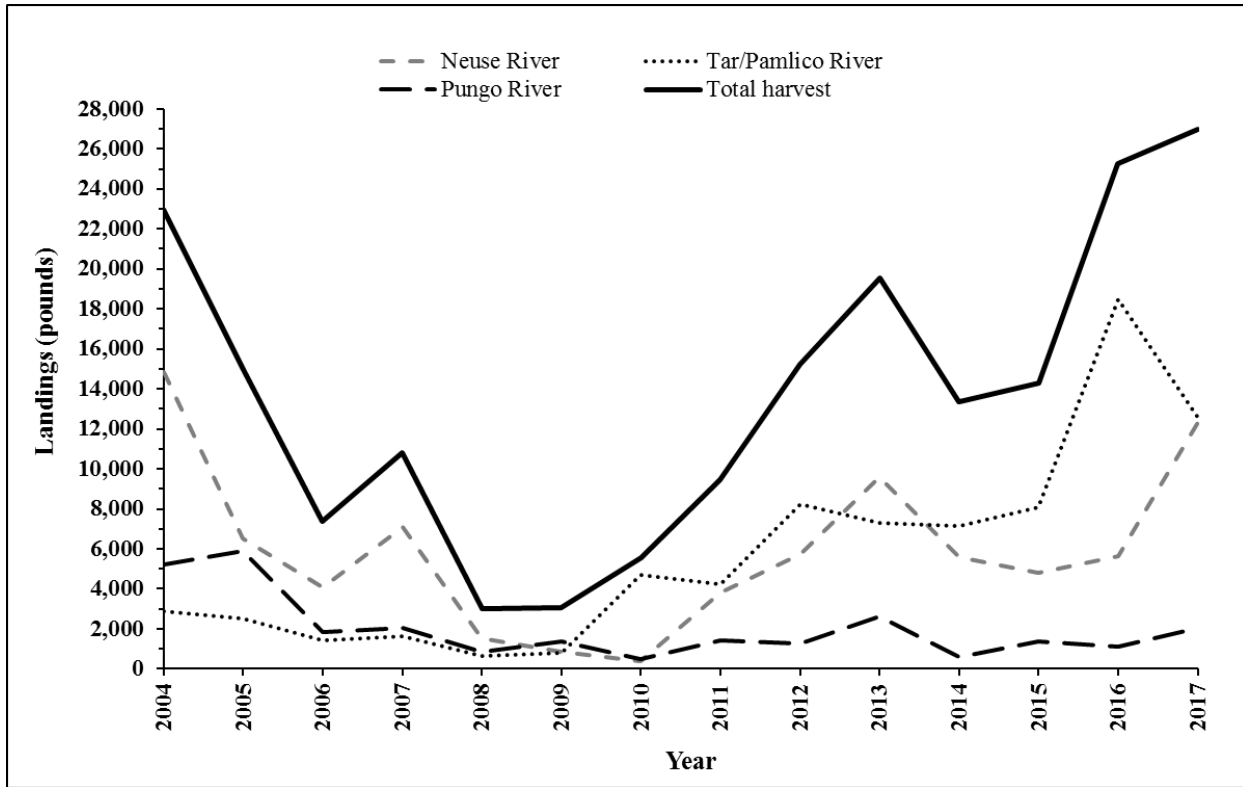


Figure 7. Recreational striped bass landings broken out by major river system in the CSMA, NC, 2004-2017.

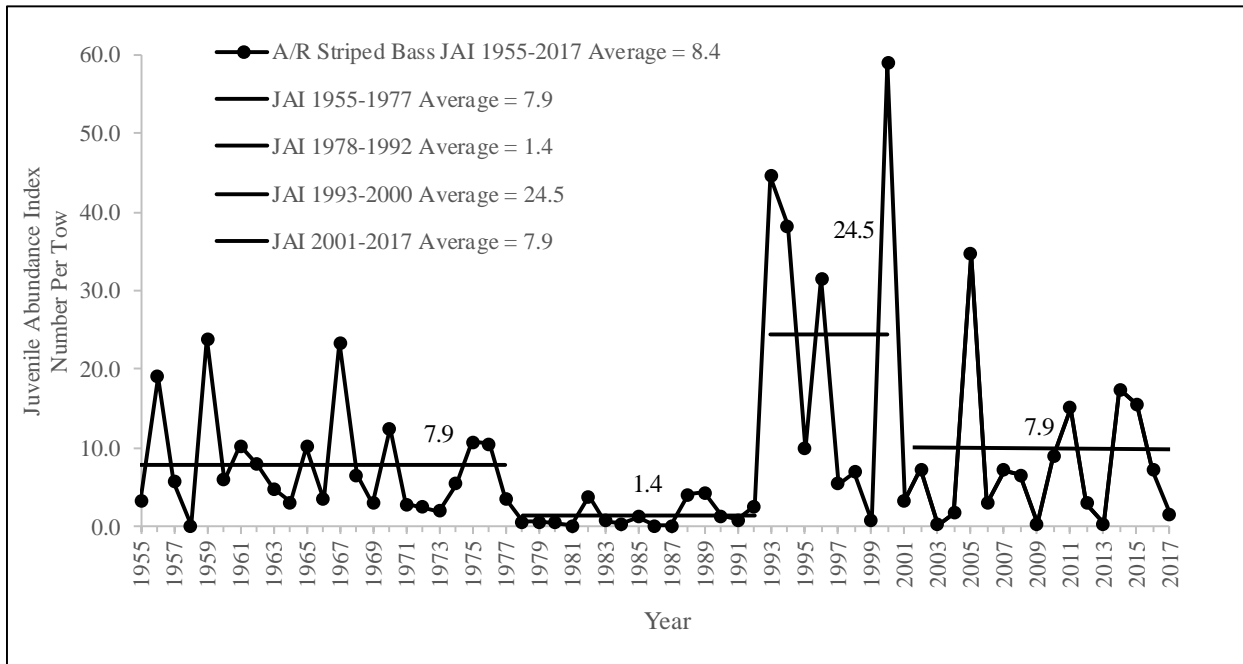


Figure 8. Juvenile abundance index (JAI) of Albemarle/Roanoke striped bass from the NCDMF juvenile trawl survey, western Albemarle Sound, NC, 1955-2017.

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

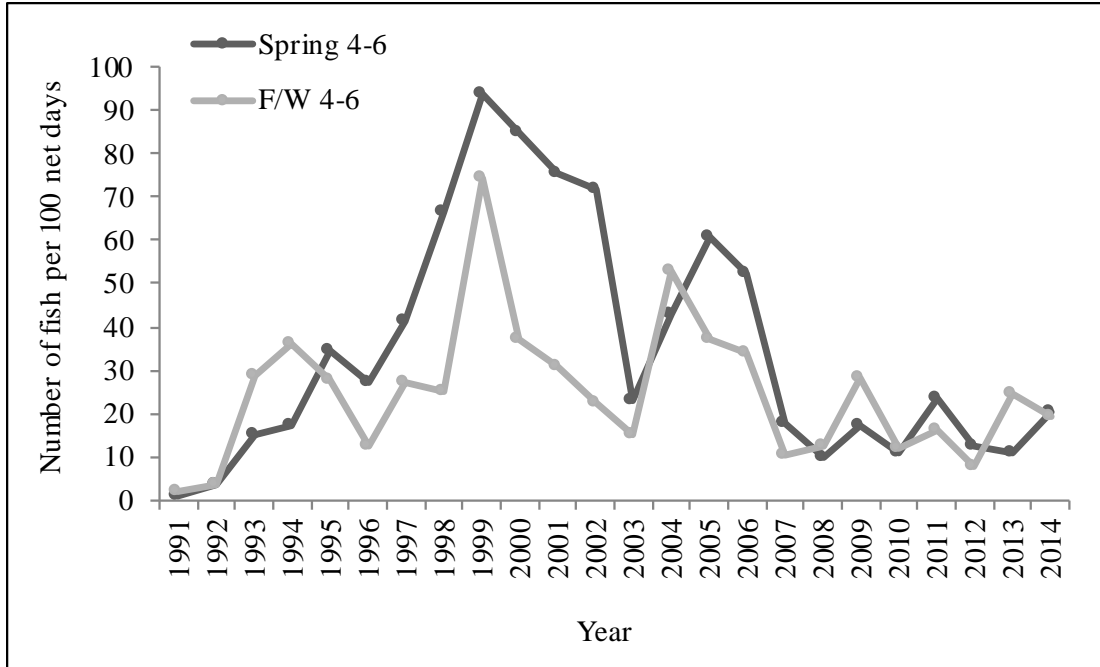


Figure 9. Relative abundance of age 4-6 Albemarle/Roanoke striped bass from the NCDMF fall/winter and spring independent gill net surveys, Albemarle Sound area, NC, 1991-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

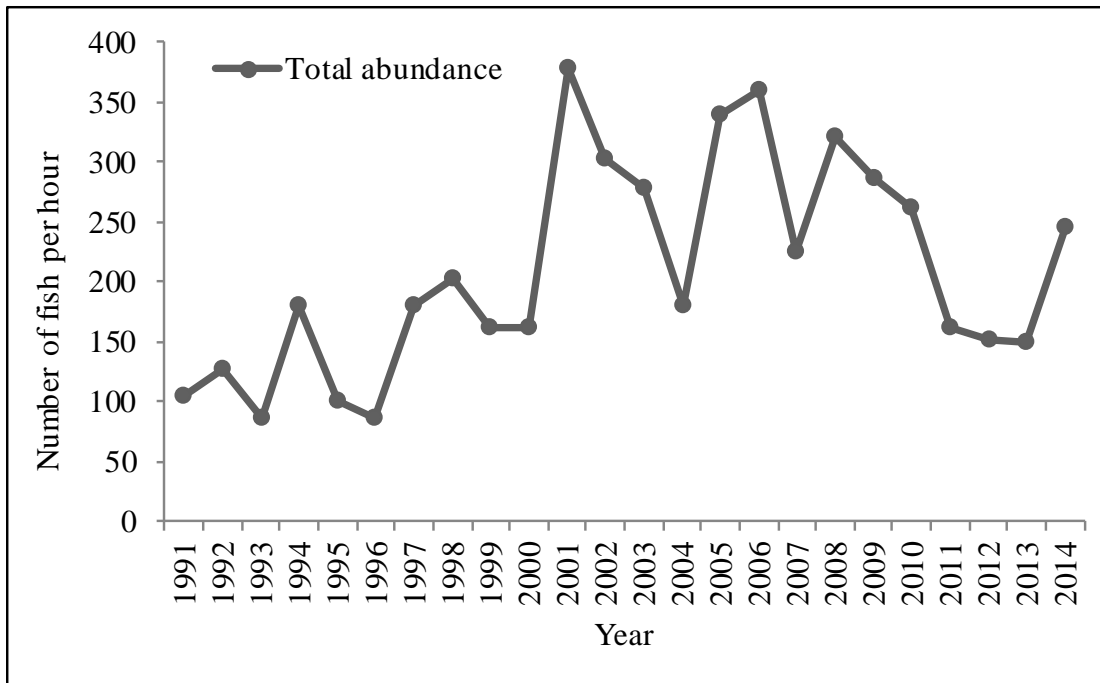


Figure 10. Relative abundance of Albemarle/Roanoke striped bass from the NCWRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

STATE-MANAGED SPECIES – ESTUARINE STRIPED BASS

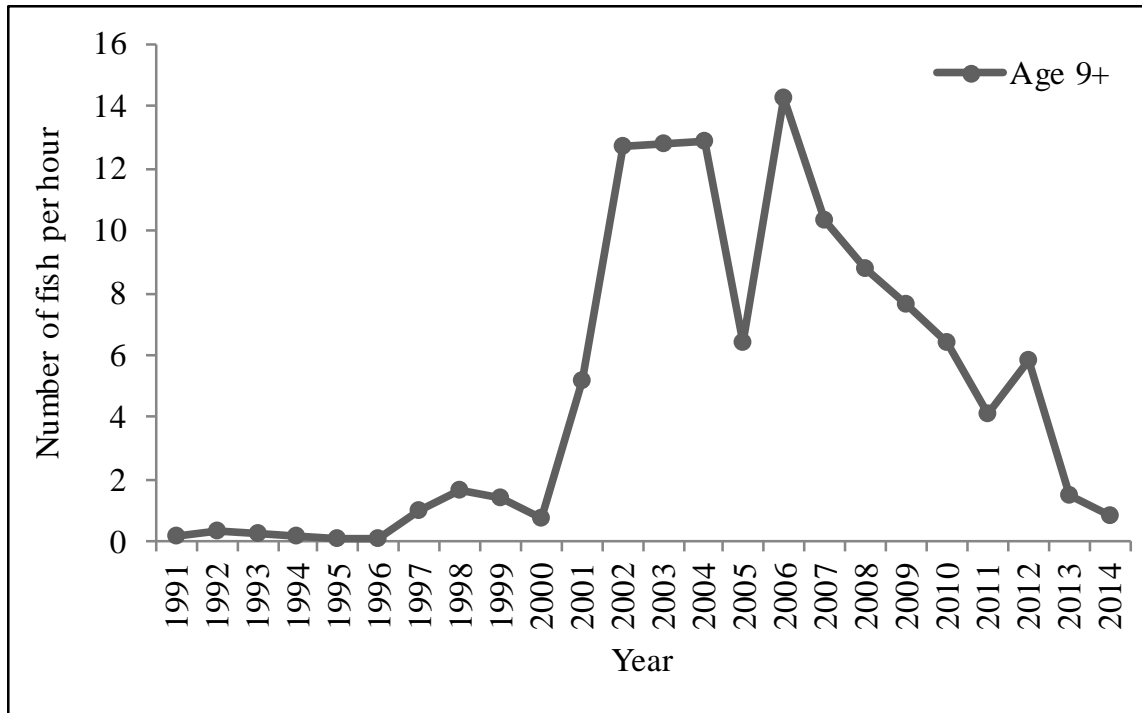


Figure 11. Relative abundance of age 9+ Albemarle/Roanoke striped bass from the NCWRC spawning grounds electrofishing survey, Roanoke River at Weldon, NC, 1991-2014. Source: Stock Status Update of Albemarle Sound-Roanoke River Striped Bass, 2016.

STATE-MANAGED SPECIES – HARD CLAM

FISHERY MANAGEMENT PLAN UPDATE HARD CLAM AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | August 2001 |
| Amendments: | Amendment 1 – June 2008 Amendment 2 – February 2017 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | 2022 |

The 2001 N.C. Hard Clam Fishery Management Plan (FMP) recommendations included adding a new mechanical clam harvest area in Pamlico Sound and rotating openings in this area with northern Core Sound, decreasing the daily harvest limit for mechanical harvest in Core Sound, changing some of the lease requirements, increasing relay of clams, and increasing funding for Shellfish Sanitation (NCDMF 2001).

The N.C. Hard Clam FMP Amendment 1, adopted in 2008 recommended the hard clam fishery from public bottom continue harvesting at current daily limits, eliminating the mechanical clam harvest rotation in Pamlico Sound, instituting a resting period in the northern Core Sound mechanical clam harvest area, and developing sampling programs to collect information necessary for the completion of a hard clam stock assessment (NCDMF 2008). Amendment 1 also endorsed several changes to the shellfish lease program to increase the accountability of the leaseholders and to improve public acceptance of the program.

The N.C. Hard Clam FMP Amendment 2, adopted by the N.C. Marine Fisheries Commission (NCMFC) in February 2017 recommended maintaining status quo on recreational harvest limits, eliminating mechanical harvest in Pamlico Sound by rule, instituting shading requirements for harvesters from April 1 to September 30, implementing modifications to shellfish lease provisions, and adding to convictions of theft on shellfish leases and franchises to the types of violations that could result in license suspension or revocation.

STATE-MANAGED SPECIES – HARD CLAM

Life History

Hard clams (*Mercenaria mercenaria*) are mostly estuarine-dependent, filter-feeding shellfish found in sandy and vegetated bottoms from Prince Edward Island, Canada to the Yucatan Peninsula, Mexico. Spawning occurs from May through November when water temperatures are between 68 degrees and 86 degrees Fahrenheit. The larvae go through several stages before settling onto a suitable bottom. During the juvenile stages, hard clams tend to be dominantly male and then become either male or female as they mature into adults. Sexual maturity is reached in hard clams when individuals reach a certain size, and the timing is therefore dependent on the rate of growth. Growth rates are highly variable because of temperature, food availability, and genetic disposition. Legal size (one inch thick) is typically reached at age 3 in North Carolina, with the oldest individual known living to 46 years.

Management Unit

All hard clams (*Mercenaria mercenaria*) occurring within North Carolina coastal waters.

Goal and Objectives

The goal of N.C. Hard Clam FMP is to manage hard clam stocks in a manner that achieves sustainable harvest and protects its ecological value. To achieve this goal, it is recommended that the following objectives be met:

1. Protect the hard clam stock from overfishing, while maintaining levels of harvest at sustained production, providing sufficient opportunity for both recreational and commercial hard clamming, and aquaculture.
2. Identify, develop, and promote research to improve the understanding of hard clam biology, ecology, population dynamics, and aquaculture practices.
3. Initiate, enhance, and continue studies to collect and analyze economic, social, and fisheries data needed to effectively monitor and manage the hard clam fishery.
4. Identify, develop and promote efficient hard clam harvesting practices while protecting habitat.
5. Promote the protection, restoration, and enhancement of habitats and water quality so that the production of hard clams is optimized.
6. Consider the socioeconomic concerns of all hard clam resource user groups, including market factors.
7. Promote public awareness regarding the status and management of the North Carolina hard clam stock.

STATE-MANAGED SPECIES – HARD CLAM

STATUS OF THE STOCK

Stock Status

The status of the hard clam stock in North Carolina is unknown due to the paucity of data available to assess the population, therefore benchmark reference values could not be determined for the stock (NCDMF 2017). Amendment 2 of the FMP recommends the status continue to be defined as unknown due to the continued lack of data needed to conduct a reliable assessment of the stock.

The statutory obligation to manage hard clams according to sustainable harvest cannot be met until the appropriate data are collected. While landings records reflect population abundance to some extent, the relationship is confounded by changes in harvest effort and efficiency.

Stock Assessment

Data limitations prevent North Carolina Division of Marine Fisheries (NCDMF) from conducting a hard clam stock assessment and calculating sustainable harvest. Currently, the only data available for the stock in most areas are the commercial landings and associated effort. For this reason, the current assessment focused on trends in catch rates in the commercial hard clam fishery from 1994 through 2013 (NCDMF 2017). Commercial landings of clams are considered a biased index of population size. Fisheries-dependent data are often not proportional to population size due to a number of caveats (e.g. area closures and market fluctuations) and should be interpreted with caution if the interest is relative changes in the population.

The North Carolina commercial hard clam fishery is subject to trip limits, which could bias catch rates (Mike Wilberg, University of Maryland Center for Environmental Science, personal communication; John Walter, National Oceanic and Atmospheric Administration Fisheries, personal communication); that is, the trip limits can affect the amount of catch that is observed per unit effort, preventing the true value of the variable from being observed. A censored regression approach was applied to calculate an unbiased index of relative abundance using data collected from a fishery with trip limits. Preliminary analysis found that for years in which greater than or equal to 50 percent of transactions equaled or exceeded the trip limit in a particular water body, the censored regression produced nonsensical results. For this reason, such years were removed from those water bodies where this occurred. (Note: this was only an issue for mechanical harvest data)

Data were obtained from the North Carolina Trip Ticket Program for 1994 through 2013. The censored response variable (catch per unit effort—the number of clams per transaction) was fit within a Generalized Additive Models for Location Scale and Shape framework using the ‘gamlss.cens’ (Stasinopoulos et al. 2014) and ‘survival’ (Therneau 2014) packages in R (R Core Team 2014). Catch rates were estimated for both hand harvest and mechanical harvest in each of the major water bodies from which hard clams are harvested, and where sufficient data were available (see previous paragraph). Hand harvest occurs year-round and is summarized by calendar year. The majority of mechanical harvest occurs from December through March with some harvest occasionally allowed during other times of the year in specific areas; therefore,

STATE-MANAGED SPECIES – HARD CLAM

mechanical harvest is summarized by fishing year (December through March). Only landings from public bottom were examined because planting of seed clams, grow-out availability, and market demand often artificially drives landings from private leases. Fisheries-dependent catch rates were expressed as numbers harvested per transaction. Catch rates were consistently higher for mechanical harvest than for hand harvest.

The Mann-Kendall test was performed to evaluate trends in the annual percentages. The Mann-Kendall test is a non-parametric test for monotonic trend in time-ordered data and allows for missing values (Gilbert 1987). The test was applied to the percentage of trip limits for hand harvest and mechanical harvest by area. Trends were considered statistically significant at $\alpha = 0.05$.

Based on the Mann-Kendall test, there were significant increasing trends over time detected in eight areas for hand harvest: Bogue Sound, Core Sound, Inland Waterway, New River, Newport River, North River/Back Sound, Shallotte River, and White Oak River. A significant decreasing trend was found in the hand harvest catch rates in Pamlico Sound. The remaining water bodies showed no trend in hand harvest catch rates over time. The Intercoastal Waterway, New River, Newport River, North River/Back Sound, and Stump Sound demonstrated significantly increasing trends in mechanical harvest catch rates over time. No trends were detected in Bogue Sound, Core Sound, or White Oak River catch rates for mechanical harvest.

Trends observed in fishery-dependent indices must be interpreted with strong caveats. In order for a fisheries-dependent index to be proportional to abundance, fishing effort must be random with respect to the distribution of the population and catchability must be constant over space and time. Other factors affecting the proportionality of fishery-dependent indices to stock size include changes in fishing power, gear selectivity, gear saturation and handling time, fishery regulations, gear configuration, fishermen skill, market prices, discarding, vulnerability and availability to the gear, distribution of fishing activity, seasonal and spatial patterns of stock distribution, change in stock abundance, and environmental variables. Many agencies, such as the NCDMF, do not require fishermen to report records of positive effort with zero catch; lack of these “zero catch” records in the calculation of indices can introduce further bias.

STATUS OF THE FISHERY

Current Regulations

Hard clams cannot be taken from any public or private bottom in areas designated as prohibited (polluted) by proclamation except for special instances for: Shellfish Management Areas (NCMFC Rule 15A NCAC 03K .0103), with a permit for planting shellfish from prohibited areas (NCMFC Rule 15A NCAC 03K .0104), and for the depuration of shellfish (NCMFC Rule 15A NCAC 03K .0107). Hard clams cannot be taken between the hours of sunset and sunrise of any day. Beginning in April 2014, time and temperature control measures were initiated for hard clams to prevent post-harvest growth of naturally-occurring bacteria that can cause serious illness in humans.

STATE-MANAGED SPECIES – HARD CLAM

Public Bottom

The minimum size limit for hard clams is one-inch thickness (shell width). Daily commercial harvest limits on public bottom are no more than 6,250 hard clams (25 bags at 250 clams per bag) per fishing operation in any coastal fishing waters regardless of the harvest methods employed. Size, daily harvest limits, and season and area limitations do not apply in some situations on public bottom for: 1) temporary openings made on the recommendation of shellfish sanitation; and 2) maintenance dredging operations, where waste of the hard clam resource is apparent due to these activities and Shellfish Sanitation deem the area safe from public health risks.

The daily hand harvest limit on public bottom is 6,250 hard clams and the fishery is open year-round. Rakes no more than 12 inches in width or weighing no more than six pounds can be used to take hard clams in any live oyster bed, in any established bed submerged aquatic vegetation or in an established bed of salt water cordgrass.

The public mechanical hard clam harvest season can occur from December 1 through March 31, and is opened by proclamation to only very specific locations. The mechanical harvest season usually begins the second Monday in December and extends through the week of March 31st. Harvest is allowed only from 7:30 a.m. to 4:00 p.m. on Monday through Friday until before the Christmas holiday and then Monday through Wednesday after December 25th for the remainder of the open harvest season.

Internal waters that can open to public mechanical hard clam harvest can only be in areas in Core and Bogue sounds, Newport, North, White Oak and New rivers and the Intracoastal Waterway north of "BC" Marker at Topsail Beach which have been opened at any time from January, 1979, through September, 1988. Public hard clam mechanical daily harvest limits vary by waterbody. In some instances mechanical harvest areas are rotated (alternately open and close) with other areas (Table 1). The White Oak River, New River, and the Intracoastal Waterway of Onslow and Pender counties (Marker 65 to the BC Marker at Banks Channel) are fished mainly with escalator dredges and are rotated on a yearly basis with maximum daily limits of 6,250 hard clams (25 bags at 250 hard clams per bag) per operation. The mechanical harvest area from Marker 72A to the New River Inlet is opened annually with a maximum daily harvest limit of 6,250 hard clams. The maximum daily harvest of 3,750 hard clams is allowed in North River, Newport River, and Bogue Sound (Table 1). Since 2008, upon adoption of Amendment 1 to the Hard Clam FMP, Core Sound has been divided into two areas and the northern area is open every other year while the southern portion is opened annually. Each area in Core Sound has a daily harvest limit of 5,000 hard clams per operation.

Recreational harvest limits from public bottom are 100 hard clams per person per day and no more than 200 hard clams per vessel. Hard clams can only be taken by hand for recreational purposes.

STATE-MANAGED SPECIES – HARD CLAM

Private Bottom

Leases and franchises in internal waters must adhere to the minimum one-inch thick size limit for the sale of hard clams for consumption. There is no daily maximum harvest limit applied to the taking of hard clams from private bottom in internal waters. Public bottom must meet certain criteria in order to be deemed suitable for leasing for shellfish cultivation and there are specific planting, production, and marketing standards for compliance to maintain a shellfish lease or franchise. Also, there are management practices that must be adhered to while the lease is in operation, such as: marking poles and signs, spacing or markers, and removal of markers when the lease is discontinued.

Possession and sale of hard clams by a hatchery or aquaculture operation, and purchase and possession of hard clams from a hatchery or aquaculture operation are exempt from the daily harvest limit and minimum size restrictions. The possession, sale, purchase and transport of such hard clams must be in compliance with the Aquaculture Operation Permit. Leases that use the water column must also meet certain standards as outlined in G.S. 113-202.1 in order to be deemed suitable for leasing and aquaculture purposes.

There is a specific application process to obtain a lease and a public comment process that is required before a shellfish lease is granted, allowing any member of the public to protest the issuance of a lease. Owners of shellfish leases and franchises must provide annual production reports to the NCDMF. Failure to furnish production reports can constitute grounds for termination. Cancellation proceedings will begin for failure to meet production requirements and interfering with public trust rights. Corrective action and appeal information is given prior to lease termination. A lease may be transferred to a new individual before the contract terms ends, however there are specific requirements to do so.

Commercial Landings

Hard clam harvest has fluctuated historically, often in response to changes in demand, improved harvesting, and increases in polluted shellfish area closures. Since 2007 it is known that about 90 percent (2007-2016 combined estimates) (NCDMF 2017) of the total commercial hard clam harvest come from public bottom in North Carolina. It is assumed that trends in hard clam landings from both sources (private and public bottom) combined can be attributed to changes in hard clam landings from public bottom since they make up the largest component to the overall harvest. Adverse weather conditions (i.e., hurricanes, heavy rain events) can impact the annual landings. One of the greatest impacts to clam harvest occurred in 1987-1988 due to red tide. The red tide was a dinoflagellate bloom that caused the closure of over 361,000 acres of public bottoms to shellfish harvest from November 1987 to May 1988. These closures affected 98 percent of the clam harvesting areas, and had its greatest impact on the clam fishermen. The dinoflagellate responsible for the red tide, *Karenia brevis*, produced a neurotoxin, which was concentrated in shellfish, making them unfit for consumption. Ten tropical cyclones (hurricanes and tropical storms) have made landfall in North Carolina since 1996 (<http://www.nc-climate.ncsu.edu>). Freshwater runoff after storm events often increase shellfish harvest area closures and causes a reduction in hard clam harvest effort for short term periods. Hard clams are a live product that have to go to market relatively quickly after harvest. Competition with hard

STATE-MANAGED SPECIES – HARD CLAM

clams grown in private culture from other states is also a known contributor to reduced market demand for wild harvested hard clams since a more consistent product can be provided from private grow out facilities.

Annual average hard clam landings from 2008-2017 was 18.4 million clams (Figure 1). Annual landings in 2017 were the lowest on record since 1975 at 14.4 million clams. There was a slight uptick in hard clam landings from 2011 to 2014, followed by a gradual decline through 2017. The landings during this period hover around only one-fourth of their peak in the 1980s. Hard clams are a live product and must to go to market and sold relatively quickly after harvest because of a short shelf life. Competition with hard clams grown in private culture from other states is also a known contributor to reduced market demand for hard clams in the wild since a more consistent product can be provided from private growers.

Hand Harvest Fishery Off Public Bottom

Hand harvest from public areas is a year-round fishery and has average landings of 14.4 million clams a year (2008-2017) (Figure 2; NCDMF 2017). Most hand harvest for clams occurs in the spring and summer when warm water is conducive to wading. Annual public hand harvest for hard clams has remained fairly constant overall, with some yearly fluctuations from 2008 to 2017 (Figure 2; NCDMF 2017).

Mechanical Harvest Fishery Off Public Bottom

Hard clam landings from public harvest, using mechanical methods, has average landings of 2.3 million clams each fishing year (2008-2017) (Figure 2). The mechanical clam harvest season usually has the highest landings at the beginning of the fishing season in December and declines as the season progresses. Landings outside of the usual mechanical clam harvest season are from temporary openings for the maintenance of channels and temporary openings in Core Creek when bacteriological levels are at acceptable levels to harvest clams. Hard clam landings and trips fluctuate from fishing year to fishing year and appear to be greatly influenced by harvest from the New River mechanical harvest area. Since 1994, when the public mechanical harvest area of New River is open, 48 to 97 percent of the total mechanical harvest landings are from this area (NCDMF 2017).

Private Culture

The NCDMF administers the shellfish lease program whereby state residents may apply to lease estuarine bottom and water columns for the commercial production of shellfish. The NCDMF does not differentiate between clam, oyster, bay scallop, and mussel leases; therefore allowing shellfish growers to grow out multiple species simultaneously or as their efforts and individual management strategy allows. For the period of 2007-2013, roughly 35 percent of all private culture operations harvested only clams (NCDMF 2017).

Private enterprise has provided over 10 percent of the total commercial hard clam harvest in North Carolina between 2008 and 2017 (Figure 3). The annual average hard clam landings from 2008 to 2017 from private production were 1.8 million clams.

STATE-MANAGED SPECIES – HARD CLAM

Recreational Landings

The recreational harvest of hard clams in North Carolina does not require a fishing license, and due to this the total amount of recreational landings cannot be estimated and remains unknown. However, a mailout survey has been used since 2010 to estimate harvest from Coastal Recreational Fishing License holders. This population of recreational harvesters makes up an unknown proportion of total recreational harvest, but still provides insight into catch rates, harvest trends, and scale of harvest. In 2010, surveys were only mailed out November and December, so harvest and effort estimates are very low (Table 2). Effort has been consistent in all full years of the survey (2011-2017). Harvest and catch rate have seen minimal fluctuations, except for 2016, which was well below average for both. This is most likely due to large rainfall events in July and August which caused widespread shellfish closures.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Currently, the only data available for the stock in all areas are the commercial landings and associated effort from the Trip Ticket Program. Sampling of commercial catches of hard clams has been ongoing in the Southern District, Morehead City Office since 1998. Additional sampling of other areas followed later as funding became available for expansion. Hard clam catches are sampled at the dealers year round when available. Trip ticket information is also obtained of the total catch in the trip. Information on the location(s) of the catch also is obtained in as much detail as possible (e.g. water body, nearest landmark, marker number, etc.). Questions to the fisherman include: What gear or gears were used, gear parameters, (i.e. length of teeth, width of escalator, headrope length), how many minutes fished with each gear, location and depth of water fished. Additional questions include whether the catch came from public bottom or leased bottom, and if catch originated from a NCDMF Shellfish Rehabilitation area. Biological information on landed catch of hard clams is collected, including: shell length (mm) and shell width (depth; in mm) by market grade.

A total of 53,773 hard clams were measured from 2008 to 2017 at fish houses (Table 3). Mean shell length has ranged from 60 mm (2.4 inches) to 73 mm (2.9 inches) in that timeframe with a minimum shell length of 27 mm (1.1 inch) to a maximum shell length of 173 mm (6.8 inches) for clams measured at the fish house (Table 3).

Fishery-Independent Monitoring

A fisheries-independent monitoring program (Program 640) is currently underway in Core Sound to provide baseline data on hard clam abundance and gather environmental information. In the future, it may be possible to expand this sampling into other areas to evaluate the entire population. Thirty randomly selected stations are sampled each year within three strata. The three designated strata were: Shellfish Mapping Strata (ST), Known Fishing Areas (FA), and Closed Shellfish Areas (CA). Sampling is performed at each station location within each stratum using small patent tongs on a 25-ft flat bottom boat. The patent tongs have an opening of 0.51 square meters. Samples are by station and three samples at each station are taken.

STATE-MANAGED SPECIES – HARD CLAM

All hard clams are measured for thickness and length to the nearest millimeter using calipers. Environmental data collected includes depth (in meters), surface and bottom salinity (parts per thousand), surface and bottom temperature (degrees Celsius), surface and bottom dissolved oxygen (milligrams per liter), secchi depth (meter), weather and wind elements, water level, distance from shore (meters), and altered state. Sediment type is qualitatively described.

Very few hard clams are caught in this program due to the nature of the gear and random stratified sampling design. The Catch per Unit Effort (CPUE) or number of clams per station has ranged annually from 0.39 to 1.27 clams per station from 2008 to 2017 (Table 4). No trend is apparent from this sampling, but it is considered a short time series with only 11 years in development (Figure 4).

MANAGEMENT STRATEGY

There are no management triggers or methods to track stock abundance, fishing mortality, or recruitment between benchmark reviews from the current FMP. Landings and effort have decreased over time. There are no data to track the recreational fishery.

Amendment 2 was adopted in February 2017 with rule changes in effect May 1, 2017. The selected management strategies of the Marine Fisheries Commission from Amendment 2 for hard clams taken from public bottom included:

- removing the Pamlico Sound mechanical clam harvest areas in rule no longer in use
- taking latitude/longitude coordinates of the poles marking the open mechanical clam harvest area in New River

For private culture of hard clams, the preferred management options in draft Amendment 2 included:

- adding convictions for theft of shellfish from leases or franchises to the list of convictions that may result in revocation of fishing licenses to implement stronger deterrents to shellfish theft and intentional aquaculture gear damage
- clarifying how production and marketing rates are calculated for shellfish leases and franchises to meet minimum production requirements
- expanding the maximum proposed lease size to 10 acres in all areas
- specifying criteria that allow a single extension period for shellfish leases of no more than two years per contract period to meet production and marketing requirements in the case of unforeseen circumstances, and reorganize the rules for improved clarity.

Amendment 2 also recommended implementing shading requirements for clams on a vessel, during transport to a dealer, or storage on a dock from June through September.

See Table 5 for Marine Fisheries Commission selected management options under Amendment 2.

STATE-MANAGED SPECIES – HARD CLAM

RESEARCH NEEDS

The specific research recommendations from Amendment 2, with its priority ranking are provided below. The prioritization of each research recommendation is designated either a HIGH, MEDIUM, or LOW standing. A low ranking does not infer a lack of importance but is either already being addressed by others or provides limited information for aiding in management decisions. A high ranking indicates there is a substantial need, which may be time sensitive in nature, to provide information to help with management decisions. Proper management of the hard clam resource cannot occur until some of these research needs are met, the research recommendations include:

- Support all proposed implementation actions under the priority habitat issue on sedimentation in the CHPP – HIGH (Ongoing)
- Improve the reliability for estimating recreational shellfish harvest – HIGH (Incomplete)
- Survey commercial shellfish license holders without a record of landings to estimate hard clam harvest from this group – MEDIUM (Incomplete)
- Determine the consequences to hard clams from impacts to habitat due to harvest practices – LOW (Incomplete)
- Develop regional juvenile and adult abundance indices – HIGH (Incomplete)
- Complete socioeconomic surveys of recreational clam harvesters – MEDIUM (Incomplete)
- Continue to complete socioeconomic surveys of commercial clam fishermen – LOW (Incomplete)
- Support collaborative research to more efficiently track bacterial sources for land-based protection and restoration efforts – MEDIUM (Ongoing)
- Quantify the relationship between water quality parameters and the cumulative effect of shoreline development units - MEDIUM (Incomplete)
- Investigate impacts of clam trawls and escalator dredges on sandy bottom environments – LOW (Incomplete)
- Investigate the effects of mechanical harvest on clam recruitment and clam mortality in the mechanical harvest areas – MEDIUM (Incomplete)

FISHERY MANAGEMENT PLAN RECOMMENDATION

Recommend maintain the current timing of the Benchmark Review. Amendment 2 of the N.C. Hard Clam FMP was adopted by the NCMFC in February 2017 with rule changes in effect on May 1, 2017.

STATE-MANAGED SPECIES – HARD CLAM

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STATE-MANAGED SPECIES – HARD CLAM

TABLES

Table 1. Current daily mechanical hard clam harvest limits by water body. Season can only be opened from December 1 through March 31 by proclamation.

| Waterbody | Daily harvest limit (number of clams) | Additional information |
|---------------------------------|--|--|
| Northern Core Sound | 5,000 | Rotates one year open and one year closed opposite the open/close rotation of the New River |
| Southern Core Sound | 5,000 | Limit reduced from 6,250 in 2001. Open annually |
| North River | 3,750 | Open annually |
| Newport River | 3,750 | Open annually |
| Bogue Sound | 3,750 | Open annually |
| White Oak River | 6,250 | Rotates one year open and one year closed opposite the open/close rotation of the New River |
| New River | 6,250 | Rotates one year open and one year closed opposite the open/close rotation of the White Oak River and the ICW in the Onslow/Pender counties areas |
| New River Inlet | 6,250 | Open annually from Marker 72A to the New River Inlet |
| ICW Onslow/Pender counties area | 6,250 | Intracoastal Waterway (maintained marked channel only) from Marker #65, south of Sallier's Bay, to Marker #49 at Morris Landing. All public bottoms within and 100 feet on either side of the Intracoastal Waterway from Marker #49 at Morris Landing to the "BC" Marker at Banks Channel. Open every other year when the New River is closed. |

STATE-MANAGED SPECIES – HARD CLAM

Table 2. Estimated number of trips, number of clams harvested, and catch rate (clams per trip) per year of Coastal Recreational Fishing License holders, 2010-2017

| Year | Number Trips | Clam Harvest | Catch Rate |
|------|--------------|--------------|------------|
| 2010 | 528 | 8731 | 18.4 |
| 2011 | 6,350 | 127,597 | 22.9 |
| 2012 | 6,726 | 146,151 | 27.3 |
| 2013 | 8,644 | 191,842 | 26.2 |
| 2014 | 6,325 | 162,656 | 28.8 |
| 2015 | 7,637 | 166,419 | 27.4 |
| 2016 | 8,456 | 84,199 | 12.3 |
| 2017 | 3,435 | 75,171 | 21.8 |

Table 3. Observed annual mean, minimum and maximum shell length (mm) of hard clams measured from commercial catches at the dealer, 2008 – 2017.

| Year | Mean Shell Length | Min Shell Length | Max Shell Length | Total Number measured |
|-----------------|-------------------|------------------|------------------|-----------------------|
| 2008 | 69 | 41 | 120 | 1,383 |
| 2009 | 64 | 39 | 112 | 1,862 |
| 2010 | 63 | 39 | 104 | 5,358 |
| 2011 | 64 | 38 | 111 | 10,670 |
| 2012 | 62 | 40 | 109 | 5,851 |
| 2013 | 63 | 40 | 108 | 4,750 |
| 2014 | 60 | 27 | 115 | 7,447 |
| 2015 | 60 | 34 | 111 | 6,218 |
| 2016 | 60 | 30 | 105 | 6,460 |
| 2017 | 73 | 41 | 173 | 3,774 |
| 10 year average | 64 | 27 | 173 | 53,773 |

STATE-MANAGED SPECIES – HARD CLAM

Table 4. Independent hard clam sampling (Program 640) annual estimates of catch per unit effort (CPUE=Number of clams per station) and their standard deviations, 2007 to 2017 for Core Sound.

| Year | Total number of stations | Number of stations with zero catch | Number of clams | CPUE (Number of clams/station) | Standard deviation |
|------|--------------------------|------------------------------------|-----------------|--------------------------------|--------------------|
| 2007 | 30 | 22 | 20 | 0.67 | 1.54 |
| 2008 | 31 | 24 | 12 | 0.39 | 0.80 |
| 2009 | 30 | 15 | 38 | 1.27 | 1.82 |
| 2010 | 30 | 19 | 22 | 0.73 | 1.36 |
| 2011 | 30 | 26 | 14 | 0.47 | 2.03 |
| 2012 | 30 | 17 | 21 | 0.70 | 1.21 |
| 2013 | 30 | 25 | 16 | 0.53 | 1.53 |
| 2014 | 30 | 24 | 21 | 0.70 | 1.78 |
| 2015 | 30 | 22 | 15 | 0.50 | 0.50 |
| 2016 | 30 | 22 | 16 | 0.53 | 0.23 |
| 2017 | 30 | 22 | 35 | 1.17 | 2.57 |

Table 5. Summary of the Marine Fisheries Commission selected management strategies from Amendment 2 of the N.C. Hard Clam Fishery Management Plan.

| Management strategies | Implementation status |
|--|---|
| MANAGEMENT OF PUBLIC BOTTOM | |
| 1. Status quo (Continue the daily harvest limit for recreational purposes at 100 clams per person per day not to exceed 200 per clams per vessel per day) | No action required |
| 2. Status quo (Maintain management of the mechanical clam harvest in existing areas from Core Sound south to Topsail Sound, including modifications to the mechanical clam harvest lines to exclude areas where oyster habitat and SAV habitat exist based on all available information) | No action required |
| 3. Remove the Pamlico Sound mechanical clam harvest areas in rule no longer in use | Rule change to 15A NCAC 03K .0302 in effect May 1, 2017 |
| 4. Take latitude/longitude coordinates of the poles marking the open mechanical clam harvest area boundary in the New River, still with the flexibility to move a line to avoid critical habitats | Completed in 2015 |
| 5. Allow mechanical clam harvesters to have access to the bottom before maintenance dredging occurs | No action required |
| 6. Status quo (Maintain current definitions and enforcement of hand harvest methods) | No action required |

STATE-MANAGED SPECIES – HARD CLAM

| Management strategies | Implementation status |
|---|--|
| 7. Allow Shellfish License holders to be eligible to acquire a Standard Commercial Fishing License after they show a history of sale of shellfish. Continue to allow commercial harvest of all other shellfish (clams included) as currently allowed | No action required |
| PRIVATE CULTURE | |
| 1. Support modification of G.S. 113-208 and G.S. 113-269 to add minimum fines for violations on shellfish leases and franchises. With minimum fines set at \$500 for the first violation and \$1,000 for the second violation | Amend G.S. 113-208 and G.S. 113-269 |
| 2. Support modification of G.S. 113-269 to include protection to all shellfish leases and franchises, not just those with water column amendments | Amend G.S. 113-269 |
| 3. Modify Rule 15A NCAC 03O .0114, regardless whether statute changes occur, so that a first conviction under G.S. 113-208 or G.S. 113-269 the Fisheries Director shall revoke all licenses issued to the licensee | Rule change to 15A NCAC 03O .0114 in effect May 1, 2017 |
| 4. Status quo (Adhere to Regional Conditions of USACE NWP48 with no adverse effect to SAV from shellfish leases and following measure identified in the interim) | No action required |
| 5. Continue the moratorium of shellfish leases in Brunswick County | No action required |
| 6. Establish a rule to support extensions for where “Acts of God” prevent lease holder from making production, with a two year extension and only one extension allowed per term | Rule change 15A NCAC 03O .0201 in effect on May 1, 2017 |
| 7. Allow leases returned to the state to remain delineated for a period of one year to allow the pre-existing leased bottom to be re-issued to other shellfish growers | Amend G.S. 113-202 |
| 8. Improve public notice of proposed lease applications on the physical lease, at fish houses, and/or through electronic notices | Ongoing |
| 9. Allow a maximum of ten acres in both mechanical methods prohibited areas and mechanical methods allowed areas | Rule change 15A NCAC 03O .0201(a)(3) in effect on May 1, 2017 |
| ENVIRONMENT AND PUBLIC HEALTH | |
| 1. Implement shading requirements for clams on a vessel, during transport to a dealer, or storage on a dock during June through September. These requirements would be implemented as a public health protection measure under 15A NCAC 03K .0110 by proclamation annually. | Existing proclamation authority, implemented beginning April 1, 2017 |

STATE-MANAGED SPECIES – HARD CLAM

FIGURES

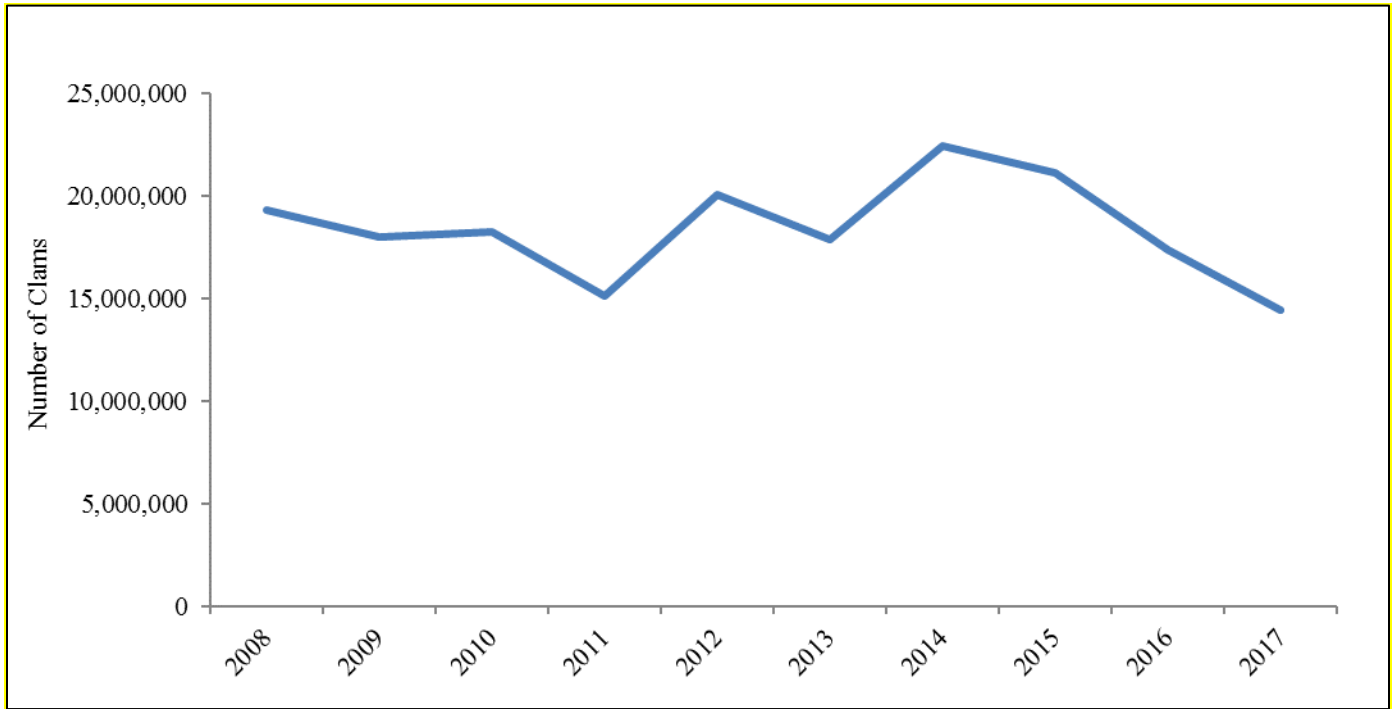


Figure 1. Annual hard clam landings (millions of clams) from private and public bottom in North Carolina, 2008 - 2017.

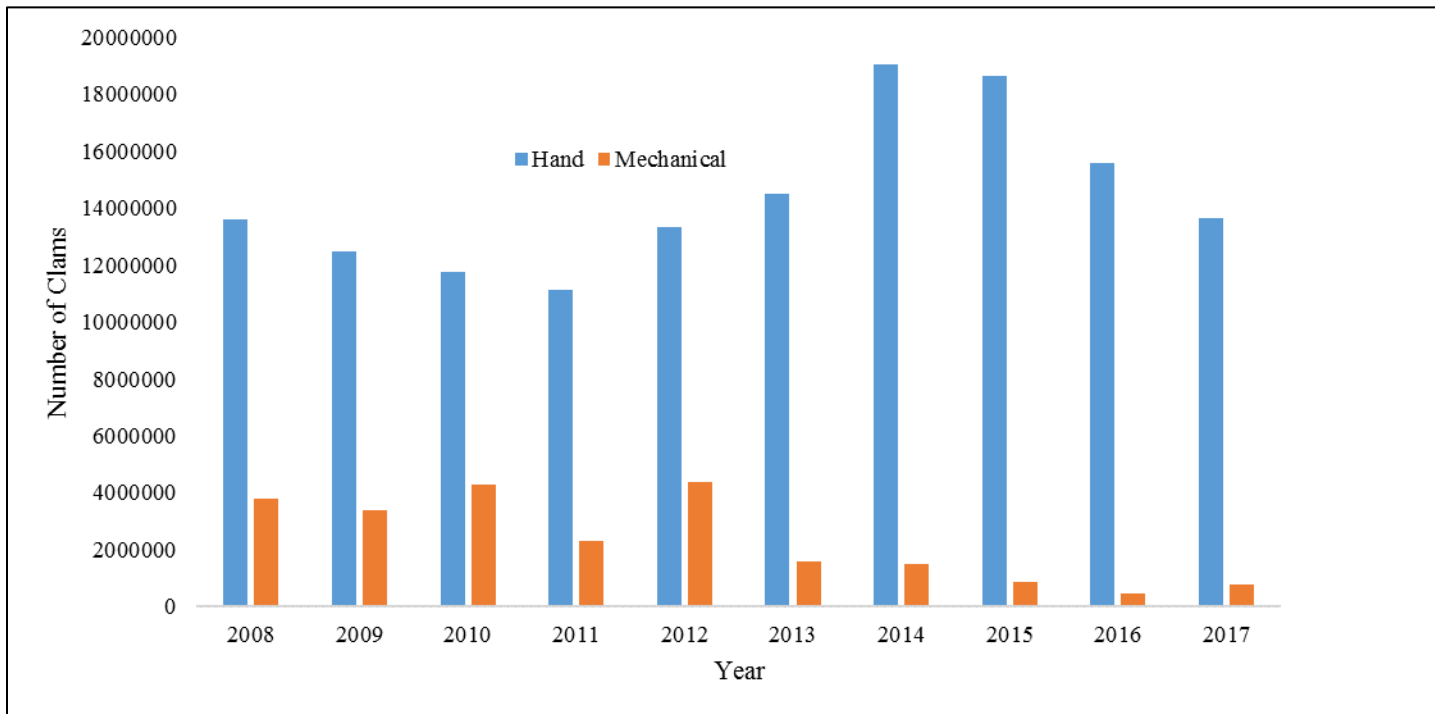


Figure 2. Annual hard clam landings (Number of clams) from hand and mechanical harvest off of public bottom, 2008 - 2017.

STATE-MANAGED SPECIES – HARD CLAM

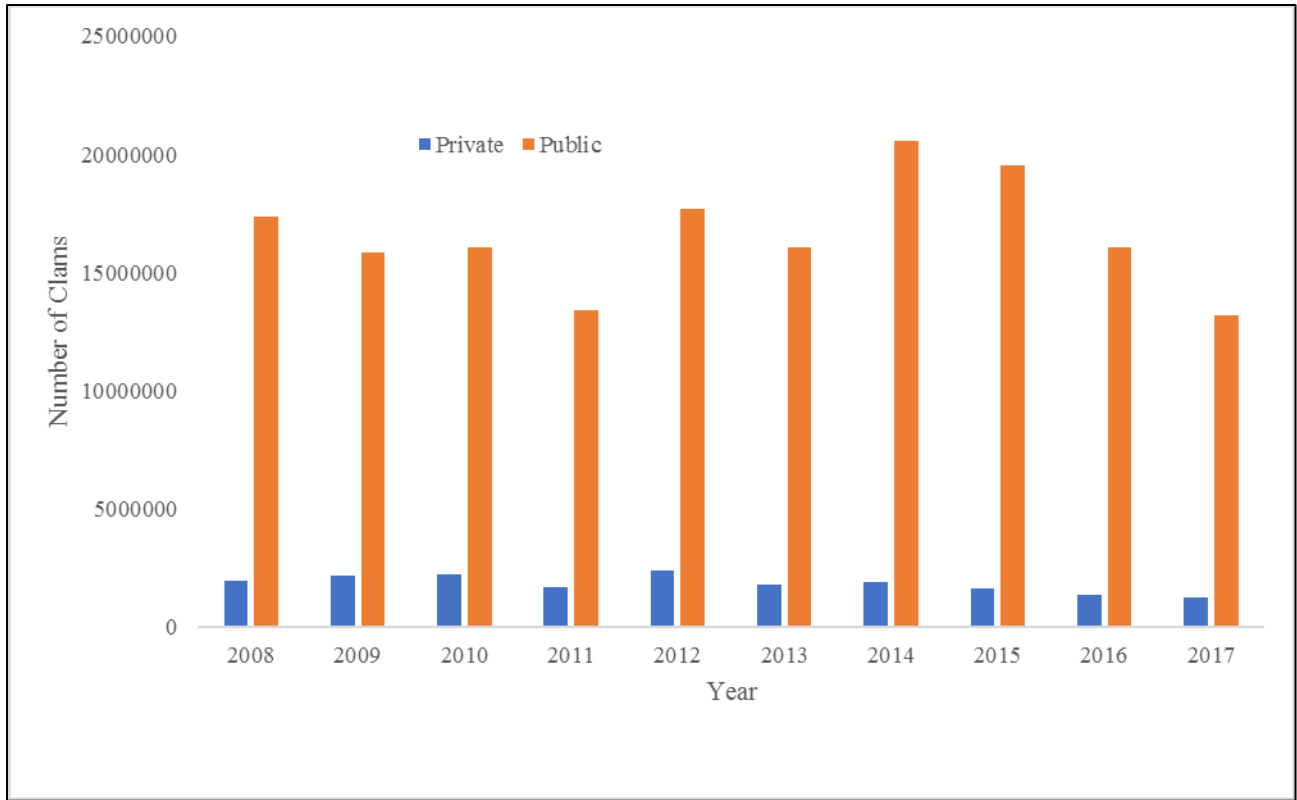


Figure 3. Annual hard clam landings (Number of clams) from private and public bottom, 2008 - 2017.

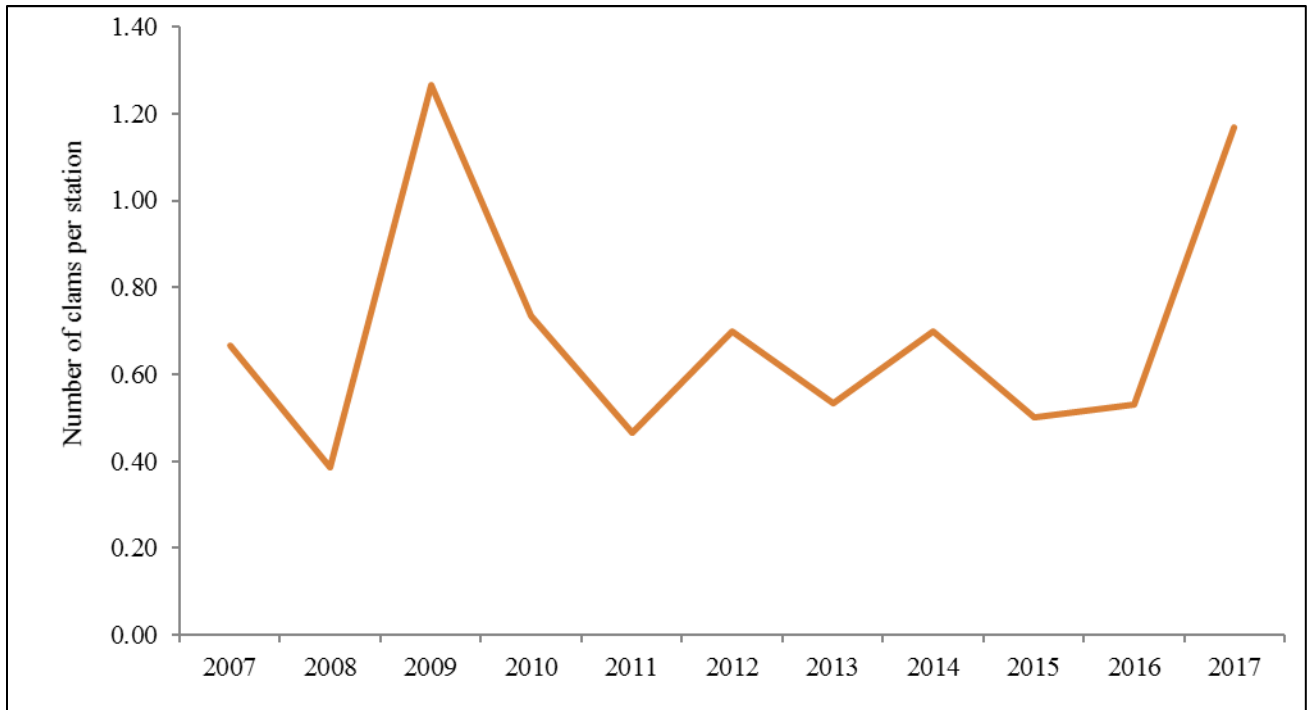


Figure 4. Annual catch per unit effort (Number of clams per stations) of hard clams in Core Sound from the independent sampling program 640, 2007 - 2017.

STATE-MANAGED SPECIES – KINGFISHES

FISHERY MANAGEMENT PLAN UPDATE KINGFISHES AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---------------|
| Original FMP Adoption: | November 2007 |
| Amendments: | None |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | November 2015 |
| Schedule Changes: | None |
| Next Benchmark Review: | July 2020 |

The original 2007 Kingfish Fishery Management Plan (FMP) developed management strategies that ensure a long-term sustainable harvest for recreational and commercial fisheries of North Carolina. The plan established the use of trend analysis and management triggers to monitor the viability of the stock. The N.C. Marine Fisheries Commission (NCMFC) also approved a rule which included proclamation authority for the North Carolina Division of Marine Fisheries (NCDMF) director the flexibility to impose restrictions on season, areas, quantity, means and methods, or size of kingfish (NCMFC Rule 15A NCAC 03M .0518), if needed. An Information Update was completed for the Kingfish FMP in November of 2015. The best available data and techniques used for the trend analysis and management triggers were refined and modified to better assess population trends as part of this FMP Information Update.

Management Unit

The North Carolina Kingfish FMP includes the three species of kingfishes (southern *Menticirrhus americanus*, Gulf *M. littoralis*, and northern *M. saxiatis*) in all coastal fishing waters of North Carolina. Southern kingfish is designated as the indicator species for this assemblage. The management unit identified in this plan does not encompass the entire unit stock range for any of the three species of kingfishes inhabiting North Carolina. This is the primary reason that a quantified state-specific stock assessment could not be conducted and further, why a regional stock assessment approach is recommended as the most appropriate mechanism for determining the stock status and the long-term viability of this stock (NCDMF 2007).

STATE-MANAGED SPECIES – KINGFISHES

Goal and Objectives

The goal of the 2007 Kingfish Fishery Management Plan is to determine the health of the stock and ensure the long-term sustainability for the kingfishes stock in North Carolina (NCDMF 2007). To achieve this goal, it is recommended that the following objectives be met:

1. Develop an objective management program that provides conservation of the resource and sustainable harvest in the fishery.
2. Ensure that the spawning stock is of sufficient capacity to prevent recruitment overfishing.
3. Address socio-economic concerns of all user groups.
4. Restore, improve, and protect critical habitats that affect growth, survival, and reproduction of the North Carolina stock of kingfishes.
5. Evaluate, enhance, and initiate studies to increase our understanding of kingfishes' biology and population dynamics in North Carolina.
6. Promote public awareness regarding the status and management of the North Carolina kingfishes stock.

STATUS OF THE STOCK

Life History

Three species of kingfishes occur in North Carolina: southern (*Menticirrhus americanus*), Gulf (*M. littoralis*), and northern kingfishes (*M. saxatilis*). Kingfish refers to a single species while kingfishes refers to multiple species. Kingfishes are demersal (live near and feed on the bottom) members of the drum family. Southern kingfish is the most abundant kingfish species from North Carolina to the east coast of Florida and Gulf of Mexico with a range extending as far as Cape May, New Jersey southward to Buenos Aires, Argentina. Northern kingfish is the most abundant kingfish species from Massachusetts to North Carolina, with a range extending from the Gulf of Maine into the Gulf of Mexico. Gulf kingfish is the most abundant kingfish species in the surf zone south of Cape Hatteras, North Carolina, and has a range extending from Virginia to Rio Grande, Brazil. The northern and southern kingfishes prefer mud or sand-mud bottom types while Gulf kingfish prefer the sandy bottoms of the surf zone. Kingfishes move from estuarine and nearshore ocean waters to deeper offshore waters as water temperature cools. Spawning takes place in the ocean from April to October. The kingfishes have several regional names including sea mullet, king whiting, king croaker, sea mink, roundhead, hard head, whiting, hake, Carolina whiting, and Virginia mullet.

Stock Status

The stock of kingfish is unassessed, thus overfishing/overfished status cannot be determined. However, results from the trend analysis suggests there are no concerns with the stock and no

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need for management at this time. A coast-wide stock assessment is a high research priority that needs to be addressed before biological reference points relative to overfished and overfishing can be determined.

Stock Assessment

The 2007 Kingfish FMP selected the use of trend analysis with management triggers as the management strategy to monitor the viability of the kingfish stock in North Carolina (NCDMF 2007). During the review of the 2007 Kingfish FMP as part of the 2015 FMP Information Update, best available data and techniques used for the trend analysis and management triggers were refined and modified to better assess population trends. The trend analysis incorporates management triggers to alert NCDMF and NCMFC to the potential need for management action based on stock conditions. The activation of any two management triggers (regardless of trigger category) two years in a row warrants further evaluation of the data and potential management action. The analysis is updated each year and all trends relative to management triggers are provided as part of this annual update. Current management triggers are based on fishery independent indices of abundance for Young-of-Year (YOY), adult fish, the proportion of catch greater than size at 50% maturity (L_{50}) and a relative fishing mortality index. YOY fish includes new fish that enter the population that year. L_{50} is the length at which 50% of the adult population is sexually mature and ready to spawn.

A formal quantitative stock assessment is not available for kingfish in North Carolina; therefore, no determination can be made relative to an overfishing or overfished status. Prior attempts at a stock assessment during the 2007 FMP development were not successful, primarily due to limited data. From these prior attempts, all reviewers noted a lack of migration (mixing) data to determine the movement patterns of kingfishes along North Carolina and the entire Atlantic coast. A regional (multi-state) stock assessment approach is likely needed to best determine the stock status for kingfish along the Atlantic coast including North Carolina. In 2008 and 2014, Atlantic States Marine Fisheries Commission (ASMFC) South Atlantic Board met to consider regional management by reviewing data on kingfishes. However, due to no major concerns with kingfish stocks, it was decided no further action was necessary. As a result, kingfish management in North Carolina continues to fall solely within the framework of the state FMP process.

STATUS OF THE FISHERY

Current Regulations

For shrimp or crab trawls, there is a three-hundred-pound trip limit for kingfishes south of Bogue Inlet from December 1 through March 31 (NCMFC Rule 15A NCAC 03J .0202 (5)). No other harvest limits are in place specific to kingfish in any other fisheries.

Commercial Landings

Commercial landings for kingfishes include southern, northern, and Gulf kingfishes combined. Landings have fluctuated historically, but have been on an increasing trend since 2011. The 2017 landings increased 12 percent from 2016 (Figure 1). The vast majority of kingfishes landed are

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from the ocean gill net fishery. The average landings from 2008 to 2017 were 555,941 pounds. Harvest of kingfishes is seasonal with peak landings in April and November. Peaks in landings coincide with seasonal movements of kingfishes along the Atlantic coast.

Recreational Landings

Recreational landings for kingfish include southern, northern, and Gulf kingfishes. Total recreational landings had been on an increasing trend from 1983 – 2015. In 2016 and 2017, recreational landings declined, with 2017 having the lowest landings since 1999 (Figure 2). Most kingfishes are landed from the ocean and the majority of the fish are caught from man-made structures, such as piers, jetties, or bridges, or from beaches. A smaller portion of kingfishes are caught in estuarine waters of the state and the majority of those fish are harvested by anglers fishing from private vessels. Recreational harvest of kingfishes is also seasonal with the majority of fish harvested during the spring and the fall, and lowest during the summer.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Kingfishes are sampled from a variety of commercial fishery surveys, including the estuarine long haul, ocean trawl, pound net, ocean gill net, estuarine gill net and ocean beach seine fisheries in N.C. A total of 50,984 kingfishes were measured from 2008 to 2017 (45,250 southern, 2,896 northern and 2,838 Gulf; Table 1). Mean length for southern kingfish ranged from 286 to 306 mm, with a minimum of 160 mm and a maximum of 558 mm. Mean length for northern kingfish ranged from 311 to 340 mm, with a minimum of 110 mm and a maximum of 445 mm. Mean length for Gulf kingfish ranged from 305 to 337 mm with a minimum of 199 mm and a maximum of 464 mm.

Recreational lengths are collected as part of Marine Recreational Informational Program (MRIP) by recreational port agents. A total of 7,976 kingfishes were measured from 2008 to 2017 (5,558 southern, 249 northern and 2,169 Gulf; Table 2). Mean length for southern kingfish ranged from 267 to 293 mm, with a minimum of 134 mm and a maximum of 505 mm. Mean length for northern kingfish ranged from 255 to 333 mm, with a minimum of 157 mm and a maximum of 406 mm. Mean length for Gulf kingfish ranged from 255 to 301 mm, with a minimum of 150 mm and a maximum of 463 mm.

Fishery-Independent Monitoring

Fishery-independent data are collected through the NCDMF Pamlico Sound Survey (Program 195), the Southeast Area Monitoring and Assessment Program – South Atlantic (SEAMAP-SA) Coastal Survey and the NCDMF Independent Gill Net Survey (Program 915). The Pamlico Sound Survey catches the most kingfishes of any of the NCDMF fishery independent sampling programs, and the majority of those are southern kingfishes. This survey has been running uninterrupted since 1987. From 1991 to present, the Pamlico Sound Survey has been conducted during the middle two weeks in June and September. The stations sampled are randomly selected from strata based upon depth and geographic location. Tow duration is 20 minutes at 2.5 knots

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using the R/V Carolina Coast pulling double rigged demersal mongoose trawls. The sample area covers all of Pamlico Sound and its bays, as well as Croatan Sound up to the Highway 64 Bridge, the Pamlico River up to Blounts Bay, the Pungo River up to Smith Creek, and the Neuse River up to Upper Broad Creek. However, most kingfish are caught in Pamlico Sound proper, and very few from the Neuse, Pamlico, and Pungo rivers. The September portion of the Pamlico Sound Survey is used to calculate a YOY index of relative abundance because there are more southern kingfish collected in the fall, and more YOY are present in the catch at this time. The relative index derived from Program 195 survey was calculated using a stratified generalized linear model (GLM) approach. The Program 195 YOY relative abundance index peaked in 2009, but has been on a decreasing trend since 2013, and remained low in 2017 (Figure 3 Table 3).

The Southeast Area Monitoring and Assessment Program-South Atlantic (SEAMAP-SA) Coastal Survey is conducted by the South Carolina Department of Natural Resources-Marine Resources Division, and provides long-term fishery independent data on the distribution and relative abundance of coastal species (Cowen and Zimney 2016). Stations are randomly selected from a pool of stations in each stratum, and sampled using paired mongoose-type Falcon trawls with tow times of 20 minutes. SEAMAP-SA Coastal Survey cruises are conducted each year in spring (mid-April to the end of May), summer (mid-July to mid-August), and fall (the first of October to mid-November). The summer portion of SEAMAP-SA Coastal Survey is used to calculate an adult index of abundance and the fall portion of SEAMAP-SA Coastal Survey is used as a young of year index of abundance. The indices derived from the SEAMAP-SA Coastal Survey were computed using standard (non-stratified) GLMs. After a peak in 2012, the SEAMAP-SA Coastal Survey adult index of relative abundance has been on a declining trend, which continued in 2017 (Figure 4; Table 3). The YOY index of relative abundance increased to well above the average in 2015, and has since returned to approximately the average in 2016 and 2017 (Figure 5; Table 3).

The Independent Gill Net Survey is designed to characterize the size and age distribution for key estuarine species in Pamlico Sound and its major river tributaries. Sampling began in Pamlico Sound in 2001 and was expanded to the current sampling area (including tributaries) in 2003. Each array of nets consists of floating gill nets in 30-yard segments of 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, and 6.5-inch stretched mesh, for a total of 240 yards of nets. Catches from an array of gill nets comprise a single sample; two samples (one shallow, one deep) totaling 480 yards of gill net are completed each trip. Gill nets are typically deployed within an hour of sunset and fished the following morning. Efforts are made to keep all soak times within 12 hours. Gill net sets are determined using a random stratified survey design, based on area and water depth. The L_{50} management trigger is based on a conservative proportion of adults in the population. This is the length at which 50 percent of the population is mature. For southern kingfish, this is 8.25 inches (210 mm) in length. One of the data sources for this management trigger comes from the Pamlico Sound Survey and has been stable over the time series (Figure 6).

Table 2 summarizes the age data for kingfishes (southern, northern, and Gulf), collected from 2008 through 2017. The majority of kingfish age samples came from Independent Gill Net Survey (Program 915), followed by the commercial ocean gill net fishery. Southern kingfish ages ranged from 0 to 9 years old. Northern kingfish ages ranges from 0 to 5 years old. Gulf

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kingfish ages ranged from 0 to 7 years old. The modal ages ranged from 1 to 3 years for southern and Gulf kingfishes, and 0 to 2 for northern kingfish.

MANAGEMENT STRATEGY

The 2007 Kingfish FMP selected the use of trend analysis and management triggers as the management strategy to monitor the viability of the kingfish stock in North Carolina (NCDMF 2007). A second management strategy promotes work to enhance public information and education. The trend analysis and management triggers are updated annually and results are presented to the NCMFC as part of the annual FMP Update. The trend analysis incorporates triggers to alert managers to the potential need for management action based on stock conditions. The activation of any two management triggers two years in a row (regardless of category) warrants further data evaluation and potential management action. The NCMFC will be notified should this criterion be met. The Pamlico Sound Survey, the Independent Gill Net Survey and the SEAMAP-SA Coastal Survey data are currently used for management triggers for kingfishes in North Carolina.

The L_{50} management trigger is based on a conservative proportion of adults in the population. This is the length at which 50 percent of the population is mature. For southern kingfish, this is 8.25 inches (210 mm) in length. Data sources for this management trigger come from two fisheries-independent surveys; the summer component of the SEAMAP-SA Coastal Survey, and the June component of the Pamlico Sound Survey.

Relative F is a simple method for estimating trends in F (Sinclair 1998). It is estimated as catch (commercial landings plus recreational harvest) divided by a fisheries-independent index of relative abundance. Here, catch (commercial landings plus recreational harvest) was divided by the SEAMAP-SA Coastal Survey spring index (Onslow, Raleigh, and Long bays, inner—shallow—strata) of relative abundance, given that the majority of catch occurs in the spring.

The kingfish management triggers are summarized as follows:

Biological Monitoring

Proportion of adults \geq length at 50 percent maturity (L_{50}) for NCDMF Program 195 June (Figure 7)

Proportion of adults $\geq L_{50}$ for NCDMF Program 915 (Figure 6)

Proportion of adults $\geq L_{50}$ for SEAMAP-SA Coastal Survey summer (Figure 8)

→ If the proportion of adults $\geq L_{50}$ falls below 2/3 of the average proportion of adults $\geq L_{50}$ for the time series, then the trigger will be considered tripped.

Fisheries-Independent Surveys—Juvenile and Adult

NCDMF Program 195 September index of YOY relative abundance (Figure 3)

SEAMAP-SA Coastal Survey summer index of adult relative abundance (Figure 4)

SEAMAP-SA Coastal Survey fall index of YOY relative abundance (Figure 5)

→ If a fisheries-independent survey falls below 2/3 of the average abundance for the time series (through 2017), then the trigger will be considered tripped.

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Other

Relative fishing mortality rate (F) (Figure 9)

→ If relative F rises above the average $+1/3$ of relative F for the time series (through 2017), the trigger will be considered tripped.

A summary of the various management triggers by year is provided in Table 3. Bold values indicate years when a particular management trigger was activated. In 2017, one management trigger was activated and only one trigger (the YOY index from the September portion of Pamlico Sound Survey) was slightly below the management trigger threshold. No action is required at this time.

RESEARCH NEEDS

The division reviewed and prioritized the research recommendations during the 2015 FMP Information Update (NCDMF 2015). The prioritization of each research recommendation is designated as a high, medium, or low priority. A low ranking does not infer a lack of importance but is either already being addressed by others or provides limited information for aiding in management decisions. A high ranking indicates there is a substantial need, which may be time sensitive in nature, to provide information to help with management decisions. Proper management of the kingfishes resource cannot occur until some of these research needs are met. The research recommendations include:

- Conduct a coast-wide stock assessment of southern kingfish along the Atlantic Coast including estimation of biological reference points for sustainable harvest – HIGH (No action)
- Validate YOY and adult indices used in trend analysis – HIGH (UNCW has conducted seine surveys in the ocean to determine trends for all three species)
- Develop a fisheries-independent survey in the ocean for juvenile and adult kingfishes – HIGH (No action)
- Collect observer data from commercial fishing operations to estimate at-sea species composition of the catch, discard rates, and lengths – HIGH (NCDMF has observers collecting data at sea for the shrimp fishery, flounder gill net fishery and other fisheries)
- Improve recreational data collection, particularly the species composition of discards, discard rates and associated biological data – HIGH (Steps have been taken to improve sampling in recreational fisheries, including a carcass collection program)
- Improve dependent commercial data collection of more sample sizes for life history information – MEDIUM (NCDMF ageing study collects kingfish for life history data)
- Evaluate and potentially expand the NCDMF fishery-independent gill net survey to provide data on species composition, abundance trends, and population age structure by including additional areas of North Carolina's estuarine and nearshore ocean waters – MEDIUM (No action)
- Continue bycatch reduction device studies in the shrimp trawl fishery to decrease bycatch – MEDIUM (Ongoing research through NCDMF and various federal agencies)
- Determine stock structure using genetics of kingfishes along North Carolina and the Atlantic Coast – LOW (Grant approved for UNCW and NCDMF to use genetic markers to delineate the population structure)

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- Develop tagging study to estimate natural and fishing mortality, to investigate stock structure, and to understand movement patterns – HIGH (No action)
- Collect histological data to develop maturity schedule with priority to southern kingfish – HIGH (NCDMF currently collecting histology samples in order to validate and update maturity schedules)
- Conduct an age validation study with priority to southern kingfish – HIGH (No action)
- Conduct study to estimate fecundity with priority to southern kingfish – MEDIUM (No action)
- Conduct study to identify spawning areas with priority for southern kingfish – MEDIUM (No action)
- Sample inlets and river plumes to determine the importance of these areas for kingfishes and other estuarine-dependent species – LOW (Sampling in the nearshore ocean through N.C. Adult Fishery Independent Survey was initiated in 2008 but discontinued in 2015. Gill net sampling in Cape Fear, New, Neuse, Pamlico, and Pungo rivers continues)
- Determine the effects of beach re-nourishment on kingfishes and their prey – LOW (Grant approved for UNCW to investigate effects of beach renourishment)
- Conduct a study to investigate how tidal stages and time of day influence feeding in kingfishes – LOW (No action)
- Increase the sample size of surveyed participants in the commercial kingfish fishery to better determine specific business characteristics and the economics of working in the fishery – LOW (NCDMF conducted a study of CRFL holders in 2009/2010)
- Update information on the participants in the recreational kingfish fishery – LOW (Socioeconomic study was conducted by NCDMF on piers)

FISHERY MANAGEMENT PLAN RECOMMENDATION

The NCDMF recommends maintaining the current review schedule.

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TABLES

Table 1. Summary of length data sampled from the kingfish commercial fishery, 2008 - 2017.

| Southern Kingfish | | | | |
|-------------------|-------------|----------------|----------------|-----------------------|
| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 290 | 160 | 446 | 9,956 |
| 2009 | 289 | 176 | 418 | 6,131 |
| 2010 | 293 | 170 | 558 | 3,927 |
| 2011 | 295 | 206 | 461 | 3,250 |
| 2012 | 290 | 203 | 433 | 4,646 |
| 2013 | 306 | 164 | 409 | 1,593 |
| 2014 | 300 | 211 | 532 | 3,732 |
| 2015 | 297 | 195 | 402 | 4,560 |
| 2016 | 303 | 181 | 437 | 3,353 |
| 2017 | 290 | 200 | 410 | 4,102 |
| Northern Kingfish | | | | |
| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 319 | 110 | 423 | 335 |
| 2009 | 317 | 174 | 401 | 301 |
| 2010 | 321 | 228 | 406 | 186 |
| 2011 | 317 | 219 | 431 | 208 |
| 2012 | 322 | 197 | 445 | 318 |
| 2013 | 335 | 218 | 406 | 930 |
| 2014 | 339 | 277 | 423 | 156 |
| 2015 | 324 | 253 | 422 | 84 |
| 2016 | 315 | 224 | 432 | 213 |
| 2017 | 340 | 255 | 442 | 165 |
| Gulf Kingfish | | | | |
| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 306 | 199 | 447 | 487 |
| 2009 | 313 | 251 | 406 | 351 |
| 2010 | 318 | 260 | 412 | 135 |
| 2011 | 337 | 219 | 455 | 366 |
| 2012 | 321 | 233 | 406 | 163 |
| 2013 | 328 | 246 | 443 | 545 |
| 2014 | 309 | 234 | 394 | 182 |
| 2015 | 324 | 268 | 413 | 161 |
| 2016 | 315 | 206 | 464 | 192 |
| 2017 | 313 | 238 | 425 | 256 |

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Table 2. Summary of length data sampled from the kingfish recreational fishery, 2008 - 2017.

| Southern Kingfish | | | | |
|-------------------|-------------|----------------|----------------|-----------------------|
| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 278 | 134 | 410 | 517 |
| 2009 | 277 | 160 | 459 | 689 |
| 2010 | 283 | 161 | 413 | 968 |
| 2011 | 277 | 185 | 418 | 583 |
| 2012 | 281 | 154 | 410 | 828 |
| 2013 | 267 | 156 | 402 | 370 |
| 2014 | 293 | 197 | 505 | 383 |
| 2015 | 273 | 162 | 475 | 258 |
| 2016 | 283 | 197 | 419 | 490 |
| 2017 | 274 | 199 | 392 | 472 |

| Northern Kingfish | | | | |
|-------------------|-------------|----------------|----------------|-----------------------|
| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 257 | 216 | 365 | 20 |
| 2009 | 278 | 223 | 383 | 19 |
| 2010 | 284 | 220 | 390 | 20 |
| 2011 | 321 | 181 | 406 | 70 |
| 2012 | 298 | 211 | 383 | 58 |
| 2013 | 283 | 157 | 375 | 26 |
| 2014 | 280 | 225 | 342 | 2 |
| 2015 | 308 | 259 | 359 | 7 |
| 2016 | 255 | 200 | 299 | 3 |
| 2017 | 333 | 248 | 367 | 24 |

| Gulf Kingfish | | | | |
|---------------|-------------|----------------|----------------|-----------------------|
| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 262 | 167 | 402 | 321 |
| 2009 | 255 | 183 | 428 | 203 |
| 2010 | 274 | 150 | 463 | 363 |
| 2011 | 296 | 191 | 427 | 223 |
| 2012 | 266 | 162 | 415 | 406 |
| 2013 | 265 | 152 | 438 | 180 |
| 2014 | 289 | 165 | 411 | 203 |
| 2015 | 301 | 215 | 406 | 63 |
| 2016 | 266 | 192 | 358 | 81 |
| 2017 | 286 | 191 | 401 | 126 |

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Table 3. Kingfish age data collected from all sources (commercial and recreational fisheries and fishery independent sampling programs) combined, 2008 - 2017.

| Southern Kingfish | | | | |
|-------------------|-----------|-------------|-------------|-------------------|
| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
| 2008 | 2 | 0 | 9 | 324 |
| 2009 | 2 | 2 | 5 | 15 |
| 2010 | 2 | 1 | 5 | 163 |
| 2011 | 2 | 0 | 6 | 243 |
| 2012 | 1 | 1 | 6 | 228 |
| 2013 | 2 | 1 | 5 | 298 |
| 2014 | 3 | 0 | 5 | 269 |
| 2015 | 2 | 0 | 5 | 353 |
| 2016 | 1 | 0 | 7 | 530 |
| 2017 | 2 | 0 | 6 | 413 |
| Northern Kingfish | | | | |
| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
| 2008 | 0 | 0 | 5 | 50 |
| 2009 | 1 | 1 | 3 | 14 |
| 2010 | 2 | 1 | 3 | 4 |
| 2011 | 2 | 0 | 4 | 115 |
| 2012 | 1 | 0 | 3 | 17 |
| 2013 | 2 | 1 | 3 | 26 |
| 2014 | 2 | 2 | 2 | 1 |
| 2015 | 2 | 0 | 2 | 40 |
| 2016 | 1 | 1 | 4 | 49 |
| 2017 | 2 | 1 | 3 | 13 |
| Gulf Kingfish | | | | |
| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
| 2008 | 1 | 0 | 7 | 47 |
| 2009 | - | - | - | 0 |
| 2010 | 3 | 3 | 3 | 1 |
| 2011 | 2 | 1 | 6 | 28 |
| 2012 | 1 | 0 | 4 | 98 |
| 2013 | 1 | 1 | 4 | 44 |
| 2014 | 2 | 1 | 4 | 38 |
| 2015 | 2 | 0 | 4 | 78 |
| 2016 | 1 | 0 | 5 | 116 |
| 2017 | 2 | 0 | 5 | 167 |

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Table 4. Summary of management trigger organized by category. Bold indicates values that activate a trigger.

| Year | BIOLOGICAL MONITORING | | | FISHERIES-INDEPENDENT SURVEYS | | | OTHER |
|-------------------------|-----------------------------|----------------------------|---------------|-------------------------------|-------------|---------------|----------------|
| | Proportion of Adults >= L50 | | | YOY Indices | | Adult Index | Relative F |
| | Program 195 June | Program 915 July-September | SEAMAP Summer | Program 195 September | SEAMAP Fall | SEAMAP Summer | Relative F |
| 1987 | 0.611 | | | 1.1 | | | |
| 1988 | 0.450 | | | 1.3 | | | |
| 1989 | 0.300 | | 0.585 | 1.7 | 6.4 | 4.1 | 47,084 |
| 1990 | 0.563 | | 0.463 | 3.2 | 6.4 | 15 | 135,272 |
| 1991 | 0.667 | | 0.894 | 5.4 | 4.7 | 20 | 40,705 |
| 1992 | 0.429 | | 0.622 | 3.8 | 1.8 | 8.0 | 44,678 |
| 1993 | 0.543 | | 0.456 | 0.1 | 2.0 | 7.7 | 158,612 |
| 1994 | 0.794 | | 0.917 | 5.5 | 5.7 | 1.3 | 189,532 |
| 1995 | 0.440 | | 0.486 | 10 | 1.5 | 5.0 | 93,382 |
| 1996 | 0.872 | | 0.780 | 0.4 | 5.6 | 2.7 | 89,697 |
| 1997 | 0.589 | | 0.373 | 0.5 | 1.1 | 5.6 | 46,676 |
| 1998 | 1.000 | | 0.769 | 0.3 | 6.1 | 2.7 | 27,432 |
| 1999 | 0.920 | | 0.608 | 5.9 | 7.1 | 14 | 60,475 |
| 2000 | 0.733 | | 0.929 | 8.9 | 3.5 | 5.5 | 123,301 |
| 2001 | 0.660 | 0.983 | 0.303 | 5.9 | 2.8 | 12 | 51,543 |
| 2002 | 0.704 | 0.978 | 0.882 | 8.2 | 6.0 | 5.6 | 50,484 |
| 2003 | 0.872 | 0.978 | 0.645 | 7.0 | 2.5 | 9.3 | 16,509 |
| 2004 | 0.513 | 0.963 | 0.284 | 5.4 | 6.2 | 22 | 16,902 |
| 2005 | 0.594 | 0.970 | 0.666 | 2.9 | 3.7 | 9.2 | 24,747 |
| 2006 | 0.541 | 0.979 | 0.423 | 39 | 3.1 | 12 | 31,103 |
| 2007 | 0.343 | 1.000 | 0.521 | 10 | 4.4 | 3.6 | 84,264 |
| 2008 | 0.488 | 0.987 | 0.520 | 17 | 4.6 | 1.9 | 77,346 |
| 2009 | 0.586 | 1.000 | 0.389 | 39 | 1.5 | 8.3 | 74,052 |
| 2010 | 0.529 | 0.981 | 0.786 | 2.3 | 4.2 | 5.5 | 37,126 |
| 2011 | 0.432 | 1.000 | 0.507 | 28 | 16 | 9.3 | 45,170 |
| 2012 | 0.511 | 1.000 | 0.368 | 6.8 | 4.0 | 30 | 12,822 |
| 2013 | 0.659 | 0.941 | 0.558 | 29 | 5.5 | 19 | 13,797 |
| 2014 | 0.422 | 0.981 | 0.548 | 8.2 | 4.9 | 19 | 44,156 |
| 2015 | 0.534 | 0.980 | 0.550 | 10 | 93 | 16 | 21,375 |
| 2016 | 0.358 | 0.963 | 0.345 | 3.0 | 9.4 | 14 | 7,067 |
| 2017 | 0.503 | 0.953 | 0.684 | 5.1 | 6.9 | 7.2 | 5,464 |
| Threshold | <0.392 | <0.652 | <0.385 | <5.9 | <5.3 | <6.8 | >76,817 |
| Total Years | 31 | 17 | 29 | 31 | 29 | 29 | 29 |
| Years Trigger Activated | 3 | 0 | 5 | 16 | 16 | 11 | 8 |

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Table 5. Summary of the N.C. Marine Fisheries Commission management strategies and their implementation status for the 2007 Kingfish Fishery Management Plan.

| Management Strategy | Implementation Status |
|--|---|
| Fisheries Management | |
| The proposed management strategy for kingfishes in North Carolina is to 1) maintain a sustainable harvest of kingfishes over the long-term and 2) promote public education. The first strategy will be accomplished by developing management triggers based on the biology of kingfishes, landings of kingfishes, independent surveys, and requesting a stock assessment of kingfishes be conducted by Atlantic States Marine Fisheries Commission (ASMFC). The second strategy will be accomplished by the NCDMF working to enhance public information and education. | Accomplished |
| Recommend ASMFC conduct a coastwide stock assessment on sea mullet. | ASMFC determined a stock assessment for the kingfishes was not necessary due to the positive trends in SEAMAP southern kingfish CPUE. |
| Endorse additional research to reduce bycatch in the shrimp trawl fishery, primarily shrimp trawl characterization studies involving at-sea observers and investigations into fish excluder devices with a higher success rate for reducing the harvest and retention of kingfish in shrimp trawls. | Ongoing |
| Implement rule giving NCDMF director proclamation authority to manage kingfish. | Accomplished. Rule 15A NCAC 3M .0518 in effect since October 1, 2008 |
| Habitat and Water Quality | |
| The NCDCM should continue promoting the use of shoreline stabilization alternatives that maintain or enhance fish habitat. That includes using oyster cultch or limestone marl in constructing the sills (granite sills do not attract oyster larvae). | Endorsed through the Coastal Habitat Protection Plan (CHPP) |
| To ensure protection of kingfish nursery areas, fish-friendly alternatives to vertical stabilization should be required around primary and secondary nursery areas. | Endorsed through the CHPP |
| The location and designation of nursery habitats should be continued and expanded by the NCDMF. | Endorsed through the CHPP |
| No trawl areas and mechanical harvest prohibited areas should be expanded to include recovery/restoration areas for subtidal oyster beds and SAV. | Endorsed through the CHPP |
| Expansion and coordination of habitat monitoring efforts is needed to acquire data for modeling the location of potential recovery/restoration sites for oysters and SAV. | Endorsed through the CHPP |
| Any proposed stabilization project threatening the passage of kingfish larvae through coastal inlets should be avoided. | Endorsed through the CHPP |
| All coastal-draining river basins should be considered for NSW classification because they all deliver excess nutrients to coastal waters, regardless of flushing rate. | Endorsed through the CHPP |
| Efforts to implement phase II stormwater rules must be continued. | Endorsed through the CHPP |
| The EEP process should be extended to other development projects. | Endorsed through the CHPP |
| Reduce sediment and nutrient loading by addressing multiple sources, including: <ul style="list-style-type: none"> • improvement and continuation of urban and agricultural BMPs, • more stringent sediment controls on construction projects, and • implementation of additional buffers along coastal waters. | Endorsed through the CHPP |

STATE-MANAGED SPECIES – KINGFISHES

FIGURES

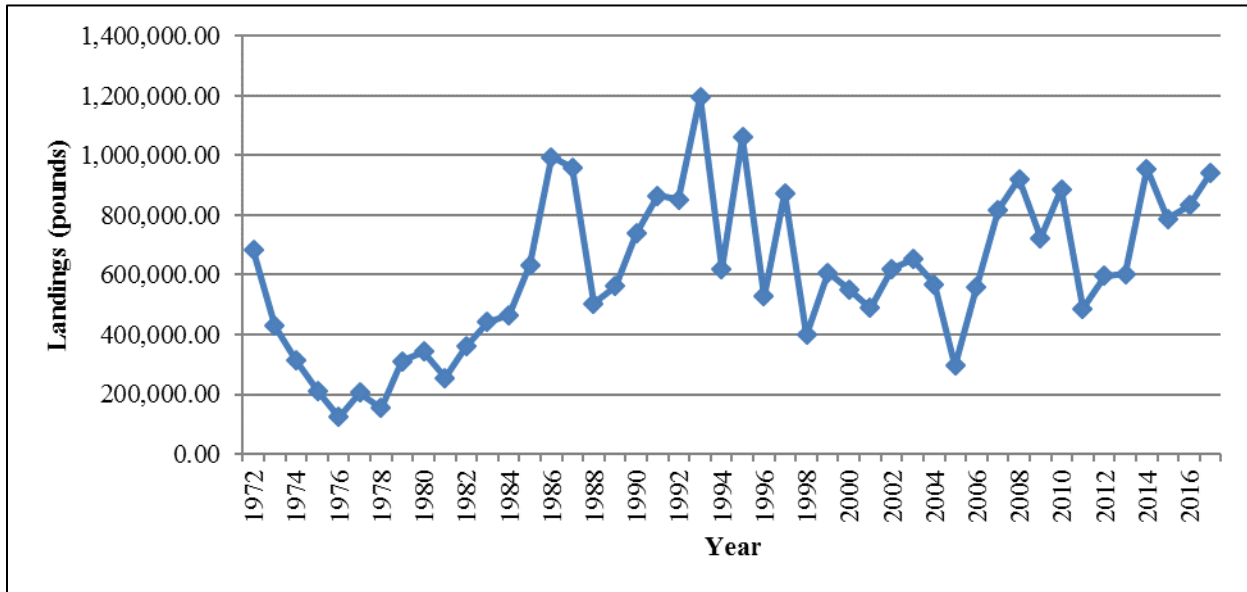


Figure 1. Commercial landings (pounds) of kingfishes (southern, northern, and Gulf combined) from 1972 to 2017.

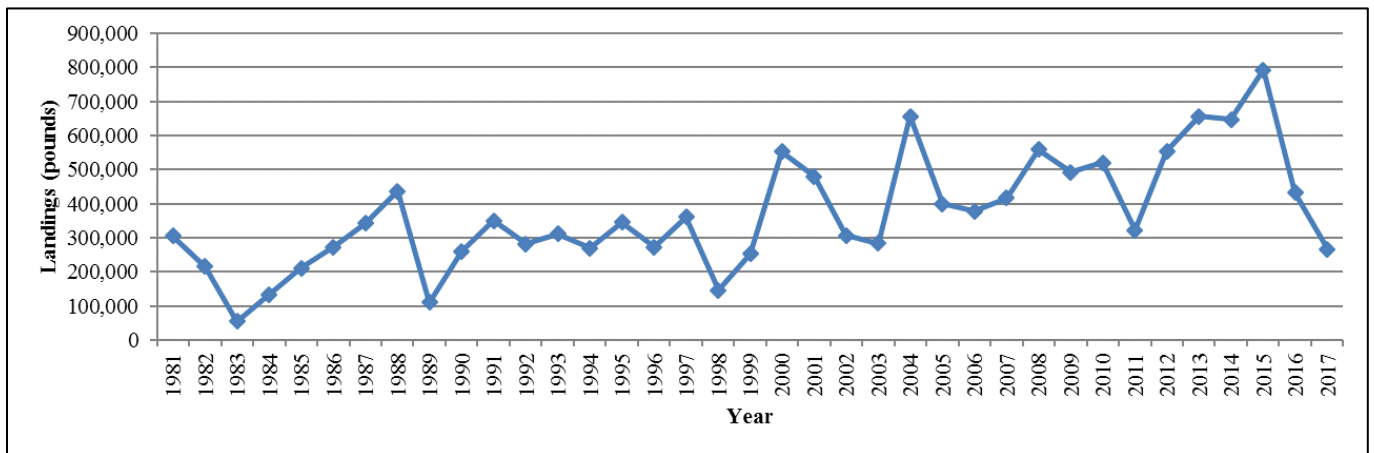


Figure 2. Recreational landings of kingfishes (southern, northern, and Gulf combined) from 1981 to 2017.

STATE-MANAGED SPECIES – KINGFISHES

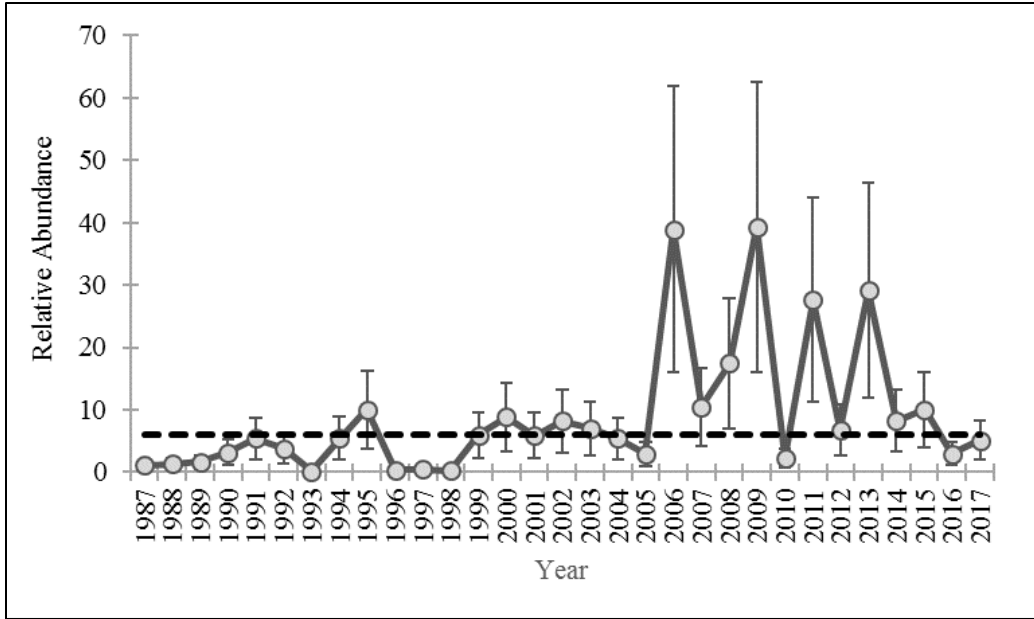


Figure 3. Annual index of relative YOY abundance for southern kingfish derived from the September component of the NCDMF Program 195 survey (excluding strata from the Neuse, Pamlico, and Pungo rivers), 1987–2017. Dotted line represents 2/3 of the average of the time series.

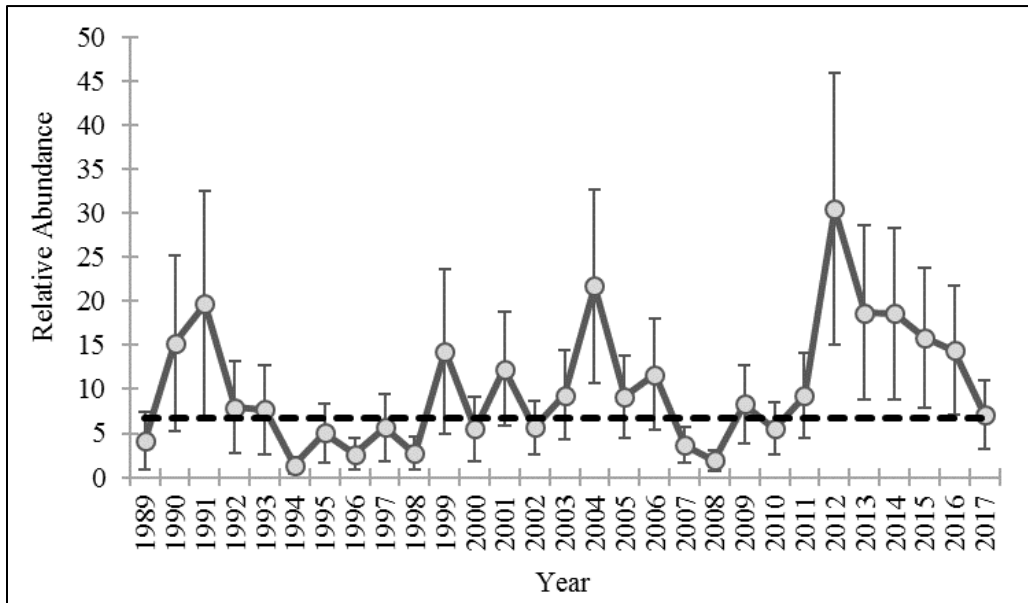


Figure 4. Annual index of relative adult abundance for southern kingfish derived from the summer component of the SEAMAP-SA Coastal Survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2017. Dotted line represents 2/3 of the average of the time series.

STATE-MANAGED SPECIES – KINGFISHES

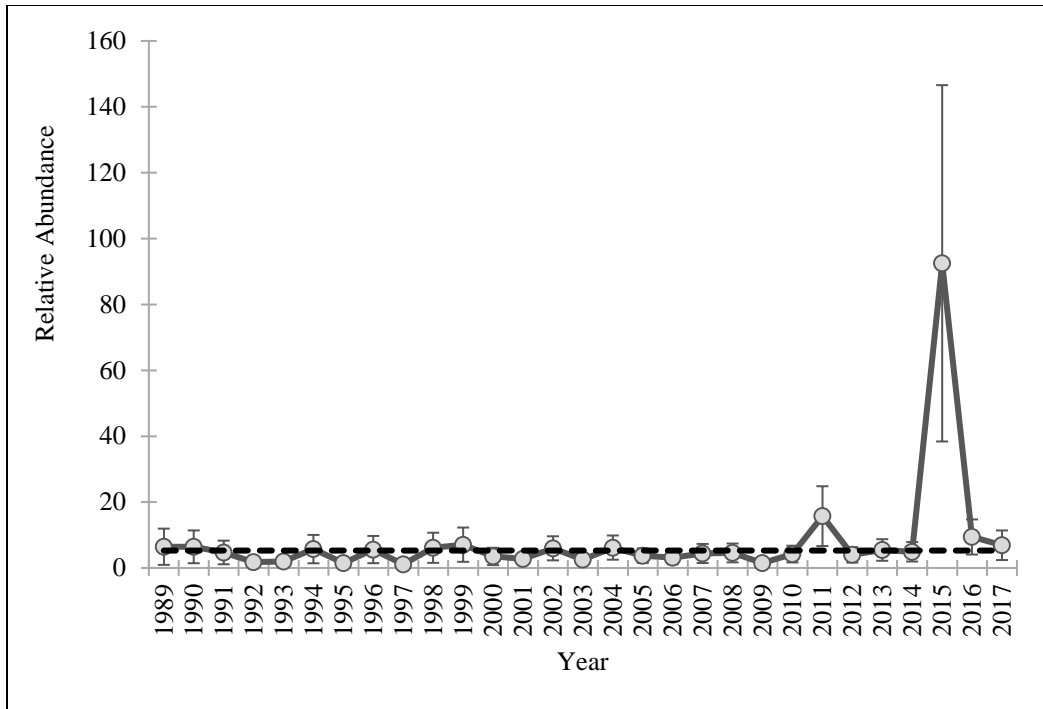


Figure 5. Annual index of relative YOY abundance for southern kingfish derived from the fall component of the SEAMAP-SA Coastal Survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2017. Dotted line represents 2/3 of the average of the time series.

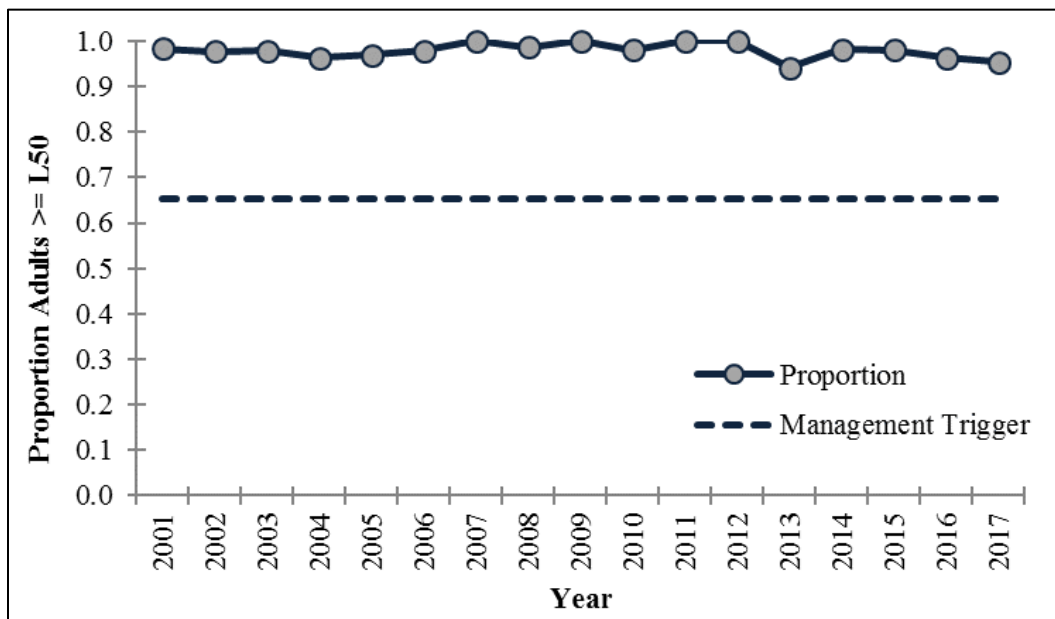


Figure 6. Annual proportions of adults (southern kingfish) greater than or equal to the length at 50% maturity occurring in the July through September component of the NCDMF Program 915 survey (Pamlico Sound, deep strata only), 2001–2017. Dotted line represents 2/3 of the average of the time series.

STATE-MANAGED SPECIES – KINGFISHES

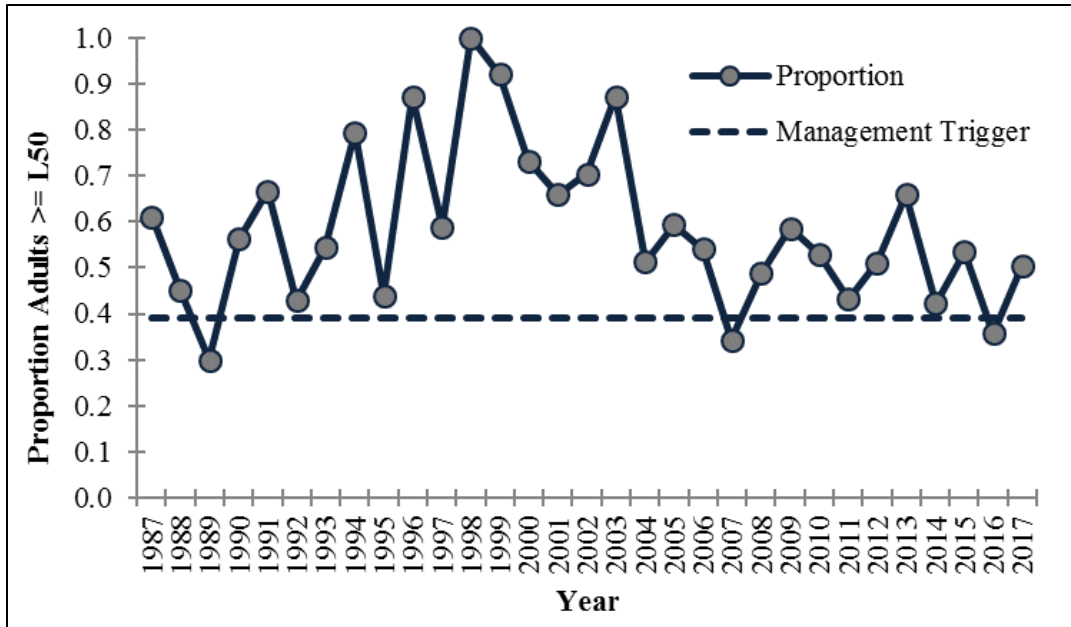


Figure 7. Annual proportions of adults (southern kingfish) greater than or equal to the length at 50% maturity occurring in the June component of the NCDMF Program 195 survey (excluding strata from the Neuse, Pamlico, and Pungo rivers), 1987–2017. Dotted line represents 2/3 of the average of the time series.

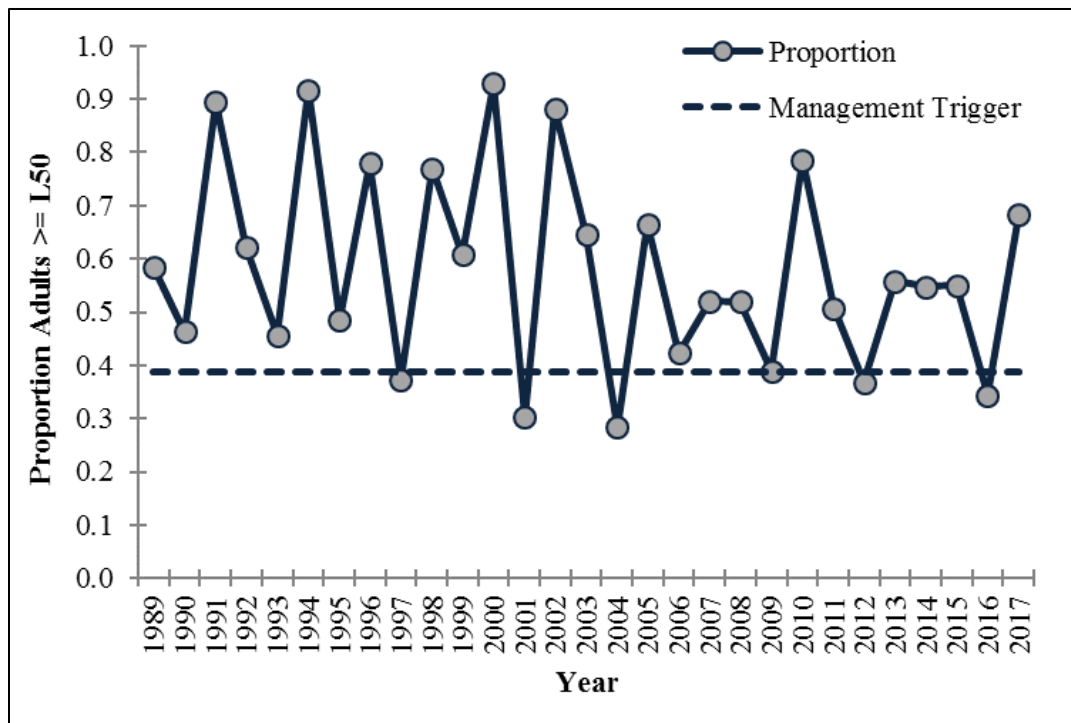


Figure 8. Annual proportions of adults (southern kingfish) greater than or equal to the length at 50% maturity occurring in the summer component of the SEAMAP-SA Coastal Survey (Onslow, Raleigh, and Long bays, inner—shallow—strata), 1989–2017. Dotted line represents 2/3 of the average of the time series.

STATE-MANAGED SPECIES – KINGFISHES

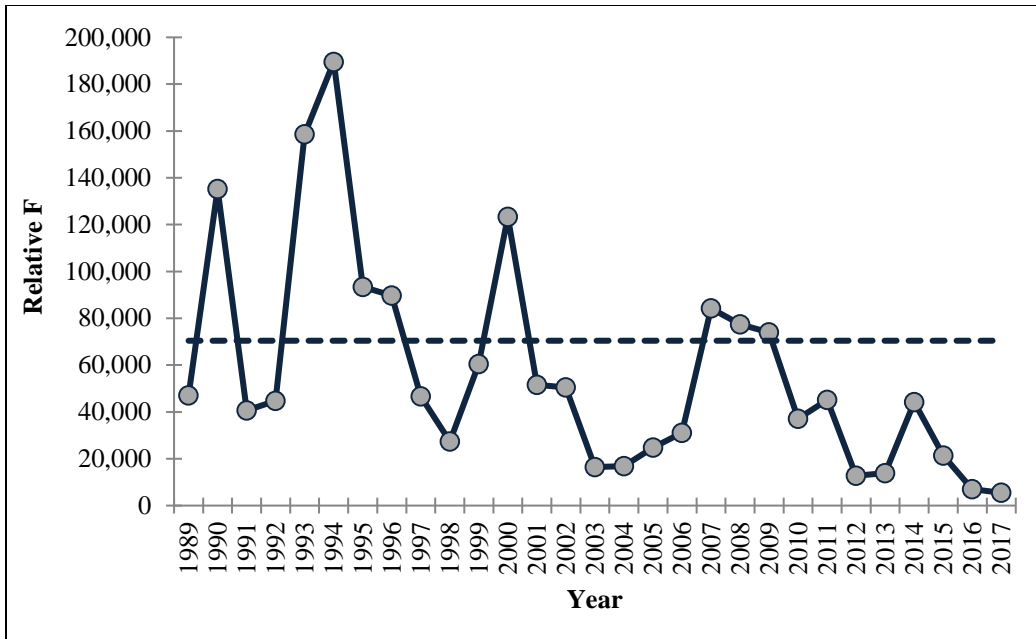


Figure 9. Relative F , as estimated as catch (commercial and recreational) divided by the SEAMAP-SA Coastal Survey spring index (Onslow, Raleigh, and Long bays, inner—shallow—strata) of relative abundance, 1989-2017. Dotted line represents 2/3 of the average of the time series.

STATE-MANAGED SPECIES – RED DRUM

FISHERY MANAGEMENT PLAN UPDATE – SCHEDULE CHANGE RECOMMENDED RED DRUM AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|-----------------------------|
| Original FMP Adoption: | March 2001 |
| Amendments: | Amendment 1 – November 2008 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Benchmark Review: | Completed February 2017 |

Red drum (*Sciaenops ocellatus*) in North Carolina are currently managed under Amendment 1 to the North Carolina Red Drum Fishery Management Plan (FMP) (NCDMF 2008). When Amendment 1 was developed, the 2007 stock assessment indicated that overfishing was not occurring in North Carolina (Takade and Paramore 2007). As a result, no new harvest restrictions for either the commercial or recreational fisheries were required when this amendment was adopted in 2008. Amendment 1 did, however, implement regulations to reduce the impact of discard mortality. These included requiring circle hooks along with fixed weights and short leaders in the summer adult red drum recreational fishery in Pamlico Sound and further expanded the gill net attendance requirements that were originally implemented as part of the original 2001 North Carolina Red Drum FMP (NCDMF 2001).

Prior to Amendment 1, restrictive harvest measures due to overfishing were implemented through the 2001 North Carolina Red Drum FMP. These measures were first implemented in October of 1998, as interim measures, while the full plan was developed. Harvest restrictions included: restricting all harvest of red drum to fish between 18 and 27 inches total length (previously allowed one fish over 27 inches); implemented a one fish recreational bag limit (previously five fish bag limit); implemented a daily trip limit for the commercial fishery that is set by the North Carolina Division of Marine Fisheries (NCDMF) director (previously no daily limit); and maintained the existing 250,000-pound annual commercial cap. The trip limit was designed to reduce harvest and to deter targeting of red drum commercially. The original FMP also implemented seasonal small mesh gill net attendance requirements to reduce discard mortality of red drum. The North Carolina Red Drum FMP was approved in March of 2001 and maintained all the interim measures. Stock assessments conducted since the implementation of

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the 2001 FMP have all indicated that management measures have been effective at preventing overfishing (Takade and Paramore 2007, SAFMC 2009, ASMFC 2017).

In addition to the state FMP, red drum in North Carolina also fall under Amendment 2 to the Atlantic States Marine Fisheries Commission (ASMFC) Red Drum FMP (ASMFC 2002). Adopted in 2002, Amendment 2 required all states to implement management measures projected to result in a 40% static spawning potential ratio (sSPR). Each state was required to implement these measures no later than January of 2003. Further, the plan also continues to require that states maintain management strategies that ensure that overfishing is not occurring and that optimum yield (OY) in the red drum fishery can be obtained. Amendment 2 compliance requirements to the states include:

- Implementing bag and size limits projected by bag and size limit analysis to achieve the minimum 40% sSPR.
- Establishing a maximum size limit of 27 inches or less in all red drum fisheries.
- Maintaining current or more restrictive commercial fishery regulations.
- Requires any commercial cap overages from one fishing year to be subtracted from the subsequent year's commercial cap.

The management measures already in place through the 2001 North Carolina Red Drum FMP were deemed sufficient to meet all the requirements of Amendment 2 to the ASMFC plan. Since that time, both the 2009 and 2017 assessments for red drum have indicated that the 40% static spawning potential ratio continues to be met or exceeded (SAFMC 2009, ASMFC 2017). Therefore, the ASMFC, to date, has continued with the current management strategy developed under Amendment 2.

To ensure compliance with interstate requirements, North Carolina also includes red drum as part of 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).

Management Unit

The Amendment 1 to the North Carolina Red Drum FMP applies to all joint and coastal waters throughout North Carolina, while the interjurisdictional plan through ASMFC applies to all states from Florida to Maine. Under the ASMFC plan, the management unit for red drum along the Atlantic coast is divided into a northern and southern stock. North Carolina and all areas north along the Atlantic coast represent the northern stock.

STATE-MANAGED SPECIES – RED DRUM

Goal and Objectives

The goal of Amendment 1 to the North Carolina Red Drum FMP is to prevent overfishing in the red drum stocks by allowing the long-term sustainable harvest in the red drum fishery. To achieve these goals, the FMP lists the following objectives:

1. Achieve and maintain a minimum overfishing threshold where the rate of juvenile escapement to the adult stock is sufficient to maintain the long-term sustainable harvest in the fishery.
2. Establish a target spawning potential ratio to provide the optimum yield from the fishery in order to maintain a state FMP that is in compliance with the requirements of the ASMFC Red Drum FMP.
3. Continue to develop an information program to educate the public and elevate their awareness of the causes and nature of problems in the red drum stock, its habitat and fisheries, and explain the rationale for management efforts to solve these problems.
4. Develop regulations that while maintaining sustainable harvest from the fishery, considers the needs of all user groups and provides adequate resource protection.
5. Promote harvest practices that minimize the mortality associated with regulatory discards of red drum.
6. In a manner consistent with Coastal Habitat Protection Plan, restore, improve and protect essential red drum habitat and environmental quality to increase growth, survival, and reproduction of red drum.
7. Improve our understanding of red drum population dynamics and ecology through the continuation of current studies and the development of better data collection methods, as well as, through the identification and encouragement of new research.
8. Initiate, enhance, and continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the red drum fishery.

STATUS OF THE STOCK

Life History

Red drum are estuarine dependent members of the drum family that includes Atlantic croaker, spot, black drum, weakfish and spotted sea trout. Ranging from Florida to Massachusetts along the Atlantic coast, red drum are most abundant from Virginia to Florida. Red drum, also called channel bass, are common throughout the coastal waters of North Carolina and is the state's saltwater fish. Large red drum (up to 90 pounds) inhabit the coastal waters throughout the year, are often observed in the surf during the spring and fall seasons and commonly found in the Pamlico Sound during the summer months. Spawning takes place in the fall around coastal inlets

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and in Pamlico Sound. Larval and juvenile red drum use various shallow estuarine habitats in coastal sounds and rivers during the first few years of life. Upon maturity (age 4 and around 32 inches in length), red drum move out of the estuaries to join the adult spawning stock in the ocean. Red drum are a long-lived species commonly reaching ages in excess of 40 years. The oldest red drum recorded was taken in North Carolina and was 62 years old. Red drum are opportunistic feeders and diet can shift with changes in age and habitat. Various types of small crabs and shrimp make up a large portion of juvenile red drum diets; while crabs and shrimp continue to make up a portion of the adult diet, adults will also frequently eat various fish species.

Stock Status

The new 2017 benchmark stock assessment indicates that the red drum stock in North Carolina is not experiencing overfishing (ASMFC 2017). The overfished status remains undetermined due to uncertainty in the adult stock size estimates.

Stock Assessment

Only the overfishing and not the overfished status can currently be determined for red drum. The threshold (below which the stock is experiencing overfishing) and the target fishing mortality rates correspond to those rates that achieve 30% and 40% static spawning potential ratio. Static spawning potential ratio is a measure of spawning stock biomass survival rates when fished at the current years' fishing mortality rate relative to the spawning stock biomass survival rates if no fishing mortality was occurring. An assessment was last completed by the ASMFC in 2017. Based on the results of this assessment the static spawning potential ratio was at or above target levels (Figure 1). Management measures have effectively controlled fishing mortality to a level sufficient to meet management targets. It is critical to note that reaching the target is only the first step in maintaining this fishery. For the red drum stock to be considered healthy and viable, the 40% static spawning potential ratio must be maintained continuously over time. Increases in the harvest rates (relaxation of current regulations) of red drum should only be allowed if those increases are not anticipated to lower the static spawning potential ratio below the management goal (40%). Reviewer comments from the most recent stock assessment provide caution that relaxation of current regulations, particularly those that increase fishing mortality on adult red drum, could quickly lead to an overfishing status (ASMFC 2017).

STATUS OF THE FISHERY

Current Regulations

All harvest is limited to red drum between an 18-inch total length minimum size and 27-inch total length maximum size for both the recreational and commercial fisheries. The recreational bag limit is one fish per day. A daily commercial bycatch allowance and an annual cap of 250,000 pounds, with payback of any overage, constrain the commercial harvest. The commercial annual cap is monitored from September 1 to August 31. Within a fishing year, 150,000 pounds is allocated to the period between September 1 and April 30 and the remainder

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is allocated to the period of May 1 to August 31. Check with the NCDMF for the most recent proclamation on red drum harvest limits including trip limits and bycatch requirements.

Commercial Landings

North Carolina's commercial landings in 2017 were 186,463 pounds; well above 2016 landings (77,017 pounds) and higher than the 10-year mean of 162,960 pounds (2008-2017; Table 1 and Figure 2). Gill nets dominated the catch in 2017 accounting for greater than 87% of the commercial landings (Table 2).

Amendment 2 to the North Carolina Red Drum FMP maintained the 250,000-pound annual cap in the commercial fishery, but shifted the commercial fishing year to September 1 through August 31. Since that time, North Carolina's commercial landings during this fishing year have averaged 149,074 pounds. The 2009/2010 and 2013/2014 fishing years had overages (Table 3). All overages were deducted from the following year's cap allowance. The 2016/2017 fishing year resulted in 109,848 pounds of red drum landings, well below the 250,000-pound annual cap.

Recreational Landings

Recreational fishing activity is monitored through the Marine Recreational Information Program. Recreational landings in 2017 were 402,390 pounds; below the 2008-2017 10-year average (331,421 pounds) but an increase from 2016 landings (230,473 pounds; Table 1 and Figure 2). Releases totaled 643,418 fish in 2017; slightly above the 2008-2017 average of 630,491 fish (Table 1).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored through fishery dependent sampling conducted by the NCDMF since 1982. Data collected in this program allow the size and age distribution of red drum to be characterized by gear/fishery. Predominant fisheries for red drum include estuarine gill nets, long haul seine/swipe nets, pound nets, and beach haul seines. Over the past decade gill nets have been the dominant gear used for red drum accounting for >90% of the overall harvest. In 2017, 87% of the red drum harvest was taken in gill nets, followed by pound nets with 12% (Table 2). In all, 673 red drum, primarily from set gill nets, were measured from the commercial fishery in 2017 (Table 4). The average size was 21 inches fork length. Average size has varied little over time ranging from 21 to 23 inches fork length since 2008. With the 18 to 27-inch slot limit on harvest, nearly all landings were from age-1 and age-2 fish. Similar to the commercial fishery, average size varies little from year to year in the recreational fishery (Table 5). In 2017, the average size recreational fish harvested was 21 inches fork length. From 2008 to 2017 this range varied little (20 to 23 inches fork length).

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Fishery-Independent Monitoring

The NCDMF has conducted a juvenile red drum seine survey on an annual basis since 1991. The seine survey provides an index of abundance for juvenile (age-0) red drum with sampling occurring from September through November. The relative abundance of juvenile red drum is highly variable with both high and low abundance occurring in recent years (Figure 3). In 2017, 326 juvenile red drum were taken in 120 seine samples for an overall state mean catch per unit effort (CPUE) of 2.72 red drum per haul. The 2017 overall mean CPUE was lower than 2016 (5.93) and was lower than the long term average of the survey of 5.42 (Table 6; Figure 3). Information gathered from this survey is currently used as an input parameter in the ASMFC Atlantic coast red drum stock assessment.

A fishery independent gill net survey was initiated by the NCDMF in May of 2001. The survey uses a stratified random sampling scheme designed to characterize the size and age distribution for key estuarine species in Pamlico Sound. By continuing a long-term database of age composition and developing an index of abundance for red drum this survey will help managers assess the red drum stocks without relying solely on commercial and recreational fishery dependent data. The overall red drum CPUE was 4.12 red drum per set in 2017, higher than the time series average of 2.86 (Table 7; Figure 4). The survey is currently used in the ASMFC Atlantic coast red drum stock assessment as an annual index of relative abundance for age-1 and age-2 red drum.

North Carolina initiated an adult red drum longline survey in 2007 that has continued through 2016. The primary objective of the survey is to provide a fisheries independent index of abundance for adult red drum occurring in North Carolina. From July through October, a standardized, stratified random sample design is employed. A standard sample consists of 1,500 meters of mainline set with 100 gangions placed at 15 meter intervals (100 hooks/set). Soak times are approximately 30 minutes. All random sampling takes place in Pamlico Sound. During the 2017 season, 337 red drum were captured out of 72 stratified random sets (4.68 red drum per set) which is similar to the time series average of 4.88 red drum per set (Table 8; Figure 5). Red drum ranged from 31 to 48 inches fork length with most being >40 inches in length. Sampling is scheduled to continue in 2018 and this survey is used in the ASMFC red drum stock assessment.

In order to describe the age structure of harvest and indices, red drum age structures are collected from various fishery independent (scientific surveys) and dependent (fisheries) sources throughout the year. In 2017, 726 red drum were collected ranging in age from 0 to 38 years (Table 9). The majority of red drum collected from harvest (18 to 27 inches total length) are ages 1 to 3.

MANAGEMENT STRATEGY

Red drum in North Carolina are managed under Amendment 1 to the North Carolina Red Drum FMP and Amendment 2 to the ASMFC Red Drum FMP. Both plans have an identical management threshold (overfishing) and management target (30% and 40% static spawning potential ratio). Stock status is determined by a formal, peer reviewed stock assessment. Amendment 2 to the ASMFC Red Drum FMP requires specific compliance criteria, including harvest restrictions designed to achieve the management target. Any changes to harvest that

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deviate from those options provided in this plan must be approved by the ASMFC South Atlantic Board. Amendment 1 to the North Carolina Red Drum FMP maintained measures for compliance and also implemented measures to reduce losses from discards in both the recreational and commercial fisheries (Table 10).

RESEARCH NEEDS

The following management and research needs are summarized from Amendment 1 to the North Carolina Red Drum FMP (status of need provided in parenthesis).

- Assess the size distribution of recreational discards (needed).
- Improved catch and effort data for the red drum recreational fishery, particularly for the fishery that occurs at night (needed).
- Development of independent surveys to monitor both the sub-adult and adult red drum populations. (ongoing through NCDMF gillnet and longline surveys).
- Continued life history studies for age and growth. Additional work needed to update maturity schedule and collect diet information specific to North Carolina (age and growth ongoing through NCDMF; maturity work scheduled to begin in 2017 through NCDMF; ongoing diet work through NCSU).
- Identification of spawning areas in North Carolina (studies conducted for Pamlico Sound, additional work needed).
- Characterize the adult recreational fishery with regard to tackle, geographic location, bait, water temperature, seasonality, hook types, etc. (needed).
- Obtain discard estimates from the commercial fisheries including information on size and disposition (ongoing through NCDMF observer program, recent expanded coverage).
- Collect data to determine the catch rates of red drum and targeted species with regard to distance from shore in the gill net fishery (needed, some data through Fishery Resource Grants and NCDMF Independent Gill Net Survey)
- Conduct a comprehensive study of gill net fishers including information on species targeted, gear characteristics and areas fished (needed, valuable ongoing data from fish house sampling and commercial observer program).
- Conduct studies to explore ways to reduce red drum regulatory discards with commercial gear while allowing the retention of targeted species (needed).
- Conduct additional research to determine the release mortality of red drum captured in gill nets (needed).
- Economic analysis of the adult red drum fishery (needed).
- Improved social and economic data collection on the recreational and commercial fishery, including information on current conflicts and potential for future conflicts in these fisheries (needed).
- Determine juvenile habitat preference and examine if recruitment is habitat limited (needed; study conducted by UNCW).
- Examine ecological use and importance of shell bottom to red drum (Needed; some work through CRFL by UNC).

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- Identify coastal wetlands and other habitats utilized by juvenile red drum and assess relationship between changes in recruitment success and changes in habitat conditions (needed).
- Assess cumulative impact of large-scale beach nourishment and inlet dredging on red drum and other demersal fish that use the surf zone (needed).
- Determine location and significance of spawning aggregation sites throughout the coast (needed).
- Determine if navigational dredging between August and October significantly impacts spawning activity (needed).
- Determine if designation of spawning areas is needed, and if specific protective measures should be developed (needed).

FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATIONS

The management program currently in place for red drum has resulted in a stock that has met ongoing management targets. Therefore, the division recommended and the Marine Fisheries Commission accepted the 2016 annual FMP update as the formal review of Amendment 1 to the North Carolina Red Drum FMP. All management strategies that have led to management targets being met will be maintained as outlined in both the state FMP and the ASMFC FMP. Stock conditions will be monitored and reported through each subsequent annual FMP update and the Marine Fisheries Commission will continue to have the option to modify the review schedule annually. The Marine Fisheries Commission approved the 2017 FMP schedule, including this schedule change recommendation for red drum, at its August 2017 business meeting. The next scheduled formal review of this plan will begin July 2022.

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Environmental Quality. North Carolina Division of Marine Fisheries. Morehead City, North Carolina. 85 pp.

SAFMC (South Atlantic Fishery Management Council). 2009. Southeast Data, Assessment and Review 18, Stock Assessment Report, Atlantic Red Drum. North Charleston, SC. 544 pp.

Takade, H and L Paramore. 2007. Stock Status of the Northern Red Drum Stock. North Carolina Division of Marine Fisheries. In-House Report, 60 pp.

TABLES

Table 1. Red drum recreational harvest and number released (Marine Recreational Information Program) and commercial harvest (North Carolina Trip Ticket Program) for 2008-2017. All weights are in pounds.

| Year | Recreational | | Landed | Commercial Weight (lb) | Total Weight (lb) |
|---------|--------------|------------|---------|------------------------|-------------------|
| | Landed | # Released | | | |
| 2008 | 50,809 | 658,887 | 231,551 | 229,809 | 461,360 |
| 2009 | 57,543 | 429,776 | 288,958 | 200,296 | 489,254 |
| 2010 | 64,024 | 635,876 | 283,286 | 231,828 | 515,114 |
| 2011 | 45,143 | 207,697 | 212,245 | 91,980 | 304,225 |
| 2012 | 52,948 | 1,533,010 | 238,312 | 66,519 | 304,831 |
| 2013 | 164,218 | 654,030 | 676,050 | 371,949 | 1,047,999 |
| 2014 | 116,601 | 382,663 | 596,447 | 90,647 | 687,094 |
| 2015 | 36,704 | 334,510 | 154,496 | 80,393 | 234,889 |
| 2016 | 62,105 | 825,046 | 230,473 | 77,017 | 307,490 |
| 2017 | 101,473 | 643,418 | 402,390 | 186,463 | 588,853 |
| Average | 75,157 | 630,491 | 331,421 | 162,690 | 494,111 |

Table 2. North Carolina’s 2017 red drum commercial harvest (pounds and percent by gear) by gear type.

| Gear | Landings (lb) | Percent |
|-----------|---------------|---------|
| Pound Net | 21,825 | 11.7 |
| Gill Net | 162,854 | 87.3 |
| Other | 1,784 | 1.0 |
| Total | 186,463 | 100 |

STATE-MANAGED SPECIES – RED DRUM

Table 3. North Carolina’s annual commercial harvest based on a fishing year beginning September 1 and ending August 31.

| Fishing Year | Landings (lb) | Annual Cap |
|--------------|---------------|------------|
| 2008/2009 | 134,161 | 250,000 |
| 2009/2010 | 275,924 | 250,000 |
| 2010/2011* | 126,185 | 224,142 |
| 2011/2012 | 94,298 | 250,000 |
| 2012/2013 | 134,372 | 250,000 |
| 2013/2014 | 262,753 | 250,000 |
| 2014/2015** | 140,892 | 237,247 |
| 2015/2016 | 64,134 | 250,000 |
| 2016/2017 | 109,848 | 250,000 |
| Average | 149,074 | |

*adjusted to pay back overage in 2009/2010 fishing year

** adjusted to pay back overage in 2013/2014 fishing year

Table 4. Red drum length (fork length, inches) data from commercial fish house samples, 2008-2017.

| Year | Mean Fork Length | Minimum Fork Length | Maximum Fork Length | Total Number Measured |
|------|------------------|---------------------|---------------------|-----------------------|
| 2008 | 23 | 13 | 29 | 1,214 |
| 2009 | 22 | 14 | 35 | 1,168 |
| 2010 | 22 | 14 | 31 | 1,134 |
| 2011 | 22 | 17 | 31 | 647 |
| 2012 | 21 | 16 | 28 | 359 |
| 2013 | 21 | 12 | 27 | 1,677 |
| 2014 | 23 | 18 | 28 | 444 |
| 2015 | 23 | 17 | 28 | 429 |
| 2016 | 21 | 16 | 27 | 681 |
| 2017 | 21 | 17 | 28 | 673 |

Table 5. Red drum length (fork length, inches) data from Marine Recreational Information Program recreational samples, 2008-2017.

| Year | Mean Fork Length | Minimum Fork Length | Maximum Fork Length | Total Number Measured |
|------|------------------|---------------------|---------------------|-----------------------|
| 2008 | 22 | 16 | 27 | 90 |
| 2009 | 23 | 18 | 28 | 136 |
| 2010 | 21 | 11 | 27 | 193 |
| 2011 | 22 | 17 | 29 | 147 |
| 2012 | 22 | 14 | 41 | 132 |
| 2013 | 21 | 17 | 28 | 333 |
| 2014 | 23 | 17 | 28 | 316 |
| 2015 | 22 | 14 | 27 | 95 |
| 2016 | 20 | 12 | 28 | 102 |
| 2017 | 21 | 8 | 27 | 288 |

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Table 6. The annual juvenile (age-0) abundance index from the North Carolina Red Drum Juvenile Seine Survey for the period of 1991-2017. N=number of samples; CPUE=number of red drum per haul; SE=Standard Error; PSE=Proportional Standard Error.

| Year | N | CPUE | SE | PSE |
|------|-----|-------|------|-----|
| 1991 | 105 | 15.12 | 2.18 | 14 |
| 1992 | 116 | 3.71 | 1.13 | 31 |
| 1993 | 117 | 12.65 | 2.22 | 18 |
| 1994 | 93 | 8.29 | 2.41 | 29 |
| 1995 | 119 | 4.61 | 0.72 | 16 |
| 1996 | 104 | 2.63 | 0.47 | 18 |
| 1997 | 126 | 13.13 | 3.07 | 23 |
| 1998 | 124 | 8.23 | 1.12 | 14 |
| 1999 | 98 | 1.84 | 0.41 | 23 |
| 2000 | 123 | 3.14 | 0.58 | 18 |
| 2001 | 122 | 0.97 | 0.19 | 19 |
| 2002 | 120 | 2.23 | 0.53 | 24 |
| 2003 | 120 | 5.01 | 1.23 | 25 |
| 2004 | 120 | 8.32 | 1.13 | 14 |
| 2005 | 120 | 9.02 | 1.40 | 16 |
| 2006 | 120 | 3.44 | 0.73 | 21 |
| 2007 | 119 | 5.46 | 1.52 | 28 |
| 2008 | 120 | 1.58 | 0.30 | 19 |
| 2009 | 120 | 1.89 | 0.66 | 35 |
| 2010 | 120 | 4.69 | 0.97 | 21 |
| 2011 | 116 | 10.82 | 3.28 | 30 |
| 2012 | 120 | 2.69 | 0.71 | 26 |
| 2013 | 120 | 1.11 | 0.30 | 27 |
| 2014 | 120 | 2.25 | 0.62 | 27 |
| 2015 | 120 | 4.88 | 1.04 | 21 |
| 2016 | 120 | 5.93 | 1.04 | 18 |
| 2017 | 120 | 2.72 | 0.56 | 21 |

STATE-MANAGED SPECIES – RED DRUM

Table 7. Annual weighted red drum CPUE (ages combined) from the North Carolina Pamlico Sound Independent Gill Net Survey, 2001-2017. N=number of samples; CPUE=number of red drum per set; SE=Standard Error; PSE=Proportional Standard Error.

| Year | N | CPUE | SE | PSE |
|------|-----|------|------|-----|
| 2001 | 237 | 1.56 | 0.31 | 20 |
| 2002 | 320 | 3.22 | 0.43 | 13 |
| 2003 | 320 | 1.25 | 0.22 | 18 |
| 2004 | 320 | 1.99 | 0.29 | 14 |
| 2005 | 304 | 2.76 | 0.41 | 15 |
| 2006 | 320 | 2.91 | 0.34 | 12 |
| 2007 | 320 | 3.19 | 1.02 | 32 |
| 2008 | 320 | 2.31 | 0.34 | 15 |
| 2009 | 320 | 4.17 | 1.27 | 31 |
| 2010 | 320 | 2.42 | 0.32 | 13 |
| 2011 | 300 | 0.45 | 0.07 | 17 |
| 2012 | 308 | 3.13 | 0.59 | 19 |
| 2013 | 308 | 6.59 | 1.12 | 17 |
| 2014 | 308 | 3.14 | 0.38 | 12 |
| 2015 | 308 | 2.10 | 0.29 | 14 |
| 2016 | 308 | 3.29 | 0.48 | 15 |
| 2017 | 308 | 4.12 | 0.68 | 17 |

Table 8. Annual adult red drum CPUE (ages combined) from the North Carolina Longline Survey from 2007-2017. N=number of samples; CPUE=number of red drum per set; SE=Standard Error; PSE=Proportional Standard Error.

| Year | N | CPUE | SE | PSE |
|------|----|------|------|-----|
| 2007 | 71 | 5.60 | 0.92 | 16 |
| 2008 | 72 | 3.79 | 0.68 | 18 |
| 2009 | 70 | 6.00 | 1.07 | 18 |
| 2010 | 72 | 5.56 | 1.14 | 21 |
| 2011 | 72 | 5.64 | 1.00 | 18 |
| 2012 | 72 | 5.22 | 0.93 | 18 |
| 2013 | 72 | 4.94 | 0.78 | 16 |
| 2014 | 72 | 4.47 | 0.63 | 14 |
| 2015 | 72 | 4.43 | 0.74 | 17 |
| 2016 | 72 | 3.40 | 0.51 | 15 |
| 2017 | 72 | 4.68 | 0.72 | 15 |

STATE-MANAGED SPECIES – RED DRUM

Table 9. Summary of red drum age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) sources from 2008-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2008 | 1 | 0 | 36 | 574 |
| 2009 | 1 | 0 | 40 | 644 |
| 2010 | 1 | 0 | 37 | 516 |
| 2011 | 1 | 0 | 38 | 256 |
| 2012 | 1 | 0 | 39 | 605 |
| 2013 | 1 | 0 | 41 | 721 |
| 2014 | 1 | 0 | 41 | 560 |
| 2015 | 1 | 0 | 42 | 428 |
| 2016 | 1 | 0 | 41 | 653 |
| 2017 | 1 | 0 | 38 | 726 |

Table 10. Management action taken as a result of Amendment 1 to the N.C. Red Drum FMP.

| MANAGEMENT STRATEGY | OUTCOME |
|---|---|
| Adult harvest limits: Status quo (no harvest over 27 inches TL) | No action required |
| Recreational targeting of adult red drum: It is unlawful to use any hook larger than 4/0 from July 1 through September 30 in the internal coastal fishing waters of Pamlico Sound and its tributaries south of the Albemarle Sound Management Area as defined in 15A NCAC 03R .0201 and north of a line beginning at a point 34° 59.7942' N - 76° 14.6514' W on Camp Point; running easterly to a point at 34° 58.7853' N - 76° 09.8922' W on Core Banks while using natural bait from 7:00 p.m. to 7:00 a.m. unless the terminal tackle consists of: A circle hook defined as a hook with the point of the hook directed perpendicularly back toward the shank, and with the barb either compressed or removed. A fixed sinker not less than two ounces in weight, secured not more than six inches from the fixed weight to the circle hook. (also continued education on fishing methods that minimize risk to fish). During July through September, unlawful to use J-hooks larger than 4/0 while fishing natural bait in Pamlico Sound and its tributaries. | Rule change implemented 15A NCAC 03J .0306 |

STATE-MANAGED SPECIES – RED DRUM

| MANAGEMENT STRATEGY | OUTCOME |
|---|--|
| <p>Recreational bag and size limits: Status quo (one fish per day between 18 and 27 inches TL)</p> | <p>No action required</p> |
| <p>Commercial limits: Trip Limit and Bycatch Provision Status quo (7 fish trip limit with 50% bycatch provision). Director retains authority to modify trip limit and bycatch provision as needed.</p> | <p>Implemented by proclamation</p> |
| <p>Allow the possession of up to 3 fish while engaged in fishing without requiring that they be subject to the bycatch provision. Upon landing/sale all red drum possessed would be subject to bycatch provision.</p> | |
| <p>Commercial Cap: Continue 250,000 lb annual cap monitored from September 1 to August 31. Implement a split season on the annual commercial cap, capping the period of September 1 to April 30 at 150,000 lb and conserving the remaining portion of the cap for the period of May 1 to August 31. Unused cap in period one would be available for period two. Any annual commercial harvest limit that is exceeded one year will result in the poundage overage being deducted from the subsequent year’s commercial harvest limit.</p> | <p>Rule change implemented 15A NCAC 03M .0501</p> |
| <p>Estuarine gill net discarded bycatch of red drum: Small Mesh Attendance (<5” stretch mesh) Year-round Attendance Expand year-round attendance within 200 yards of shore to include the area of the lower Neuse out to the mouth of the river.</p> | <p>Rule change implemented 15A NCAC 03R .0112</p> |
| <p>Seasonal Attendance Modify the seasonal attendance requirements for small mesh gill nets (currently May 1 to October 31) to include the period of May 1 through November 30 in the following locations:</p> | <p>Rule change implemented 15A NCAC 03J .0103 & 15A NCAC 03R .0112</p> |
| <p>a) All primary and permanent secondary nursery areas and modified no-trawl areas</p> | |

STATE-MANAGED SPECIES – RED DRUM

| MANAGEMENT STRATEGY | OUTCOME |
|--|---|
| b) Within 200 yards of any shoreline for the areas of Pamlico, Pungo, Neuse and Bay Rivers and bays | |
| c) Within 50 yards of any shoreline in the areas of Pamlico and Core Sound south to the NC/SC line | |
| d) Area Core Sound and south is excluded from 50 yard shoreline attendance requirement during October and November | |
| Modification to current small mesh seasonal attendance area along the Outer Banks (i.e. modified no-trawl area) | Rule change implemented 15A NCAC 03R .0112 |
| Large Mesh (>5” stretch mesh) Require all unattended large mesh gill nets to be set a minimum of 10 feet from any shoreline from June through October | Rule change implemented 15A NCAC 03J .0103 |
| The use of gigs, gaffs or spears to take red drum: Continue to prohibit and move Proclamation FF-40-2001 into rule | Rule change implemented 15A NCAC 03M .0501 |

STATE-MANAGED SPECIES – RED DRUM

FIGURES

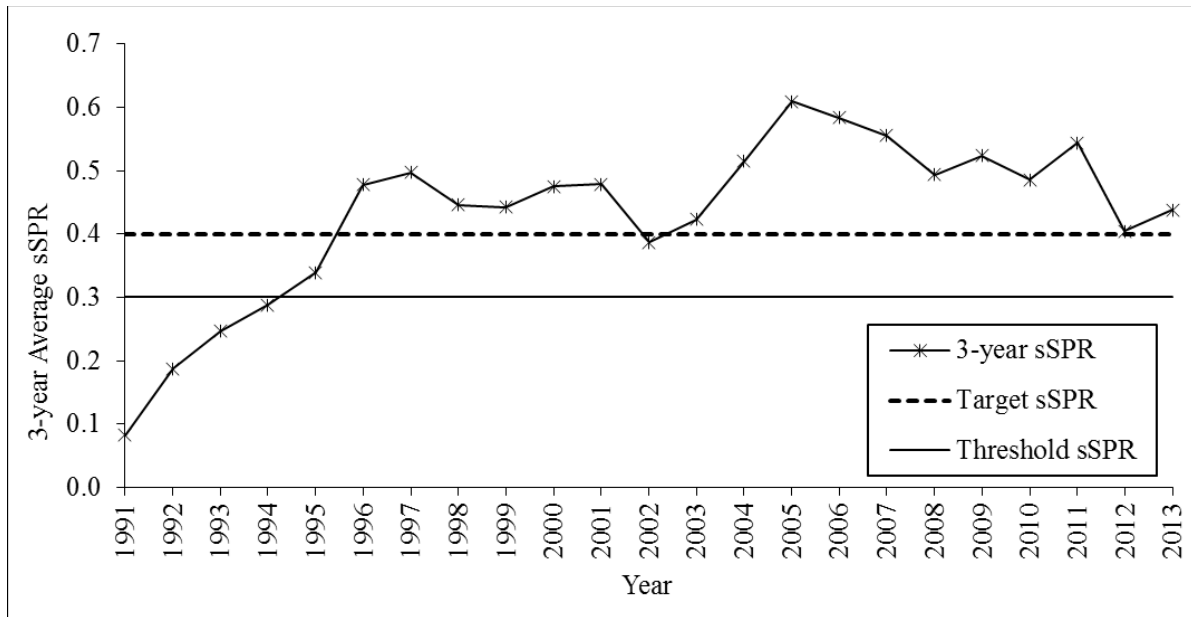


Figure 1. Northern region (North Carolina north) red drum estimates of three-year average static spawning potential ratios (sSPR). Three-year average includes current and previous two year's sSPR estimates. The dashed line shows the 30% overfishing threshold and the solid line shows the 40% target sSPR.

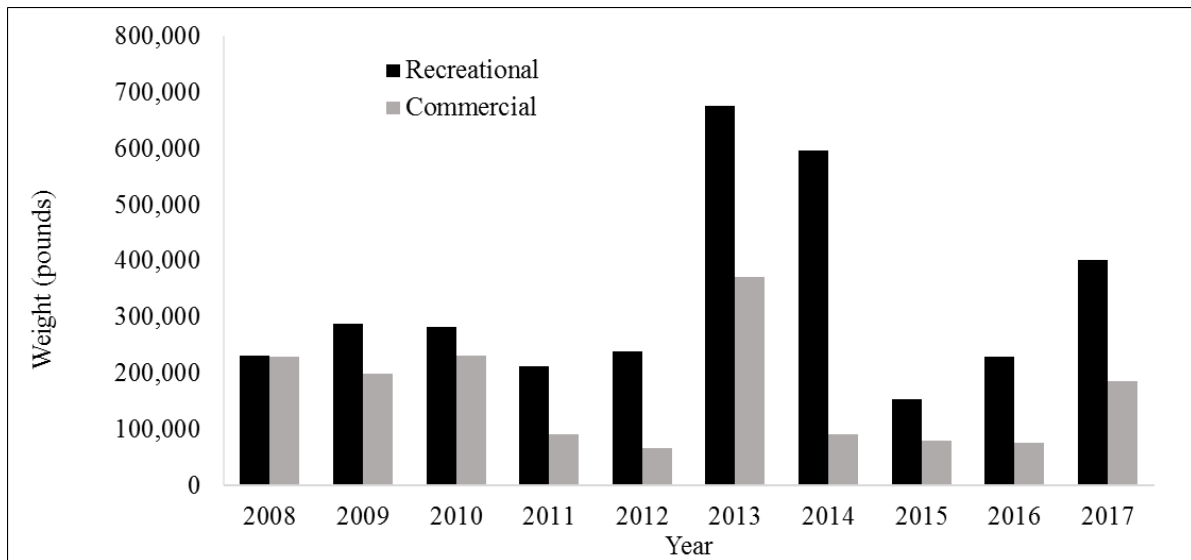


Figure 2. Annual commercial and recreational landings in pounds for red drum in North Carolina from 2008 to 2017.

STATE-MANAGED SPECIES – RED DRUM

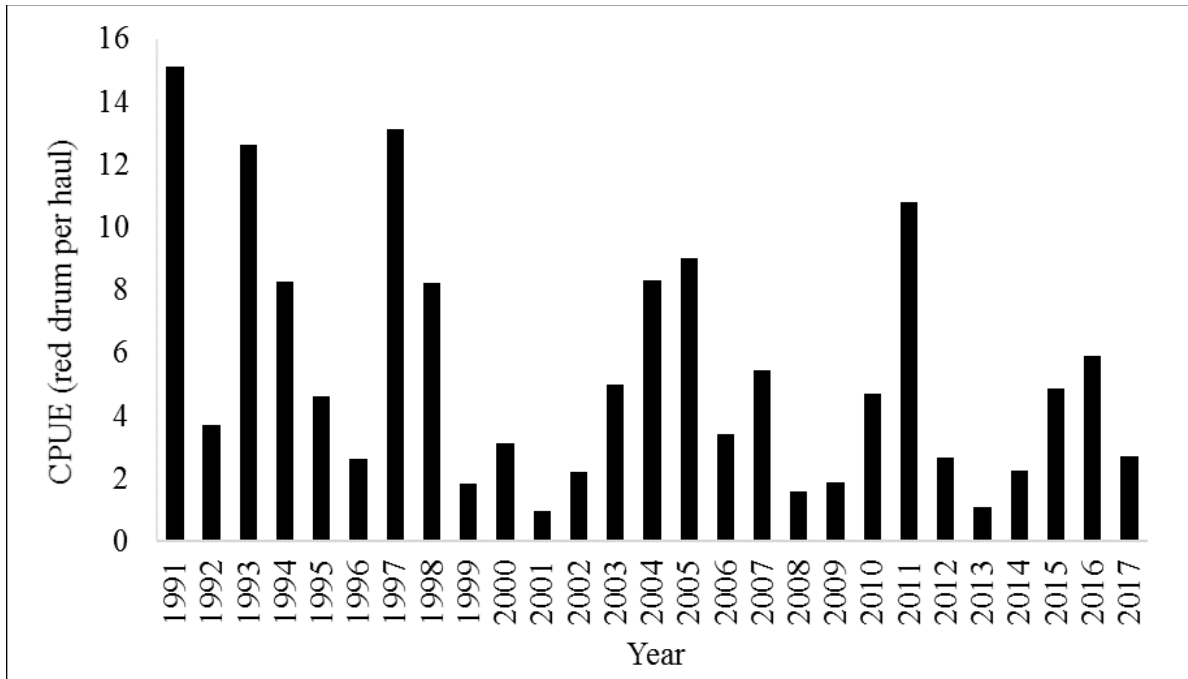


Figure 3. The annual juvenile (age-0) abundance index from the North Carolina Red Drum Juvenile Seine Survey for the period of 1991-2017.

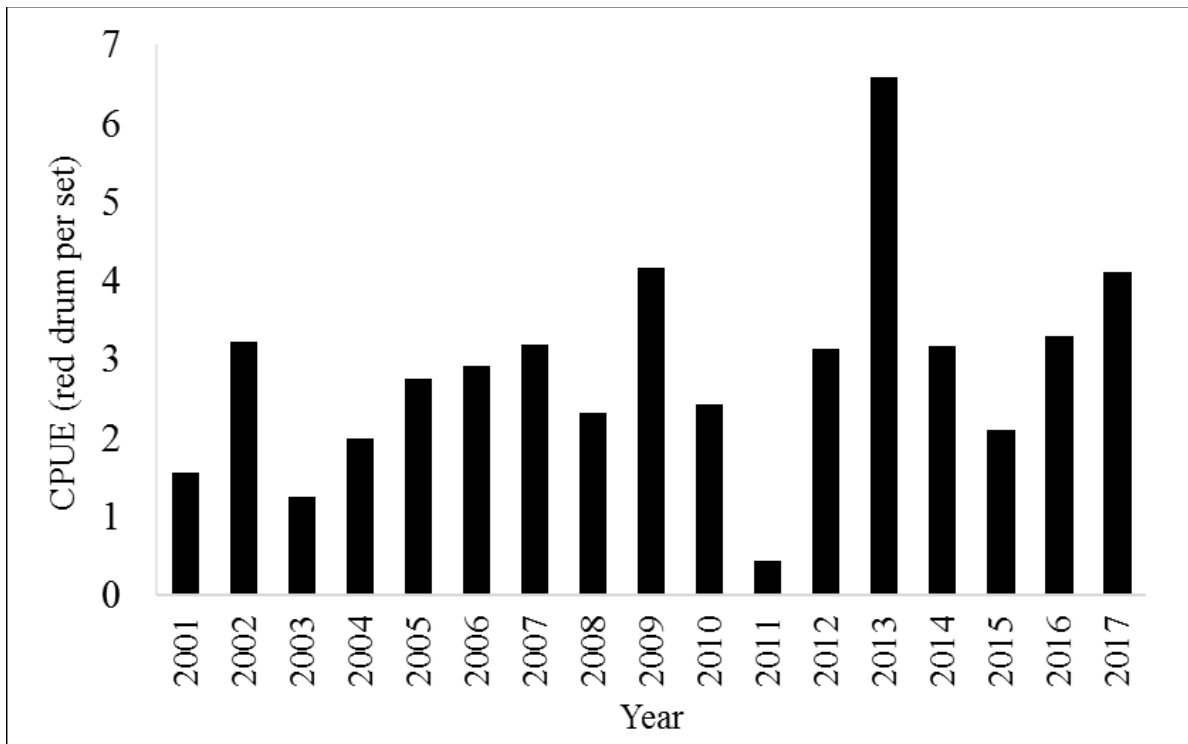


Figure 4. Annual weighted red drum CPUE (number captured ages combined) from the North Carolina Pamlico Sound Independent Gill Net Survey from 2001-2017.

STATE-MANAGED SPECIES – RED DRUM

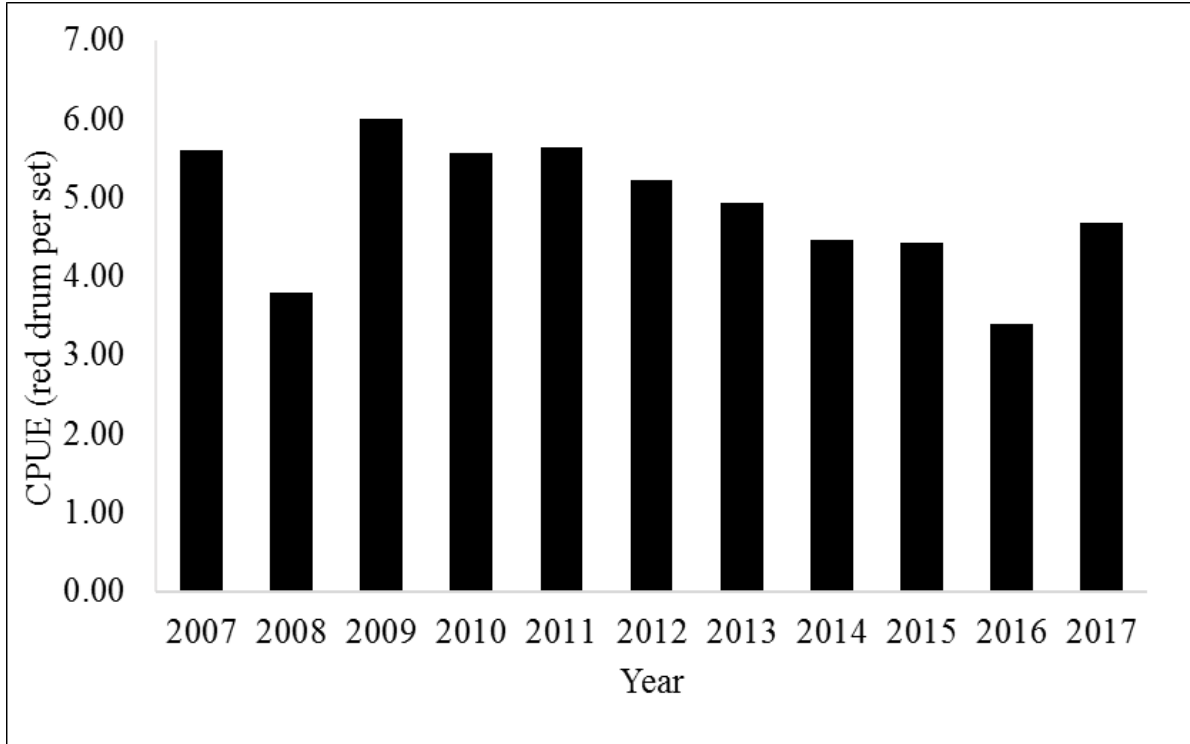


Figure 5. Annual adult red drum CPUE (number captured for ages combined) from the North Carolina Red Drum Longline Survey from 2007-2017.

STATE-MANAGED SPECIES – RIVER HERRING

FISHERY MANAGEMENT PLAN UPDATE RIVER HERRING AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | February 2000 |
| Amendments: | Amendment 1 – September 2007 Amendment 2 – May 2015 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | May 2025 |

In North Carolina blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*), collectively known as river herring, are managed under Amendment 2 to the North Carolina River Herring Fishery Management Plan (FMP) for River Herring. The original North Carolina River Herring FMP adopted February of 2000, focused on issues pertaining to stock conditions (overfished and recruitment overfishing), habitat degradations, and research/monitoring expansion to provide assessment data and socioeconomic data. Amendment 1 to the North Carolina River Herring FMP implemented a no-harvest provision for commercial and recreational fisheries of river herring in coastal waters of the state, effective in 2007. This was a result of the North Carolina Division of Marine Fisheries (NCDMF) 2005 stock assessment of river herring (data through 2003) that determined blueback herring and alewife were overfished and overfishing was occurring, there was minimal recruitment with continued declines in abundance for both species, and high fishing mortality rates. Additional management strategies included gear restrictions and stock recovery indicators. It also included a 7,500 pounds limited research set-aside harvest to be used for data collection and to provide product to local herring festivals. The NCDMF Director allocated a maximum of 4,000 pounds to be used for this research season, which occurred in the Chowan River Herring Management Area around Easter week each year. Additional outcomes of Amendment 1 included implementing monitoring programs, endorsing additional research on predation, restoration, impediments, bycatch and supporting spawning area habitat protection.

Amendment 2 to the North Carolina River Herring FMP was finalized in 2015 with three issues: 1) eliminating the discretionary river herring harvest season and permit since it was not serving

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the intended purposes of providing biological data for stock analysis and local product; 2) moving the Albemarle Sound/Chowan River Herring Management Areas to 15A NCAC 03R .0202, which corrected a reference and corrected the boundary of the Cashie River Anadromous Fish Spawning Area, and 3) removing alewife and blueback herring from exceptions in the Mutilated Finfish Rule 15A NCAC 03M .0101.

Due to the Rules Review Committee receiving at least 10 letters requesting legislative review (pursuant to G.S. 150B), a portion of the third issue to prohibit possession of river herring (alewife and blueback herring) greater than six inches aboard a vessel or while engaged in fishing from the shore or a pier underwent legislative review during the 2016 spring short session. Since a bill was not introduced specifically disapproving the rule, the rule was effective June 13, 2016 in the River Herring Rule 15A NCAC 03M .0513.

In addition to the state FMP, North Carolina river herring also are managed through Amendment 2 of the Atlantic States Marine Fisheries Commission (ASMFC) Interstate FMP for Shad and River Herring. Adopted in 2009, Amendment 2 requires management measures from the ASMFC be adopted by North Carolina as the minimum standard for the fishery, while the North Carolina plan can adopt additional measures. Additionally, Amendment 2 requires that states and jurisdictions develop sustainable FMPs in order to maintain a commercial and/or recreational river herring fishery past January 2012.

To ensure compliance with interstate requirements, North Carolina also manages this species 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).

Management Unit

Blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*) management authority lies with the ASMFC. Responsibility for management action in the Economic Exclusive Zone (EEZ), located from 3 to 200 miles from shore, lies with the Secretary of Commerce through the Atlantic Coastal Fisheries Cooperative Management Act in the absence of a federal FMP. The NCDMF also has a state FMP in place for statewide management of river herring.

Goal and Objectives

The goal of Amendment 2 to the North Carolina River Herring FMP is to restore the long-term viability of the river herring population. To achieve this goal, the plan adopts the following objectives:

STATE-MANAGED SPECIES – RIVER HERRING

1. Identify and describe population attributes necessary to sustain long-term stock viability.
2. Protect, restore, and enhance spawning and nursery area habitats.
3. Initiate, enhance, and/or continue programs to collect and analyze biological, social, economic, fishery, and environmental data needed to effectively monitor and manage the river herring fishery.
4. Promote education and public information to help the public understand the causes and nature of problems in the river herring stocks, its habitats and fisheries, and the rationale for management efforts to solve these problems.

The goal of Amendment 2 to the ASMFC Interstate FMP for Shad and River Herring (River Herring Management) is to protect, enhance, and restore east coast migratory spawning stocks of alewife and blueback herring in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass. To achieve this goal, the plan adopts the following objectives:

1. Prevent further declines in river herring (alewife and blueback herring) abundance.
2. Improve our understanding of bycatch mortality by collecting and analyzing bycatch data.
3. Increase our understanding of river herring fisheries, stock dynamics and population health through fishery-dependent and independent monitoring, in order to allow for evaluation of management performance.
4. Retain existing or more conservative regulations for American shad and hickory shad.
5. Promote improvements in degraded or historic alosine critical habitat throughout the species' range.

STATUS OF THE STOCK

Life History

River herring is a collective term for alewife and blueback herring. River herring are anadromous fishes, meaning they migrate from the ocean, through inlets into coastal bays and sounds and ascend into freshwater rivers and streams to spawn. Alewife spawn in rivers, lakes, and tributaries from northeastern Newfoundland to South Carolina, but are most abundant in the Mid-Atlantic and the Northeast. Blueback herring prefer to spawn in swift flowing rivers and tributaries from Nova Scotia to northern Florida, but are most numerous in waters from the Chesapeake Bay south. Mature alewife (ages 3 to 8) and blueback herring (ages 3 to 6) migrate rapidly downstream after spawning. Juveniles remain in tidal freshwater nursery areas in spring and early summer, but may also move upstream with the encroachment of saline water. As water temperatures decline in the fall, juveniles move downstream to more saline waters. Little information is available on the life history of juvenile and adult river herring after they emigrate to the sea and before they mature and return to freshwater to spawn.

STATE-MANAGED SPECIES – RIVER HERRING

Adult river herring feed primarily on zooplankton (small, often microscopic animals floating in the water column) although they may also feed on fish eggs, crustacean eggs, insects and insect eggs, and small fish in some areas and in larger individuals. In general, alewife are larger than blueback herring of the same age and with each species females are larger than males. Total length for either species in North Carolina rarely exceeds 12 inches.

Stock Status

An Atlantic coastwide stock assessment update for river herring was completed in the August 2017, with data through 2015, by the Atlantic States Marine Fisheries Commission. Results indicate that river herring remain depleted and at near historic lows on a coastwide basis (ASMFC 2017). The North Carolina portion of the coastwide stock assessment is for the Chowan River blueback herring stock only, due to the long-term data available for this area. River herring in other parts of the state are currently listed as unknown by the Atlantic States Marine Fisheries Commission due to the lack of data for these systems. The stock assessment update found that, although the North Carolina stock in the Chowan River was not experiencing overfishing (harvesting from a stock at a rate greater than the stock's reproductive capacity to replace fish removed through harvest) due to the harvest moratorium, the stock still remains overfished. The factors leading to this recommendation of stock status remain largely unchanged since the 2012 stock assessment, despite a fishing pressure that is negligible. The spawning stock biomass remains 12 percent of the amount necessary to replace itself in the complete absence of fishing (Figure 1).

Stock Assessment

The ASMFC stock assessment update used a forward-projecting, age-structured statistical catch-at-age model for the Chowan River blueback herring stock. The stock assessment incorporated blueback herring data from total in-river catches, age compositions, length compositions and a fisheries-independent juvenile index to estimate age-3 abundance and mortality rates, from 1972-2015. Based on the 2015 fishing mortality rate and female spawning stock biomass estimates, the Chowan River blueback herring population is overfished but over-fishing is not occurring. Estimates of fishing mortality have been close to zero since the moratorium. Juvenile abundance is well below the target of 60 fish per haul with no increasing pattern evident. The percentage of repeat spawners varied from 2007 through 2010, remaining below the target of 10 percent, but has exceeded the target since 2011 to the highest level in 34 years of 16.8 percent in 2015. Female SSB has been increasing since 2010, but still remains at approximately 12 percent of the target of 1.8 million kilograms.

It is also worthy to note the importance physical habitat and water quality play in the recovery of the river herring stocks in North Carolina and coast-wide. In North Carolina, considerable habitat area has been lost through wetland drainage, stream channelization and conversion to other uses. Some streams are blocked by dams, storm debris, and other physical barriers. Migration and spawning may be affected by the replacement of small road bridges and culverts. Oxygen consuming wastes are discharged into several streams and practices to control non-point discharges are inadequate causing nuisance algal blooms, fish kills, and fish diseases over the

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years. The NCDMF initiated a survey of culverts and obstructions following Amendment 1 to the 2000 River Herring FMP. The list created from the survey has resulted in the replacement of failing culverts and prioritized other for replacement or repair.

STATUS OF THE FISHERY

Current Regulations

In 2007, Amendment 1 to the North Carolina River Herring FMP implemented a no-harvest provision for commercial and recreational fisheries of river herring in coastal waters. The North Carolina River Herring FMP Amendment 2, adopted by the North Carolina Marine Fisheries Commission (NCMFC) in May 2015, eliminated the discretionary river herring harvest season and permit, removed alewife and blueback herring from exceptions in the Mutilated Finfish Rule, and prohibited the possession of river herring (alewife and blueback herring) greater than six in aboard a vessel or while engaged in fishing from the shore or a pier.

Commercial Landings

Amendment 1 implemented a no-harvest provision in 2007. Table 1 includes information on landings data from 2007 through 2016 when the discretionary harvest season was prosecuted before being eliminated under Amendment 2. Landings from 1950 through the late 1970s averaged 11 million pounds annually and peaked in 1969 at approximately 20 million pounds (Figure 4). Most landings occurred in the Chowan River and Albemarle Sound system. River herring landings declined sharply in the late mid-1980s, prior to any regulations specific to river herring which weren't enacted until 1995.

Recreational Landings

There is currently no recreational fishery for river herring per the no harvest provision outlined in Amendment 1. Formerly, most river herring caught recreationally were likely used for personal consumption or for bait. For the years leading up to the 2007 harvest closure, the extent of river herring harvest for personal consumption and bait in coastal North Carolina is unknown.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored through fishery dependent sampling conducted by the NCDMF since 1982. The dominant gears for river herring were gill nets and pound nets. In 2007, the no-harvest provision essentially eliminated commercial landings. However, the Chowan River Pound Net survey was implemented in 2008, for the 2009 sampling year, to provide estimates of commercial catch-per-unit effort (CPUE), percent of repeat spawners, and age and sex data for alewife and blueback herring. Tables 2 and 3 describe the mean, minimum and maximum length data for the last 9 years 2009 to 2017 for alewife and blueback.

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Tables 4 and 5 describe the modal age, minimum and maximum age, and total number aged from this survey. Aging for 2017 female bluebacks is incomplete therefore only the male ages are reported in Table 5. Total pound net effort, total river herring catch, and CPUE for the Chowan River Pound Net Survey (Table 6) shows a downward trend through 2012 followed by an increasing trend through 2017. Over 70 percent of the pound net catch is estimated to be alewife based on weekly samples for biological data collection from the pound net survey.

Figure 3 illustrates the blueback herring percent repeat spawners, the number of fish that have spawned two or more times, observed in the Chowan River Pound Net Survey from 2008 through 2017. From 2011 to 2016, the percent repeat spawners has exceeded the stock status indicator target of 10 percent.

Fishery-Independent Monitoring

River herring are monitored regularly in several of the division's fishery independent monitoring programs, including Program 100 (Juvenile Anadromous Independent Fishery), Program 135 (Striped Bass Independent Gill Net Survey), Program 150 (Adult Anadromous Spawning Area Survey), and Program 160 (Anadromous Egg and Larval Survey). Tables 7 and 8 show the modal, minimum, and maximum age for alewife and blueback from 2008 to 2017.

Data from Program 100 is used to annually calculate the juvenile abundance index (JAI) for blueback herring. The first of the stock status indices, it involves a CPUE of 60 young-of-the-year blueback herring for three consistent years in the Program 100 survey. Figure 2 illustrates that the target JAI for blueback herring has remained well below the target during the time series, 1972 through 2017.

MANAGEMENT STRATEGY

Amendment 1 to the 2000 North Carolina River Herring FMP implemented four stock recovery indicators to evaluate stock status. Under Amendment 2 to the 2000 River Herring FMP, the plan development team determined that only three of the stock recovery indicators were necessary and decided that the term stock status indicator was more appropriate. The three stock status indicators were adopted by the River Herring FMP plan development team, each based on a three-year moving average. The plan development team recommended using the first two stock status indicators (juvenile abundance and repeat spawners) as a trigger for doing a stock assessment earlier than 10 years. If a three-year moving average of each of the indicators was above the threshold, it would trigger the need for a new stock assessment, which would determine the third stock status indicator. The third stock status indicator sets the threshold that determines when the river herring fishery will re-open.

1. Catch per unit effort (CPUE) of 60 young-of-the-year per haul in the Albemarle Sound juvenile abundance survey.
2. Ten percent repeat spawners observed in fishery-dependent pound net samples.
3. Spawning stock biomass (SSB) of 30 percent unfished SSB, estimated in stock assessment model.

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Collectively, these indices represent *minimal* stock rebuilding goals for the recovery of river herring stocks in the Albemarle Sound and Chowan River. In the 2012 stock assessment ASMFC recommended a ten-year interval between stock assessments (ASMFC 2012). The plan development team recommended using the first two stock status indicators (juvenile abundance and repeat spawners) as a trigger for doing a stock assessment earlier than 10 years. If a three-year moving average of the first two indicators was above the threshold, it would trigger the need for a new stock assessment, which would determine the third stock status indicator.

The stock status indicator for percent repeat spawners has exceeded the target of 10 percent since 2011, except for 2017. The increase in the percent repeat spawners is a positive sign, which means that the current management strategy is working. Juvenile abundance has remained well below the target since the early 1990s. Spawning stock biomass will need to continue to increase enough to see results in the juvenile index before the fishery could reopen.

RESEARCH NEEDS

Table 9 provides the NCMFC selected management strategies from Amendment 2 adopted in May 2015. The specific research recommendations identified in the current FMP (Amendment 2) and the priority and status of each are listed below.

Life History

- Conduct studies of river herring egg and larval survival and development in North Carolina river systems. **High priority**
- Conduct research on predation of all life stages of river herring in the Albemarle Sound and other systems in North Carolina (including invasive species such as blue catfish and other predators). **Medium priority**
- Conduct studies on energetics of feeding and spawning migrations of river herring in North Carolina. **Medium priority**

Stock Status

- Estimate bycatch and discard mortality of river herring captured incidentally in Atlantic Ocean fisheries coastwide. **High priority**
- Estimate bycatch and discard mortality of river herring captured incidentally in inside fisheries. **Medium priority**

Environmental Factors

Water Quality Recommendations

- Evaluate effects of existing and future water withdrawals on water quality, quantity and fisheries habitat in coastal watersheds. NCDWM and NCWRC review and comment on water withdrawals and their effect on fisheries and habitat. **High priority**
- Determine if contaminants are present and identify those that are potentially detrimental to various life history stages of river herring. Long term water quality monitoring devices have been maintained and deployed to identify shifts or swings in water quality in multiple tributaries in the Albemarle Sound area. **High priority**
- Evaluate the impacts/effects of reverse osmosis (RO) plants on receiving waters and aquatic resources. NCDWM and NCWRC provide comments on permit applications for RO plants;

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some work by universities to evaluate effects of RO plants in local river systems. **Low priority**

Obstruction Recommendations

- Identify all man-made physical obstructions to river herring migrations (update Collier and Odom project) and prioritize impediments for removal /replacement after identification. The NCDMF has surveyed culverts in the Chowan River area and developed a priority list for replacement or repair. This information will be used by a paid graduate student to investigate fish friendly culverts. **High priority**
- Identify research needs regarding impediments to river herring migration. **High priority**

Impingement and Entrainment Recommendations

- Research is needed to determine the fate of river herring eggs, larvae and juveniles that are impinged, and then released through screen cleaning operations. **Low priority**

Climate change

- The specific effects of climate change, including warming water, increased drought severity, and loss of flood plain spawning habitat should be further investigated. **Low priority**

FISHERY MANAGEMENT PLAN SCHEDULE RECOMMENDATION

Pertaining to the current FMP schedule, the plan development team recommended using the first two stock status indicators (juvenile abundance and repeat spawners) as a trigger for doing a stock assessment earlier than 10 years. If a three-year moving average of each of the indicators was above the threshold, it would trigger the need for a new stock assessment, which would determine the third stock status indicator. It is recommended the review schedule for river herring remain the same.

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TABLES

Table 1. Harvest landings and value of discretionary river herring harvest season in North Carolina, 2008-2017.

| Year | # of Permits Issued | Quota (lb/permit/period) | Harvest (lb) | Value (\$) |
|-------|---------------------|--------------------------|--------------|------------|
| 2008 | 13 | 250 | 1,292 | 775 |
| 2009 | 27 | 125 | 643 | 836 |
| 2010 | 30 | 125 | 1,765 | 1,765 |
| 2011 | 23 | 150 | 1,611 | 1,611 |
| 2012 | 18 | 150 | 678 | 678 |
| 2013 | 12 | 150 | 743 | 743 |
| 2014 | 27 | 150 | 989 | 1,319 |
| 2015* | -- | -- | -- | -- |
| 2016* | -- | -- | -- | -- |
| 2017* | -- | -- | -- | -- |

*Discretionary harvest season eliminated in 2015 under Amendment 2 to the River Herring FMP.

STATE-MANAGED SPECIES – RIVER HERRING

Table 2. Blueback herring mean, minimum and maximum length data from 2008-2017 from dependent sampling surveys.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|-------|-------------|----------------|----------------|-----------------------|
| 2008* | 225 | 191 | 279 | 928 |
| 2009* | 225 | 198 | 267 | 546 |
| 2010* | 224 | 192 | 260 | 833 |
| 2011* | 229 | 190 | 264 | 500 |
| 2012* | 229 | 180 | 265 | 412 |
| 2013* | 229 | 196 | 276 | 492 |
| 2014* | 217 | 191 | 260 | 691 |
| 2015* | 225 | 198 | 274 | 589 |
| 2016* | 225 | 199 | 278 | 456 |
| 2017* | 226 | 193 | 261 | 528 |

*2008 a no-harvest provision went into effect and the Chowan River Pound Net survey began in 2009.

Table 3. Alewife mean, minimum and maximum length data from 2008-2017 from dependent sampling surveys.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|-------|-------------|----------------|----------------|-----------------------|
| 2008* | 227 | 190 | 287 | 1,872 |
| 2009* | 236 | 197 | 276 | 1,000 |
| 2010* | 241 | 203 | 282 | 822 |
| 2011* | 247 | 201 | 283 | 806 |
| 2012* | 248 | 190 | 286 | 641 |
| 2013* | 234 | 196 | 330 | 854 |
| 2014* | 234 | 202 | 295 | 1,037 |
| 2015* | 235 | 201 | 282 | 998 |
| 2016* | 233 | 195 | 283 | 773 |
| 2017* | 238 | 194 | 299 | 1,335 |

*2008 a no-harvest provision went into effect and the Chowan River Pound Net survey began in 2009.

STATE-MANAGED SPECIES – RIVER HERRING

Table 4. Alewife ages from the dependent sampling surveys, 2008-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|-------|-----------|-------------|-------------|-------------------|
| 2008* | 5 | 4 | 8 | 588 |
| 2009* | 5 | 3 | 7 | 342 |
| 2010* | 6 | 3 | 7 | 277 |
| 2011* | 6 | 3 | 8 | 211 |
| 2012* | 4 | 3 | 8 | 259 |
| 2013* | 3 | 2 | 7 | 308 |
| 2014* | 3 | 2 | 6 | 328 |
| 2015* | 4 | 3 | 9 | 309 |
| 2016* | 4 | 3 | 8 | 311 |
| 2017* | 5 | 3 | 7 | 346 |

*samples from the Chowan River pound net survey

Table 5. Blueback ages from the dependent sampling surveys, 2008-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|-------|-----------|-------------|-------------|-------------------|
| 2008* | 4 | 3 | 7 | 474 |
| 2009* | 4 | 3 | 7 | 251 |
| 2010* | 4 | 3 | 7 | 247 |
| 2011* | 4 | 3 | 6 | 171 |
| 2012* | 4 | 3 | 7 | 181 |
| 2013* | 5 | 3 | 7 | 210 |
| 2014* | 4 | 3 | 7 | 198 |
| 2015* | 4 | 3 | 7 | 184 |
| 2016* | 4 | 3 | 8 | 226 |
| 2017* | 5 | 3 | 7 | 243 |

*samples from the Chowan River pound net survey

Table 6. Total pound net effort, catch and CPUE for the Chowan River pound net survey 2009-2017.

| Year | Total Effort | | Total RH (lbs) | Total CPUE |
|-------|--------------------|--|----------------|------------|
| | (# of Active Sets) | | | |
| 2009 | 217 | | 89,245 | 411.3 |
| 2010 | 260 | | 71,532 | 275.1 |
| 2011 | 286 | | 74,485 | 260.4 |
| 2012 | 315 | | 18,415 | 58.5 |
| 2013 | 238 | | 27,396 | 115.1 |
| 2014 | 271 | | 45,619 | 168.3 |
| 2015 | 253 | | 49,560 | 195.9 |
| 2016 | 228 | | 77,372 | 339.4 |
| 2017 | 231 | | 137,374 | 594.7 |
| Total | 255.4 | | 65,666.4 | 268.7 |

STATE-MANAGED SPECIES – RIVER HERRING

Table 7. Alewife ages from the independent gill net survey 2008-2017, Albemarle Sound.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2008 | 5 | 3 | 7 | 428 |
| 2009 | 5 | 2 | 7 | 472 |
| 2010 | 6 | 3 | 8 | 490 |
| 2011 | 6 | 3 | 8 | 388 |
| 2012 | 5 | 3 | 7 | 181 |
| 2013 | 4 | 3 | 6 | 319 |
| 2014 | 4 | 3 | 7 | 361 |
| 2015 | 5 | 3 | 7 | 269 |
| 2016 | 5 | 3 | 7 | 183 |
| 2017 | 5 | 3 | 6 | 233 |

Table 8. Blueback ages from the independent gill net survey 2008-2017, Albemarle Sound.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2008 | 4 | 2 | 7 | 254 |
| 2009 | 5 | 3 | 7 | 330 |
| 2010 | 4 | 3 | 6 | 127 |
| 2011 | 4 | 3 | 6 | 112 |
| 2012 | 5 | 3 | 6 | 69 |
| 2013 | 3 | 2 | 6 | 211 |
| 2014 | 3 | 2 | 5 | 320 |
| 2015 | 4 | 3 | 8 | 141 |
| 2016 | 5/6 | 3 | 7 | 157 |
| 2017 | 5 | 3 | 7 | 176 |

Table 9. Summary of the N.C. Marine Fisheries Commission management strategies and their implementation status for Amendment 2 of the River Herring Fishery Management Plan

| Management Strategy | Implementation Status |
|---|---------------------------------|
| Eliminate the discretionary river herring harvest season and permit | Existing proclamation authority |
| Moving the Albemarle Sound/Chowan River Herring Management Areas to correct boundary reference for the Cashie River Anadromous Fish Spawning Area | 15A NCAC 03R .0202 |
| Remove alewife and blueback herring from the Mutilated Finfish Rule | 15A NCAC 03M .0101 |
| Prohibit possession of alewife and blueback herring greater than six inches aboard a vessel or while engaged in fishing from the shore or a pier. | 15A NCAC 03M .0513 |

STATE-MANAGED SPECIES – RIVER HERRING

FIGURES

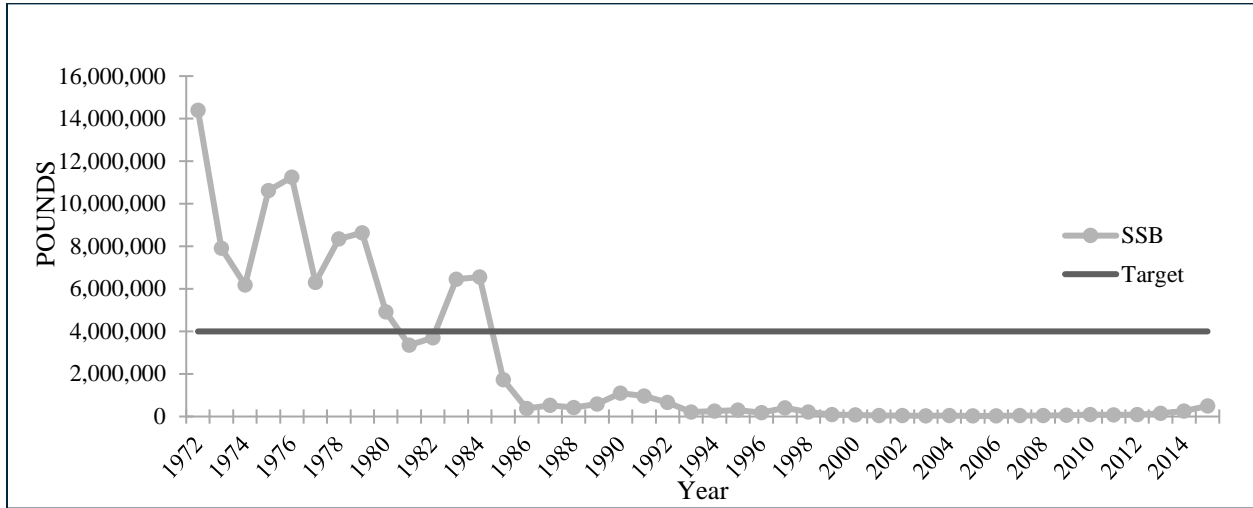


Figure 1. Annual estimate of female spawning stock biomass (SSB) in pounds for the Chowan River blueback herring stock, 1972-2015 (ASMFC 2017).

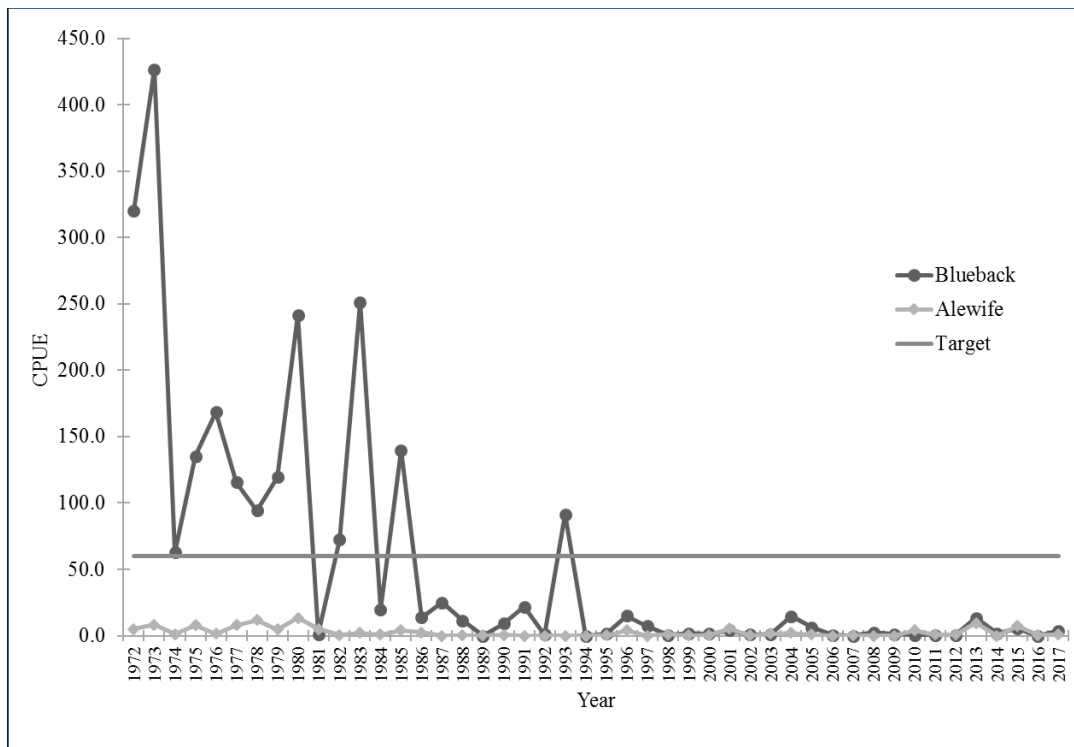


Figure 2. River herring (blueback and alewife) juvenile abundance index from the NCDMF Albemarle Sound juvenile survey, 1972-2017.

STATE-MANAGED SPECIES – RIVER HERRING

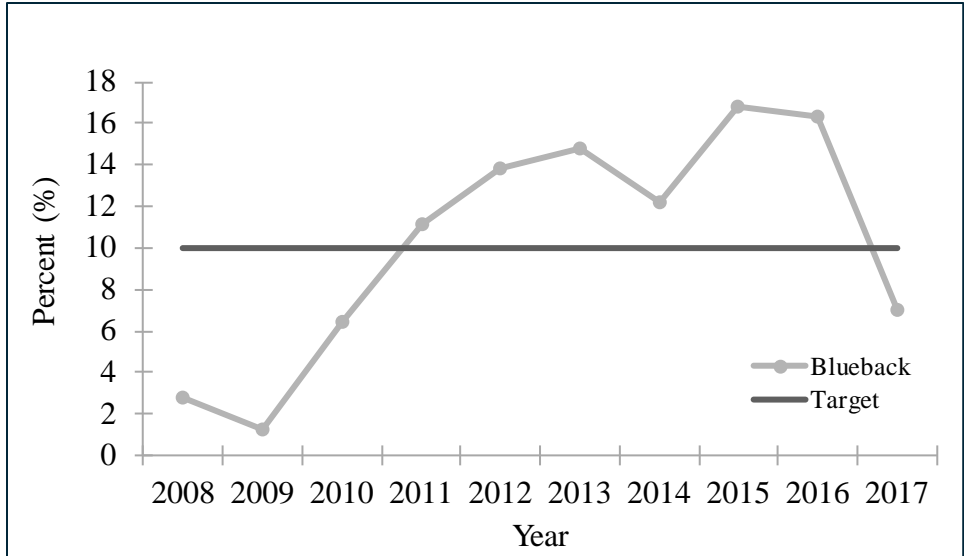


Figure 3. Percent of blueback herring repeat spawners in the Chowan River Pound Net Survey, 2008-2017.

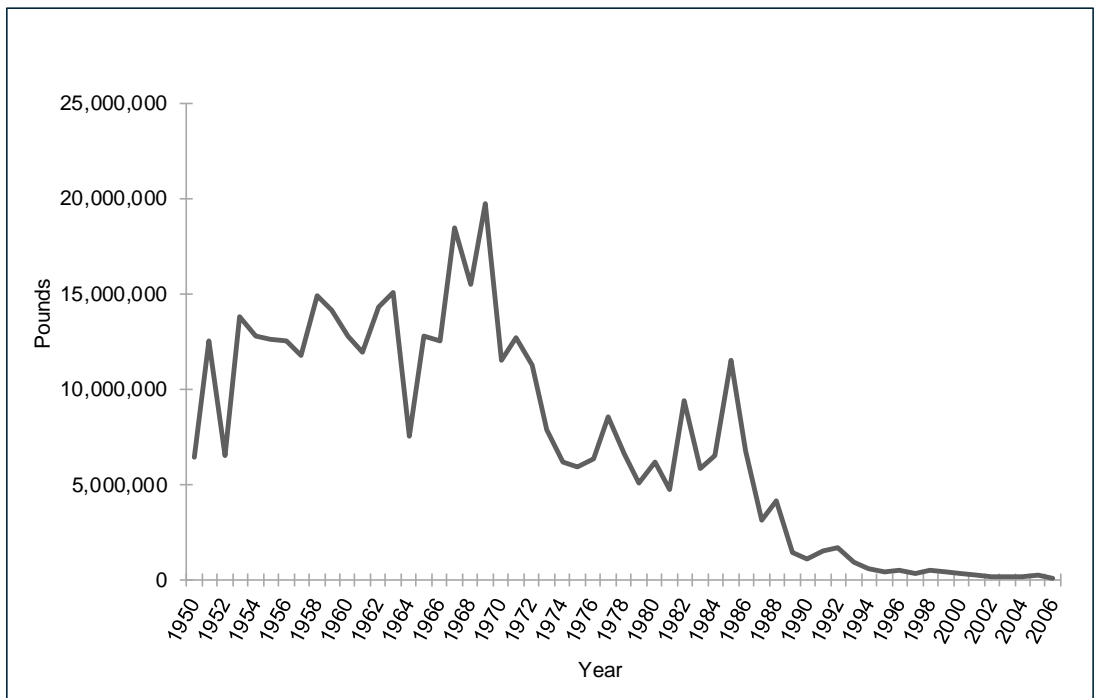


Figure 4. Statewide N.C. Commercial River Herring Landings, 1950 – 2006.

STATE-MANAGED SPECIES – SHEEPSHEAD

FISHERY MANAGEMENT PLAN UPDATE SHEEPSHEAD AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|------|
| Original FMP Adoption: | None |
| Amendments: | None |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | None |

Sheepshead (*Archosargus probatocephalus*) was initially managed as part the South Atlantic Fishery Management Council's (SAFMC) Snapper Grouper Fishery Management Plan (FMP). The plan restricted recreational anglers to an aggregate 20 fish bag limit; there was no commercial trip limit, and neither sector had a size limit. In state waters, North Carolina deferred to the Council and the same regulations were followed. In April 2012, sheepshead was officially removed from the SAFMC's snapper grouper management complex through the Comprehensive Annual Catch Limit Amendment (Amendment 25) (SAFMC 2011). Subsequently, North Carolina's proclamation authority for the management of the species was invalidated since sheepshead was no longer part of the North Carolina Fishery Management Plan for Interjurisdictional Fisheries or a Council managed species. In November 2012, the N.C. Marine Fisheries Commission (NCMFC) requested that a rule be developed for sheepshead; and in November 2013, approved the rule (15A NCAC 03M .0521) that specifies the Director's proclamation authority, including the ability to implement size, bag, and trip limits, as well as season and gear restrictions. In July 2014, N.C. Division of Marine Fisheries (NCDMF) began developing potential management measures for sheepshead to present to the NCMFC. In 2015, the Commission implemented new regulations that included size, bag, and trip limits in order to prevent overharvest, as well as to allow a greater number of individuals to spawn before being harvested. There currently is no state or federal FMP for sheepshead.

Management Unit

North Carolina manages sheepshead in state coastal waters (internal and 0 to 3 miles in Atlantic Ocean).

STATE-MANAGED SPECIES – SHEEPSHEAD

Goal and Objectives

None

STATUS OF THE STOCK

Life History

Sheepshead are a relatively large and long-lived member of the porgy family that ranges from Nova Scotia, Canada to Florida and the Gulf of Mexico south to the Atlantic coast of Brazil. They are generally found year-round in North Carolina's coastal waters ranging from inshore brackish waters to offshore rocky bottom. Juveniles are associated with shallow vegetated habitat as well as hard structures that offer protection. As sheepshead grow larger, they move to more typical adult habitat including oyster reefs, rocks, pilings, jetties, piers and wrecks. Migration patterns based on mark recapture studies have not documented large scale north-south movements. Movement instead tends to be towards inlets during the fall and winter when adult sheepshead migrate to ocean waters to spawn.

Sheepshead are omnivores, meaning they eat plant material as well as animals (barnacles, crabs, oysters). Sheepshead grow quickly up to age 6, and then their growth slows. After their first year, sheepshead average 10 inches, at which less than 50 percent of the individuals are sexually mature. Most sheepshead mature at age 2 (12 inches) and all sheepshead are mature by ages 3 to 5 (14 inches). In North Carolina, sheepshead commonly attain a length of 20 to 25 inches with weights ranging from 5 to 15 pounds. The maximum reported age in North Carolina is 29 years.

Stock Status

The Division is continuing to collect data from recreational, commercial, and independent sampling efforts to estimate trends in abundance of sheepshead; age structure, maturity, and other biological information is also being collected.

Stock Assessment

Currently, there is not a stock assessment for sheepshead in North Carolina.

STATUS OF THE FISHERY

Current Regulations

In 2015, the NCMFC implemented a 10-inch fork length (FL) minimum size limit for both recreational and commercial fisheries. There is a recreational bag limit of 10 fish per person per day or per trip (if a trip occurs over more than one calendar day). Commercial fishing operations are limited to 300 pounds per trip with two exceptions; gig and spear operations are limited to 10 fish per person per day or trip (if a trip occurs over more than one calendar day), and pound net operations are exempt from the commercial trip limits.

STATE-MANAGED SPECIES – SHEEPSHEAD

Commercial Landings

Sheepshead are primarily caught as bycatch in several of North Carolina's commercial fisheries (gill nets, pound nets, haul seines). A targeted spear fishery has developed in the last six years, and the gig fishery has also become more popular in this time (Table 1). Estuarine gill nets and pound nets have made up the majority of the landings in the last 10 years (Table 1). In 2017, the majority (84%) of the commercial landings came from pound nets (58%) and estuarine gill nets (26%); an additional 8% was landed by spears and gigs, combined (Table 1). Landings have fluctuated from year to year, with the highest landings occurring in 2013 and 2014 (Table 2; Figure 1). The landings for the last three years have been lower than the 10-year average (131,082 pounds) (Table 2; Figure 1).

Recreational Landings

The recreational fishery tends to be more of a targeted fishery compared to the commercial. This fishery is primarily a hook and line fishery, but the species is becoming a favorite of spear fishermen. Recreational harvest accounted for 68% of North Carolina's total harvest (pounds) from 2008-2017 (Table 3). Like the commercial catch, landings have fluctuated from year to year with annual harvest ranging from 116,683 pounds in 2016 to a high of 500,096 pounds in 2013 (Table 3; Figure 1). In 2017, recreational landings were 74% of the total harvest and 30% above the 10-year average (284,527 pounds) (Table 3; Figure 1).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored through fishery dependent sampling programs conducted by NCDMF. Data collected in these programs allow the size and age distribution of sheepshead to be characterized by gear and fishery. In 2017, 401 lengths were measured at fish houses or on the water, the majority of which came from the estuarine gillnet, spear, and pound net fisheries. The mean size of commercial caught sheepshead was 14 inches FL (Table 4). This has varied slightly from year to year (12 to 15 inches FL), with the average and minimum sizes being smaller when there was no size limit.

Similar to the commercial fishery, average size varies little from year to year in the recreational fishery (Table 5). In 2017, the average size recreational sheepshead was 14 inches fork length (Table 5). In both fisheries, sublegal fish (<10 inches fork length) are still being harvested (Tables 4 and 5). This is most likely due to fishermen being unaware of changes in regulations, and/or confusing sheepshead and black drum regulations. While the size limits differ, black drum are measured for total length and sheepshead for fork length.

Fishery-Independent Monitoring

A fishery independent gill net survey was initiated by the NCDMF in May of 2001. The survey utilizes a stratified random sampling scheme designed to characterize the size and age distribution for key estuarine species in Pamlico Sound. By continuing a long-term database of age

STATE-MANAGED SPECIES – SHEEPSHEAD

composition and developing an index of abundance for sheepshead this survey will help managers assess the sheepshead stocks without relying solely on commercial and recreational fishery dependent data. The overall sheepshead Catch per Unit Effort (CPUE; Number of sheepshead per set) was 0.44 in 2017, 57% above the time series CPUE (Table 6; Figure 2).

In order to describe the age distribution of the harvest and indices, sheepshead age structures are collected from various fishery independent and dependent sources throughout the year. Otolith collection for sheepshead is relatively new; while there is age data going back to 2008, the sample size is low and ages have not yet been verified. The majority of sheepshead collected from 2015-2017 were ages 2 to 5 (Table 7). In 2017, 269 sheepshead were collected ranging in age from 1 to 28.

MANAGEMENT STRATEGY

See Table 8 for current management strategies and implementation status for sheepshead.

RESEARCH NEEDS

- Develop a tagging program to determine migration patterns as well as juvenile and adult abundance indices for use in the development of a stock assessment model to determine sustainability. The program should include methods to estimate tag retention, reporting rate, and tagging-induced mortality (needed)
- Continue monitoring of recreational and commercial catches (ongoing through NCDMF fisheries dependent sampling programs)
- Collect ageing structures, update maturity schedule (ongoing through NCDMF sampling programs and CRFL histology grant)
- Collect age and sex information from recreational and commercial fisheries (ongoing through NCDMF fisheries dependent sampling programs)
- Conduct spawning area surveys (needed; some work to be done by CMAST through CRFL)

LITERATURE CITED

SAFMC (South Atlantic Fishery Management Council). 2011. Comprehensive Annual Catch Limit (ACL) Amendment (Amendment 25 to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region). South Atlantic Fishery Management Council, 4055 Faber Place, Ste 201, North Charleston, S.C. 29405. (Available online at: https://www.dropbox.com/s/iz8wn5vec36hpis/CompACLAm_101411_FINAL.pdf?dl=0)

STATE-MANAGED SPECIES – SHEEPSHEAD

TABLES

Table 1. North Carolina’s commercial sheepshead landings (pounds) by gear type, 2008-2017 (N.C. Trip Ticket Program).

| Year | Landings (pounds) by Gear | | | | | | |
|------|---------------------------|--------------------|------------------------|-----------|----------------|--------|-------|
| | Pound net | Estuarine gill net | Diving spears and gigs | Long haul | Ocean gill net | Trawls | Other |
| 2008 | 41,107 | 26,347 | 2,909 | 10,495 | 2,662 | 5,585 | 623 |
| 2009 | 49,164 | 57,668 | 3,178 | 15,803 | 1,107 | 4,250 | 1,220 |
| 2010 | 49,205 | 59,271 | 2,998 | 37,974 | 1,345 | 5,604 | 1,235 |
| 2011 | 55,729 | 40,653 | 5,946 | 13,143 | 1,594 | 2,015 | 1,897 |
| 2012 | 46,233 | 32,565 | 15,916 | 9,780 | 1,974 | 2,140 | 1,274 |
| 2013 | 94,780 | 48,194 | 15,259 | 12,497 | 3,055 | 3,940 | 2,501 |
| 2014 | 92,988 | 39,524 | 21,886 | 11,777 | 3,253 | 2,581 | 1,367 |
| 2015 | 73,035 | 27,254 | 13,695 | 337 | 5,741 | 3,998 | 776 |
| 2016 | 36,839 | 30,844 | 14,761 | 262 | 2,509 | 7,068 | 1,223 |
| 2017 | 73,933 | 33,750 | 10,720 | 411 | 1,677 | 7,047 | 738 |

Table 2. North Carolina commercial sheepshead landings (pounds), number of dealers and ex-vessel value, 2008-2017 (N.C. Trip Ticket Program).

| Year | Dealers | Ex-Vessel Value | Pounds |
|------|---------|-----------------|---------|
| 2008 | 130 | \$53,053 | 89,726 |
| 2009 | 136 | \$82,340 | 132,390 |
| 2010 | 130 | \$99,666 | 157,631 |
| 2011 | 136 | \$90,068 | 120,976 |
| 2012 | 149 | \$92,837 | 109,881 |
| 2013 | 148 | \$145,794 | 180,225 |
| 2014 | 139 | \$159,274 | 173,376 |
| 2015 | 130 | \$139,237 | 124,836 |
| 2016 | 130 | \$116,501 | 93,506 |
| 2017 | 139 | \$154,923 | 128,275 |

STATE-MANAGED SPECIES – SHEEPSHEAD

Table 3. North Carolina recreational sheepshead harvest pounds, harvest number and number released and PSE=Proportional Standard Error, 2008-2017 (Marine Recreational Information Program).

| Year | Harvest Weight | | Harvest Number | | Released | |
|------|----------------|------|----------------|------|----------|------|
| | Pounds | PSE | Number | PSE | Number | PSE |
| 2008 | 381,995 | 28.7 | 175,412 | 24.2 | 69,537 | 23.4 |
| 2009 | 220,237 | 23.8 | 124,328 | 21.6 | 99,500 | 24.8 |
| 2010 | 420,108 | 17.3 | 145,873 | 16.3 | 63,557 | 18.7 |
| 2011 | 180,145 | 26.9 | 66,689 | 23.7 | 22,623 | 27.8 |
| 2012 | 293,570 | 19.6 | 119,899 | 16.3 | 79,668 | 18.7 |
| 2013 | 500,096 | 14.5 | 273,211 | 18.1 | 154,083 | 23.4 |
| 2014 | 143,782 | 22.8 | 61,379 | 21.0 | 72,520 | 20.3 |
| 2015 | 217,148 | 22.0 | 76,496 | 22.3 | 34,908 | 21.9 |
| 2016 | 116,683 | 24.6 | 42,137 | 22.2 | 75,865 | 30.0 |
| 2017 | 371,503 | 17.7 | 128,083 | 17.1 | 200,301 | 16.8 |

Table 4. Sheepshead length (fork length, inches) data from commercial fish house samples, 2008-2017.

| Year | Mean Length (inches) | Minimum Length (inches) | Maximum Length (inches) | Total Measured (number) |
|------|----------------------|-------------------------|-------------------------|-------------------------|
| 2008 | 13 | 5 | 24 | 1,527 |
| 2009 | 12 | 6 | 23 | 1,491 |
| 2010 | 13 | 7 | 24 | 1,811 |
| 2011 | 14 | 5 | 24 | 1,317 |
| 2012 | 13 | 5 | 37 | 1,236 |
| 2013 | 13 | 7 | 24 | 1,426 |
| 2014 | 14 | 7 | 23 | 1,327 |
| 2015 | 15 | 8 | 24 | 1,001 |
| 2016 | 15 | 8 | 24 | 987 |
| 2017 | 14 | 9 | 23 | 401 |

Table 5. Sheepshead length (fork length, inches) data from Marine Recreational Information Program samples, 2008-2017.

| Year | Mean Length (inches) | Minimum Length (inches) | Maximum Length (inches) | Total Measured (number) |
|------|----------------------|-------------------------|-------------------------|-------------------------|
| 2008 | 13 | 7 | 21 | 108 |
| 2009 | 12 | 7 | 21 | 159 |
| 2010 | 14 | 8 | 26 | 221 |
| 2011 | 14 | 7 | 25 | 160 |
| 2012 | 13 | 6 | 23 | 254 |
| 2013 | 12 | 6 | 24 | 351 |
| 2014 | 13 | 8 | 25 | 99 |
| 2015 | 14 | 9 | 23 | 134 |
| 2016 | 14 | 8 | 25 | 106 |
| 2017 | 14 | 4 | 22 | 272 |

STATE-MANAGED SPECIES – SHEEPSHEAD

Table 6. Annual weighted sheepshead Catch Per Unit Effort (Number per set all ages combined) from the North Carolina Pamlico Sound Independent Gill Net Survey, 2001-2017. N=number of samples; CPUE=Catch per unit effort; SE=Standard Error; PSE=Proportional Standard Error.

| Year | N | CPUE | SE | PSE |
|------|-----|------|------|-----|
| 2001 | 237 | 0.13 | 0.06 | 46 |
| 2002 | 320 | 0.14 | 0.04 | 29 |
| 2003 | 320 | 0.08 | 0.02 | 25 |
| 2004 | 320 | 0.13 | 0.03 | 23 |
| 2005 | 304 | 0.08 | 0.02 | 25 |
| 2006 | 320 | 0.08 | 0.02 | 25 |
| 2007 | 320 | 0.11 | 0.03 | 27 |
| 2008 | 320 | 0.11 | 0.03 | 27 |
| 2009 | 320 | 0.30 | 0.05 | 17 |
| 2010 | 320 | 0.18 | 0.04 | 22 |
| 2011 | 298 | 0.16 | 0.06 | 38 |
| 2012 | 308 | 0.12 | 0.03 | 25 |
| 2013 | 308 | 0.30 | 0.07 | 23 |
| 2014 | 308 | 0.45 | 0.09 | 20 |
| 2015 | 306 | 0.26 | 0.06 | 23 |
| 2016 | 308 | 0.20 | 0.04 | 20 |
| 2017 | 308 | 0.44 | 0.10 | 23 |

Table 7. Summary of sheepshead age samples collected from both dependent (commercial and recreational) and independent (survey) sources, 2015-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2015 | 4 | 1 | 10 | 135 |
| 2016 | 5 | 0 | 29 | 215 |
| 2017 | 2 | 1 | 28 | 269 |

Table 8. Summary of management strategies and their implementation status for sheepshead.

| Management Strategy | Implementation Status |
|---|--|
| HARVEST MANAGEMENT | |
| Implement a size limit, recreational bag limit, and commercial trip limit by June 1, 2015 | Proclamation authority through Rule 15A NCAC 03M .0521 |

STATE-MANAGED SPECIES – SHEEPSHEAD

FIGURES

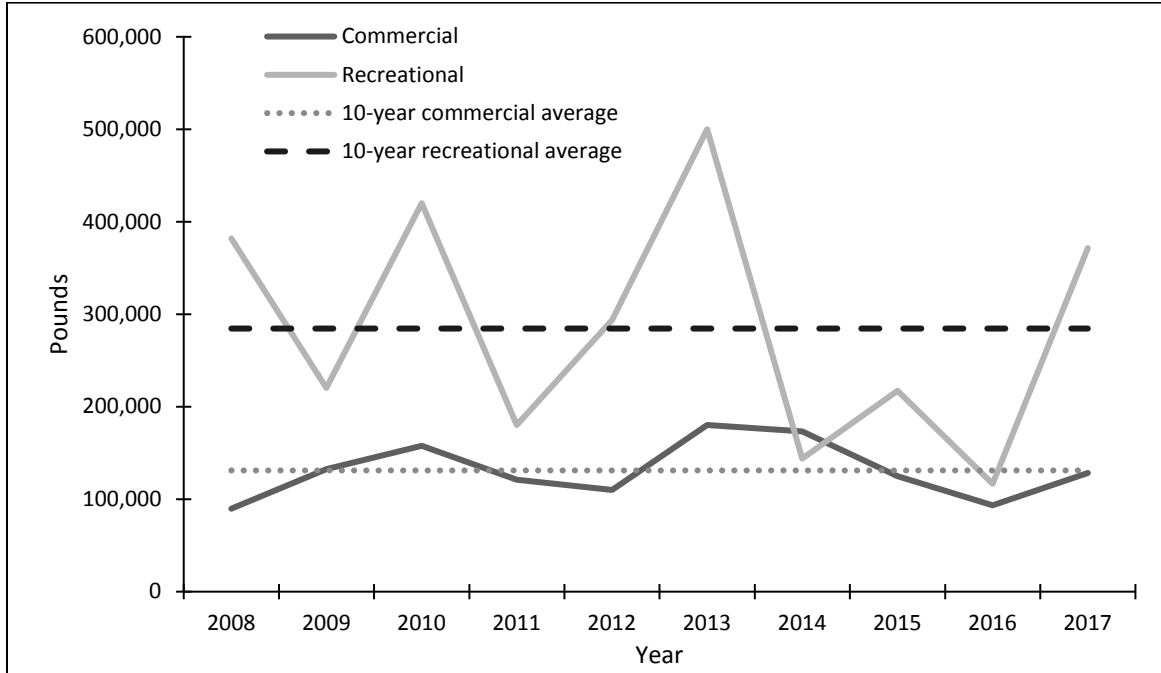


Figure 1. North Carolina commercial (N.C. Trip Ticket Program) and recreational (Marine Recreational Information Program) sheephead landings (pounds), 2008-2017.

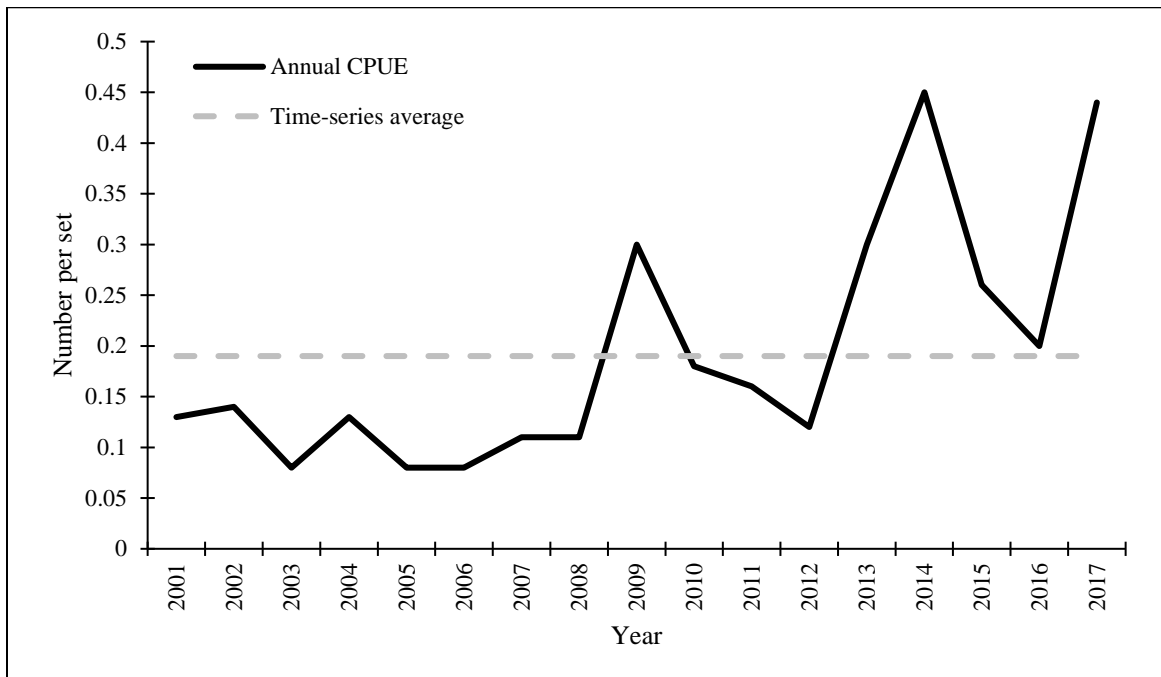


Figure 2. Annual index of abundance of sheephead in the NCDMF Pamlico Sound Independent Gill Net Survey, 2001-2017.

STATE-MANAGED SPECIES – SHRIMP

**FISHERY MANAGEMENT PLAN UPDATE
SHRIMP
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|-----------------------------|
| Original FMP Adoption: | April 2006 |
| Amendments: | Amendment 1 – February 2015 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | July 2020 |

The N.C. Shrimp Fishery Management Plan (FMP) was approved in April 2006 by the N.C. Marine Fisheries Commission (NCMFC; NCDMF 2006). The plan included a 90-foot headrope limit in some internal waters, allowed skimmer trawls as a Recreational Commercial Gear License (RCGL) gear and made recommendations on the minimum shrimp size at which some water bodies open to trawling. The plan also closed some areas in the state to protect habitats and juvenile finfish and established a 48-quart (heads-on) recreational limit. A restriction on the use of shrimp trawls above the Highway 172 Bridge over New River took effect in 2010 and this area above the bridge is now limited to skimmer trawls only. This strategy was codified into rule through Amendment 1.

Amendment 1 was adopted in February 2015 and was limited in scope to bycatch issues in the commercial and recreational fisheries (NCDMF 2015). It recommended a wider range of certified bycatch reduction devices (BRD) to choose from, and the requirement of two BRDs in shrimp trawls and skimmer trawls beginning June 1, 2015 (SH-2-2015). It increased the daily harvest limit for cast nets in closed areas. Amendment 1 also established a maximum combined headrope length of 220 feet in all internal coastal waters where there is no existing maximum combined headrope requirements, allowing for a phase-out period until January 1, 2017. Shrimp trawling was also prohibited, effective May 1, 2015 in the Intracoastal Waterway channel from the Sunset Beach Bridge to the South Carolina line, including the Shallotte River, Eastern Channel and lower Calabash River, to protect small shrimp. Amendment 1 also permitted a live bait shrimp fishery to allow live bait fishermen with a permit to fish until 12:00 p.m. (noon) on Saturdays; effective May 1, 2017.

STATE-MANAGED SPECIES – SHRIMP

An industry workgroup was formed to test gear modifications to reduce bycatch, to the extent practicable, with a 40 percent target reduction in the shrimp trawl fishery. In 2015, five experimental gear combinations were tested during the summer on large vessels in the Pamlico Sound. During the summer and fall of 2016, four additional gear combinations were tested on large vessels in the Pamlico Sound. In the final year of the study, 2017, three gear combinations were tested on both small and large vessels in the Atlantic Ocean and the Pamlico Sound. Gear combinations with larger tailbag mesh sizes (>1 ½-inches), reduced TED grid size (3-inch), and larger fisheyes were found to significantly reduce finfish bycatch. Four of the 12 gear combinations tested met or exceeded the 40% target reduction in finfish bycatch while also minimizing shrimp loss (Brown et al. 2017, 2018). Overall, finfish bycatch reductions ranged from 4.5 to 57.2 percent. Differences in shrimp catch between the control and experimental nets ranged from a 16.2 percent loss to a 9.9 percent gain. Results from the industry workgroup testing as well as the workgroup recommendation were presented to the NCMFC at its May 2018 business meeting. At this meeting the commission voted to require fishermen to use one of four gear combinations tested by the workgroup that achieved at least 40 percent finfish bycatch. These gears were found to reduce finfish bycatch by 40.1 to 57.2 percent. The new gear configurations will be required in all shrimp trawls, except skimmer trawls, used in inside waters where greater than 90-foot headrope length is allowed (Pamlico Sound and portions of Core Sound, Pamlico River and Neuse River); effective July 1, 2019. The commission also voted to continue the shrimp industry workgroup and explore funding options for more studies, to survey fishermen to determine what bycatch reduction devices the shrimp trawl industry currently uses, and to begin development of Amendment 2 to the Shrimp Fishery Management Plan.

Management Unit

The management unit includes the three major species of shrimp: brown (*Farfantepenaeus aztecus*), pink (*F. duorarum*), and white (*Litopenaeus setiferus*) and its fisheries in all coastal fishing waters of North Carolina, which includes the Atlantic Ocean offshore to three miles.

Goal and Objectives

The goal of the N.C. Shrimp Fishery Management Plan is to utilize a management strategy that provides adequate resource protection, optimizes the long-term commercial harvest, maximizes social and economic value, provides sufficient opportunity for recreational shrimpers, and considers the needs of all user groups. To achieve this goal, it is recommended that the following objectives be met:

1. Minimize waste and enhance economic value of the shrimp resource by promoting more effective harvesting practices.
2. Minimize harvest of non-target species of finfish and crustaceans and protected, threatened, and endangered species.
3. Promote the protection, restoration, and enhancement of habitats and environmental quality necessary for enhancing the shrimp resource.

STATE-MANAGED SPECIES – SHRIMP

4. Maintain a clear distinction between conservation goals and allocation issues.
5. Reduce conflicts among and within user groups, including non-shrimping user groups and activities.
6. Encourage research and education to improve the understanding and management of the shrimp resource.

STATUS OF THE STOCK

Life History

There are three shrimp species that make up the shrimp fishery in North Carolina. They are the brown shrimp, *Farfantepenaeus aztecus*, pink shrimp, *F. duorarum* and white shrimp, *Litopenaeus setiferus*. The lifecycle of these three species are similar in that the adults spawn offshore and eggs are hatched into free-swimming larvae. These larvae develop through several stages into post-larvae. Once post-larval shrimp enter the estuaries, growth is rapid and is dependent on salinity and temperature. As the shrimp increase in size, they migrate from the upper reaches of small creeks to deeper saltier rivers and sounds. By late summer and fall, they return to the ocean to spawn. The maximum life span of shrimp can range from 16 to 24 months and may reach a size of 7 to 11 inches.

Stock Status

Population size is regulated by environmental conditions, and while fishing reduces the population size over the season, fishing is not believed to have any impact on subsequent year class strength unless the spawning stock has been reduced below a minimum threshold level by environmental conditions. Because of high fecundity and migratory behavior, the three species are all capable of rebounding from a very low population size in one year to a large population size in the next, provided environmental conditions are favorable.

Stock Assessment

Estimates of population size are not available but since the fishery is considered an annual crop and fished at near maximum levels, annual landings are probably a good indication of relative abundance. Annual variations in catch are presumed to be due to a combination of prevailing environmental conditions, fishing effort, and the effects of changes in the economics of the fishery.

STATUS OF THE FISHERY

Current Regulations

General Rules

- Channel net is defined as a net used to take shrimp which is anchored or attached to the bottom at both ends or with one end anchored or attached to the bottom and the other end attached to a boat [15A NCAC 03I .0101(3)(b)].
- Headrope is defined as a support structure for the mesh or webbing of a trawl that is nearest to the water surface when in use [15A NCAC 03I .0101(3)(i)].
- Nursery areas are defined as areas in which for reasons such as food, cover, bottom type, salinity, temperature and other factors, young finfish and crustaceans spend the major portion of their initial growing season [15A NCAC 03I .0101(4)(f)].
- Military danger zones and restricted areas are designated in 15A NCAC 03R .0102 and are enforced by the appropriate federal agency [15A NCAC 03I .0110(a)].
- Maps or charts showing the boundaries of areas identified by rule or in proclamations are available for inspection [15A NCAC 03I .0121(a)].
- The NCDMF shall mark boundaries with signs insofar as may be practical. No removal or relocation of signs shall have the effect of changing the classification or affect the applicability of any rule pertaining to that body of water [15A NCAC 03I .0121(b)].

Rules Specific to Commercial Nets, Pots, Dredges, and Other Fishing Devices

- It is unlawful to use or set a fixed or stationary net in the Intracoastal Waterway where it may be a hazard to navigation, block more than two-thirds of any natural or manmade waterway, in the middle third of any marked navigation channel [15A NCAC 03J .0101(1), (2), and (3)].
- It is unlawful to possess aboard a vessel while using a trawl in internal waters more than 500 pounds of finfish from December 1 through February 28 and 1,000 pounds of finfish from March 1 through November 30 [15A NCAC 03J .0104(a)].
- It is unlawful to use trawls nets in internal coastal waters from 9:00 p.m. on Friday through 5:00 p.m. on Sunday, except for the areas described in the next bullet [15A NCAC 03J .0104(b)(1)].
- It is unlawful to use trawl nets from December 1 through February 28 from one hour after sunset to one hour before sunrise in portions of the Pungo, Pamlico, Bay, Neuse, and New rivers [15A NCAC 03J .0104(b)(5)(A), (B), (C), (D), and (E)].
- It is unlawful to use trawl nets in Albemarle Sound and its tributaries [15A NCAC 03J .0104(b)(3)].
- The Director may by proclamation, require bycatch reduction devices or codend modifications in trawl nets to reduce the catch of finfish that do not meet size limits or are unmarketable as individual foodfish by reason of size [15A NCAC 03J .0104(d)].
- It is unlawful to use trawl nets in designated pot areas opened to the use of pots by 15A NCAC 03J .0301(a)(2) within an area bound by the shoreline to the depth of six feet [15A NCAC 03J .0104(b)(6)].
- It is unlawful to use shrimp trawls for the taking of blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to commercial shrimp trawling provided that the weight of the crabs shall not exceed 50 percent of the total weight

STATE-MANAGED SPECIES – SHRIMP

- of the combined crab and shrimp catch; or 300 pounds, whichever is greater [15A NCAC 03J .0104(f)(2)].
- It is unlawful to use shrimp trawls for recreational purposes unless the trawl is marked with a pink buoy on the tailbag [15A NCAC 03J .0104(e)].
 - The Fisheries Director may, by proclamation, close any area to trawling for specific time periods in order to secure compliance with this rule [15A NCAC 03J .0104(g)].
 - It is unlawful to use a channel net until the Director specifies by proclamation when and where channel nets and other fixed nets for shrimping can be used [15A NCAC 03J .0106(a)(1)].
 - It is unlawful to set a channel net without yellow light reflective tape on the staffs, stakes and buoys [15A NCAC 03J .0106(a)(2)].
 - Channel nets cannot be set with any portion of the set within 50 feet of the center line of the Intracoastal Waterway (ICW) channel or in the middle third of any navigation channel marked by the Corps of Engineers or the Coast Guard. Fishermen must attend channel nets by being no more than 50 yards from the set at all times [15A NCAC 03J .0106(a)(3), (4), and (5)].
 - The maximum corkline length of a channel net that can be used or possessed is 40 yards. No channel net, net buoys or stakes can be left in coastal waters from December 1 through March 1. From March 2 through November 30, cables and any attached buoy must be connected together with non-metal line when not attached to the net. Metallic floats or buoys to mark sets are unlawful [15A NCAC 03J .0106(b), (c), (d), and (e)].
 - Channel nets must be properly marked with yellow light reflective tape and the owner's identification on each buoy. Identification includes one of the following: owner's N.C. motorboat registration number or the U.S. vessel documentation number or owner's last name and initials. Channel nets, anchor lines or buoys are not to be used in any way that constitutes a hazard to navigation [15A NCAC 03J .0106(f) and (g)].
 - It is unlawful to use channel nets to take blue crabs in internal waters, except that it shall be permissible to take or possess blue crabs incidental to channel net operations provided that the weight of the crabs does not exceed 50 percent of the total weight of crab and shrimp or 300 pounds, whichever is greater [15A NCAC 03J .0106(h)(1)(A) and (B)].
 - The Director may, by proclamation, close any area to channel net use for specific time periods in order to secure compliance with the above bullet [15A NCAC 03J .0106(h)(2)].
 - It is unlawful to use nets from June 15 through August 15 in the waters of Masonboro Inlet or in the ocean within 300 yards of the beach between Masonboro Inlet and a line running 138° through the water tank on the northern end of Wrightsville Beach, a distance parallel with the beach of 4,400 yards. It is unlawful to use trawls within one-half mile of the beach between the Virginia line and Oregon Inlet [15A NCAC 03J .0202(1) and (2)].
 - It is unlawful to use a trawl with a mesh length less than four inches in the body and three inches in the extension and on and three-fourths inches in the cod end or tail bag from the west side of Beaufort Inlet Channel to the shore off Salter Path within a half mile of shore [15A NCAC 03J .0202(3)].
 - From December 1 through March 31 it is unlawful to possess finfish caught incidental to shrimp and crab trawling in the Atlantic Ocean unless the weight of the combined catch of shrimp and crabs exceeds the weight of finfish; except that crab trawlers working south of Bogue Inlet may keep up to 300 pounds of kingfish, regardless of their shrimp or crab catch weight [15A NCAC 03J .0202(5)].

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- It is unlawful to use shrimp trawls in all waters west of a line beginning at the southeastern tip of Baldhead Island at a point 33° 50.4833'N – 77° 57.4667' W; running southerly in the Atlantic Ocean to a point 33° 46.2667'N – 77° 56.4000' W from 9:00 p.m. through 5:00 a.m. [15A NCAC 03J .0202(8)].
- It is unlawful to use trawl nets upstream of the Highway 172 Bridge in New River from 9:00 p.m. through 5:00 a.m. when opened by proclamation from August 15 through November 30 (15A NCAC 03J .0208).
- It is unlawful to use any commercial fishing gear in the Southport Boat Harbor, Brunswick County and to use any commercial fishing gear in the Progress Energy Intake Canal between the fish diversion screen and the Brunswick nuclear power plant (15A NCAC 03J .0206 and .0207).
- It is unlawful to use shrimp pots with mesh lengths smaller than one and one-fourth inches stretch or five-eighths inch bar [15A NCAC 03J .0301(e)].
- It is unlawful to use pots with leads or leaders to take shrimp. Leads are defined as any fixed or stationary net or device used to direct fish into any gear [15A NCAC 03J .0301(l)].
- In Dare County, commercial fishing gear may not be used within 750 feet of licensed fishing piers when opened to the public. Commercial fishing gear may not be used in the Atlantic Ocean off of portions of Onslow, Pender, and New Hanover counties during specified time frames [15A NCAC 03J .0402(a)(1)(A)(ii), (a)(2)(A), (a)(2)(B)(i) and (ii), (a)(3)(A), (a)(3)(B)(i) and (iii), (a)(4)].
- Shrimp pound net set is defined as a pound net set constructed of stretch mesh equal to or greater than one and one-fourth inches and less than or equal to two inches [15A NCAC 03J .0501(a)(6)].
- A permit is required to deploy a pound net set and must be operational for a minimum of 30 consecutive days during the permit period. Each pound required the permittee's identification on a sign attached to a stake at the permitted ends of each set at all times. They must have yellow light reflective tape or yellow light reflective devices on each pound and have a marked navigational opening at least 25 feet wide at the end of every third pound and marked with yellow light reflective tape or yellow light reflective devices [15A NCAC 03J .0501(b) and (c)].
- It is unlawful to use a RCGL shrimp pound net unless it is marked by attaching to the offshore lead, one hot pink floating buoy. The owner shall be identified on the buoy by engraving the gear owner's current boat registration number or the owners U.S. vessel documentation name. Each shrimp pound must be set a minimum of 100 yards from a RCGL pound net set or 300 yards from an operational permitted shrimp pound net set [15A NCAC 03J .0501(d)(1) and (2)].
- It is unlawful within 30 days of abandonment of a permitted pound net set to fail to remove all stakes and associated gear from coastal fishing waters [15A NCAC 03J .0501(g)].
- Pound net permit applications, renewals and transfers are to comply with the permitting procedures and requirements for obtaining all NCDMF-issued permits. Application process, criteria for the granting of the permit, operational requirements and other elements of the shrimp pound net set permits are found in 15A NCAC 03J .0502, .0503, .0504, and .0505.

Rules Specific to Shrimp

- It is unlawful to take shrimp with nets until the Director opens the season in various waters by proclamation (15A NCAC 03L .0101).

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Proclamations may specify any hours of day or night or both and any other conditions appropriate to manage the fishery. Some areas never open to shrimping, some areas are open year round, and some areas open and close throughout the year dependent upon shrimp movement and their size. Open areas to trawling are considered the shrimp open areas for all other gears including cast nets. All proclamations beginning with SH identify the open and closed areas and are found here throughout the year:

<http://portal.ncdenr.org/web/mf/proclamations-current>.

- It is unlawful to take shrimp by any method from 9:00 p.m. on Friday through 5:00 p.m. on Sunday except in the Atlantic Ocean or with the use of fixed and channel nets, hand seines, shrimp pots and cast nets [15A NCAC 03L .0102].
- It is unlawful to take shrimp with mesh lengths less than one and one-half inches in trawls, one and one-fourth inches in fixed nets, channel nets, float nets, butterfly nets and hand seines [15A NCAC 03L .0103(a)(1) and (2)].
- It is unlawful to take shrimp with a net constructed in a manner as to contain an inner or outer liner of any mesh size. Net material used as chafing gear shall be no less than four inches mesh length [15A NCAC 03L .0103(b)].
- It is unlawful to take shrimp with trawls which have a combined headrope of greater than 90 feet in internal coastal waters except in Pamlico Sound, Pamlico River downstream of Pamlico Point/ Willow Point and Neuse River downstream of Winthrop Point/Windmill Point [15A NCAC 03L .0103(c)(1), (2), and (3)].
- It is unlawful to use a shrimp trawl in the Pungo River, upstream of Wades Point/Abel Bay, Pamlico River upstream of the entrance to Goose Creek/Wades Point and Neuse River upstream of Cherry Point/Wilkerson Point 15A [NCAC 03L .0103(d)].
- It is unlawful to possess more than 48 quarts, heads-on or 30 quarts heads-off of shrimp per person per day or per vessel per day for recreational purposes [15A NCAC 03L .0105(1)].
- It is unlawful to take or possess shrimp taken from any area closed to the taking of shrimp except for two quarts per person per day may be taken with a cast net in a closed area [15A NCAC 03L .0105(2)].
- It is unlawful to use trawls in the crab spawning sanctuaries from March 1 through August 31 [15A NCAC 03L .0205(a)].
- It is unlawful to use a trawl net in any primary or permanent secondary nursery area [15A NCAC 03N .0104, and .0105(a)].
- Special secondary nursery areas may be opened to shrimp and crab trawling from August 16 through May 14 [15A NCAC 03N .0105(b)].
Special secondary nursery areas open by proclamation and vary in their open time periods within the August 16 through May 14 window. They are opened once the finfish amount has declined to reduce bycatch.

Recreational Licenses and Limits

- RCGL gear includes one shrimp trawl with a headrope not exceeding 26 feet in length per vessel, five shrimp pots, skimmer trawls, not exceeding 26 feet in total combined width and one shrimp pound net with each lead 10 feet or less in length and with a minimum lead net mesh of 1 ½ inches and enclosures constructed of net mesh of 1 ¼ inches or greater and with all dimensions being 36 inches or less. Attendance is required at all times for shrimp pounds [15A NCAC 03O .0302(a)(2), (3), (7), and (8)].
- It is unlawful for a RCGL holder to use pots, including shrimp pots unless each pot is

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marked by attaching one hot pink floating buoy; the buoy should be engraved with the gear owners boat registration number or U.S. vessel documentation name [15A NCAC 03J .0302(a)(1) and (2)].

- It is unlawful to possess more than 48 quarts, heads-on, or 30 quarts, heads-off, of shrimp per person per day or per vessel per day [15A NCAC 03L .0105].
- It is unlawful to possess more than 48 quarts, heads-on, or 30 quarts, heads-off, of shrimp when only one person aboard a vessel possesses a valid RCGL and recreational commercial fishing equipment [15A NCAC 03O .0303(e)].
- It is unlawful to possess more than 96 quarts, heads on or 60 quarts, heads-off, of shrimp if more than one person aboard a vessel possesses a valid RCGL and recreational commercial fishing equipment [15A NCAC 03O .0303(f)].

Turtle Excluder Device Requirements

- It is unlawful to use a shrimp trawl that does not conform with the federal requirements for Turtle Excluder Devices (TEDs) [15A NCAC 03L .0103(g)].
- It is unlawful to trawl for shrimp in the Atlantic Ocean without TEDs within one nautical mile of shore from Browns Inlet to Rich's Inlet without a valid permit to waive the requirement to use TEDs in the Atlantic Ocean when allowed by proclamation from April 1 through November 30. It is unlawful to tow more than 55 minutes from April 1 through October 31 and 75 minutes from November 1 through November 30. It is unlawful to not fully empty the contents of each net after each tow. It is unlawful to refuse to take observers. It is unlawful to fail to report any sea turtle captured [15A NCAC 03O .0503(d)(1), (2), (3), (4), and (5)].

Federal Regulations

- 33 CFR 334.410 through 334.450
These rules designate prohibited and restricted military areas, including locations within North Carolina coastal fishing waters, and specify activities allowed in these areas.
- 50 CFR 223.206 - Exceptions to prohibitions relating to sea turtles.
The incidental taking of sea turtles in the shrimp trawl fishery is exempted from section 9 of the Endangered Species Act if conservation regulations are followed and include the installation of National Oceanic and Atmospheric Administration (NOAA) Fisheries approved TEDs and alternative tow times for skimmer trawls, pusher-head trawls and butterfly trawls.
- 50 CFR 223.207 – Approved TEDs
This lists NOAA Fisheries approved TEDs such as the single-grid hard TEDs, hooped hard TEDs, special hard TEDs and soft TEDs, along with materials and gear specifications. Testing protocols for TEDs are also included in this rule.
- 50 CFR 229.7 – Monitoring of incidental mortalities
This requires that fishermen who participate in a Category I or II fishery are required to accommodate an observer onboard your vessel(s) up on request
- 50 CFR 622, Appendix D – Approved Bycatch Reduction Devices (BRDs)
This lists NOAA Fisheries approved BRDs and provides technical specifications for the construction and subsequent legal enforcement of these BRDs.

Rules implemented in Amendment 1 to the N.C. Shrimp Fishery Management Plan on May 1, 2015

- Modify the definition of mesh length to apply to diamond-mesh and square-mesh nets in support of a management strategy to require an additional bycatch reduction device in skimmer and otter trawls, which can include a square-mesh T-90 panel [15A NCAC 03I .0101(3)(n)].
- Codify an existing management strategy prohibiting the use of trawl nets, except skimmer trawls, upstream of the N.C. 172 Bridge over the New River in Onslow County to continue reducing bycatch [15A NCAC 03J .0208(a) and (b)].
- Clarify the Division of Marine Fisheries Director's proclamation authority for shrimp harvest restrictions [15A NCAC 03J .0104(g)].
- Establish a maximum combined headrope length of 220 feet in all internal coastal waters where there is no existing maximum combined headrope requirements, allowing for a phase-out period until Jan. 1, 2017 [15A NCAC 03L .0103(d)(1), (2), and (3)].
- Allow cast-netting of shrimp in all areas otherwise closed to shrimping and increasing the harvest limit in these areas to four quarts, heads-on, or 2 ½ quarts, heads-off [15A NCAC 03L .0105(2)].
- Prohibit shrimp trawling in the Intracoastal Waterway channel from the Sunset Beach Bridge to the South Carolina line, including the Shallotte River, Eastern Channel and lower Calabash River, to protect small shrimp [15A NCAC 03R .0114(4), (5), (6), and (7)].
- Establish a Permit for Weekend Trawling for Live Shrimp to allow live bait fishermen with a permit to fish until 12:00 p.m. (noon) on Saturdays [15A NCAC 03J .0104(b)(1)(B), 03L .0102(1), (2), and (3), and 03O .0503(k)(1), (2), and (3)].

Commercial Landings

Landings in the North Carolina shrimp fishery vary from year to year and are dependent primarily on environmental conditions. Environmental factors, especially severity of winter temperatures, and salinity can have a major influence on the yearly harvest. North Carolina's shrimp fishery is unusual in the southeast because all three species are taken here and most of the effort occurs in internal waters. While South Carolina, Georgia, and Florida allow limited inside waters shrimping, much of their fisheries are conducted in the Atlantic Ocean and white shrimp comprise most of their harvest (NCDMF 2015).

Commercial activity occurs in all waters. The shrimp fishery in the northern portion of the state is conducted in Pamlico, Croatan, and Roanoke sounds and Pamlico, Pungo, Bay, and Neuse rivers. The otter trawl is the predominant gear used in this portion of the state. The shrimp fishery in the central coastal area of the state occurs in Neuse River, Core Sound, North River, Newport River, Bogue Sound, and White Oak River. A variety of methods are used to catch shrimp including trawls, skimmer trawls, channel nets, shrimp pounds, and cast nets. Trawls are used on all three species in both the estuary and the ocean with two-seam trawls used for brown and pink shrimp and four-seam and tongue trawls for white shrimp, which tend to swim higher in the water column and will jump to the surface when disturbed. Most trawling in the central portion of the state is conducted at night. Channel nets are popular around Harkers Island in the Straits and North River while skimmer trawling is very popular in Newport River and New River.

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In the southern portion of the state, the fishery is characterized by a large number of small boats fishing internal waters (primarily the Intracoastal Waterway, New, and Cape Fear rivers) and larger vessels fishing the Atlantic Ocean primarily off New River, Carolina Beach, and Brunswick County. Many of the small boats are fished by individuals who shrimp part-time or for personal consumption. Use of gears other than trawls has increased primarily in the area from New River to Rich's Inlet. Channel, float, and butterfly nets make use of tidal currents to push shrimp into the nets and offer the advantages of less fuel consumption and less bycatch than traditional shrimp trawls. Channel nets are fished extensively in the areas around New River and Topsail inlets. To shrimp with a "float net", fishermen attach large floats to the doors and top lines of trawls to make the net fish up in the water column and are pulled slowly forward to harvest shrimp that are migrating to the inlets at night. Butterfly nets use this same harvest strategy but are attached to a metal frame and are held stationary in the water column to capture shrimp as the current carries them into the net. Skimmer trawls have become more popular around New River and Topsail Sound. These alternative gears are employed very little in areas south of Rich's Inlet, however tidal conditions seem favorable for their use. Cast nets and seines are also used to harvest shrimp to provide live shrimp for the commercial bait fishery.

Landings provided by the trip ticket program are combined for the three shrimp species (Figure 1). Total landings from 1994 to 2017 have averaged 7,244,330 pounds per year. In 2017, 13,892,730 pounds of shrimp were landed; the highest annual landings of the 24-year time series. Total landings increased 5.3 percent from 2016 to 2017. Annual shrimping effort (number of trips) has fluctuated with shrimp abundance, but it appears to have gradually declined since 1994 (NCDMF 2015). This is due to a number of things including cheaper imported shrimp prices, increasing fuel prices, and fishermen retiring out of the industry. Landings in 2005 were lowest on record, likely from several reasons; many large trawlers remained scalloping instead of shrimping because prices were high and the days at sea were extended (NCDMF 2015). Hurricanes Katrina (8/29/05) and Rita (9/4/05) hit the Gulf coast, negatively affecting the fishing industry. Shrimp breeding operations in the Gulf shut down with only one operational in September and some North Carolina shrimpers could not sell their product (NCDMF 2015). The number of trips has increased slightly since 2011; however, decreased 2 percent from 2016 to 2017 (Figure 2).

Recreational Landings

Shrimp are harvested recreationally throughout the state by otter trawls, skimmer trawls, seines, cast nets, shrimp pots and shrimp pounds with specific gear limitations. Since July 1, 1999, anyone wishing to harvest shrimp recreationally with commercial gear is required to purchase a Recreational Commercial Gear License (RCGL). The RCGL is an annual license that allows recreational fishermen to use limited amounts of commercial gear to harvest seafood for their personal consumption. Seafood harvested under this license cannot be sold. Fishermen using this license are held to recreational size and possession limits, gear marking and gear limit and configuration requirements. Many of the species taken by recreational users of commercial gear are included in fisheries management plans. Until 2002, the influence that RCGL holders may have on these species was unknown. Two survey strategies were used to collect information from RCGL holders; a socioeconomic survey, conducted in 2001, 2004, and 2007, and catch and

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effort surveys conducted monthly from 2002 through 2008. Both surveys were terminated in 2008 due to budget constraints. RCGL holders harvested an average of 52,352 pounds of shrimp a year from 2002 to 2008 (NCDMF 2015). The highest landings occurred in 2002 (101,766 pounds), followed by 2008 (54,359 pounds) and 2003 (50,961 pounds). Recreational landings of shrimp are currently unknown since this survey was discontinued in 2008.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Currently, the only data available for the stock in all areas are the commercial landings and associated effort from the Trip Ticket Program. No fishery dependent monitoring program exists for shrimp.

Fishery-Independent Monitoring

The Estuarine Trawl Survey (Program 120) is a fishery-independent multispecies monitoring program that has been ongoing since 1971 in the months of May and June. One of the key objectives of this program is to provide a long-term data base of annual juvenile recruitment for economically important species. This survey samples fixed stations, a set of 104 core stations with additional stations as needed. The core stations are sampled from western Albemarle Sound south through the South Carolina border each year without deviation two times in the months of May and June. This survey targets juvenile finfish, blue crabs, and penaeid shrimp. A two-seam 10.5 foot headrope trawl with a 1/4-inch mesh in the body and 1/8-inch mesh in the tailbag is used. A one-minute tow is conducted covering a distance of 75 yards. All species taken are sorted, identified, and a total number is recorded for each species. For target species, a subset of at least 30 to 60 individuals is measured. Environmental data are collected, including salinity, dissolved oxygen, temperature, wind speed, and direction.

Trends in the annual brown shrimp catch per unit effort (CPUE) measured as the number of brown shrimp per station in Program 120 sampling shows fluctuations from year to year (Figure 3). The annual brown shrimp CPUE decreased 5 percent from 2016 to 2017. The proportional standard error was below 20 in all but three years from 1988 to 2017 (Table 2). A PSE of “20” and less was established by the Atlantic Coast Cooperative Statistics Program (ACCSP) as a standard when considering the precision of a given metric. The margin of error for the annual brown shrimp CPUE is low, therefore providing greater confidence in the samples as an expression to the population (Table 2).

As indicated in the stock status section, annual landings are a good indication of relative abundance of shrimp in the coastal fishing waters of North Carolina. Estimates of recruitment calculated from the annual brown shrimp CPUE can also be used to determine year class strength. Trends in overall shrimp landings from June and July, months were brown shrimp predominately make up the harvest, show similar trends as the Program 120 data (Figure 4). Currently, there are no juvenile indices for white and pink shrimp in North Carolina.

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MANAGEMENT STRATEGY

The management strategy for the shrimp fisheries in North Carolina is to continue to: 1) optimize resource use over the long-term, and 2) minimize waste. The first strategy is accomplished by protection of critical habitats, and gear and area restrictions to protect the stock. Minimization of waste is accomplished by gear modifications, bycatch reduction devices, area closures, and harvest restrictions.

There are no management triggers or methods to track stock abundance, fishing mortality, or recruitment between benchmark reviews from the current FMP. Landings and effort have decreased over time (NCDFM 2015). There are no data to track the recreational fishery.

Amendment 1 was adopted in February 2015 and was limited in scope to bycatch issues in the commercial and recreational fisheries. The management strategy for this amendment recommended a wider range of certified bycatch reduction devices to choose from, the requirement of two bycatch reduction devices in shrimp trawls and skimmer trawls (beginning June 1, 2015), and increased the daily harvest limit for cast nets in closed areas. Amendment 1 also established a maximum combined headrope length of 220 feet in all internal coastal waters where there is no existing maximum combined headrope requirements, allowing for a phase-out period until January 1, 2017. Shrimp trawling was also prohibited, effective May 1, 2015 in the Intracoastal Waterway channel from the Sunset Beach Bridge to the South Carolina line, including the Shallotte River, Eastern Channel and lower Calabash River, to protect small shrimp. With the adoption of the Amendment 1, the Marine Fisheries Commission further directed the division to develop a live bait permit to allow permitted fishermen to fish until 12:00 p.m. (noon) on Saturdays.

An industry workgroup was formed as a management strategy through Amendment 1, to test gear modifications to reduce bycatch, to the extent practicable, with a 40 percent target reduction in the shrimp trawl fishery. At its May 2018 business meeting, the Marine Fisheries Commission voted to require fishermen to use one of four gear combinations tested by the workgroup that achieved at least 40 percent finfish bycatch. The new gear configurations will be required in all shrimp trawls, except skimmer trawls, used in inside waters where greater than 90-foot headrope length is allowed (Pamlico Sound and portions of Core Sound, Pamlico River and Neuse River); effective July 1, 2019. The commission also voted to continue the shrimp industry workgroup and explore funding options for more studies, to survey fishermen to determine what bycatch reduction devices the shrimp trawl industry currently uses, and to begin development of Amendment 2 to the Shrimp Fishery Management Plan. The information paper titled “Shrimp Fishery Management Plan (FMP) Amendment 1: Consideration of Gear Modifications to Reduce Bycatch in the North Carolina Shrimp Trawl Fishery” will serve as a Revision to Amendment 1 to the North Carolina Shrimp Fishery Management Plan and will document the management strategy changes and rationale. All other management strategies contained in Amendment 1 will remain in place until another Revision, Supplement, or Amendment to the N.C. Shrimp Fishery Management Plan occurs.

See Table 3 for the specific current management strategies.

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RESEARCH NEEDS

The N.C. Marine Fisheries Commission selected research strategies and implementation status are provided in Table 3. Proposed research needs and status of need is provided in parenthesis from Amendment 1 include:

- Continue to conduct bycatch characterization work across all strata (for example: dominant species, season, areas, vessel type, number of nets/rigs, headrope length) - HIGH (ongoing through NCDMF)
- Initiate/increase state monitoring and reporting on the extent of unutilized bycatch and fishing mortality on fish less than age-1 in the shrimp trawl fishery - HIGH (needed)
- Continue to develop and test methods to reduce bycatch in the commercial and recreational shrimp trawl fisheries - HIGH (ongoing in commercial shrimp trawl fishery through NCDMF and the industry workgroup)
- Obtain mortality (immediate and post-harvest) estimates of culled (active and passive) bycatch from gears used in the recreational and commercial shrimp fisheries - HIGH (needed)
- Continue to develop standard protocol for bycatch estimations - HIGH (ongoing at NCDMF with collaborative efforts with other agencies and researchers)
- Continue to define and quantify the intensity, duration and spatial scale of trawling effort in N.C. estuaries - HIGH (ongoing through NCDMF)
- Determine species interactions and predator/prey relationships for prominent shrimp trawl bycatch - HIGH (needed)
- Determine how the resuspension of sediment, siltation, and non-point source pollution from adjacent land use practices impacts trends in shrimp abundance and habitat degradation - HIGH (needed)
- Determine the spatial and biological characteristics of submerged aquatic vegetation that maximize their ecological value to shrimp for restoration and conservation purposes - HIGH (ongoing through the Coastal Habitat Protection Plan)
- Effort data needs to be collected to provide estimates based on actual time fished (or number of tows), rather than number of trips - HIGH (needed)
- Improve accuracy of self-reported license gear survey data, or investigate other means of accurately obtaining shrimp fleet characteristic - HIGH (needed)
- Examine how sedimentation, hydrologic alterations, and environmental conditions affect the abundance of brown shrimp (*Farfantepenaeus aztecus*) in southeastern North Carolina - HIGH (needed)
- Conduct research to quantify the number of protected species interactions with the shrimp fishery - MEDIUM (ongoing through NCDMF)
- Continue to develop and test methods to reduce interactions with protected species in the commercial and recreational shrimp trawl fisheries – MEDIUM (ongoing work being conducted by NOAA)
- Initiate sampling to investigate if additional areas currently open to shrimping need changes to their habitat designations - MEDIUM (needed)

STATE-MANAGED SPECIES – SHRIMP

- Evaluate the effectiveness and efficiency of the current sampling protocol used to manage shrimp - MEDIUM (needed)
- Continue to map and quantify the habitat structure and sediment types in North Carolina estuaries - MEDIUM (ongoing through NCDMF)
- Continue to measure the effects of trawling on sediment size distribution and organic carbon content – MEDIUM (needed)
- Expand current social and economic surveys to specifically collect information on shrimp fishermen - MEDIUM (needed)
- Continue to determine the extent of recreational shrimp harvest that is occurring. This group primarily use cast nets to take shrimp either for bait or personal consumption - MEDIUM (needed)
- Continue to support research to determine the status of protected species along the N.C. coast to better anticipate and prevent interactions (for example: migration patterns and habitat utilization) - LOW (ongoing support continued to provide information as interactions with protected species occurs)
- Continue to investigate the impact of tiger shrimp in North Carolina. waters - LOW (research conducted through NOAA)
- Initiate research to determine the impacts of endocrine disrupting chemicals (EDCs) on the various life stages of shrimp - LOW (needed)

FISHERY MANAGEMENT PLAN RECOMMENDATION

Recommend maintain the current timing of the Benchmark Review. Amendment 1 of the N.C. Shrimp FMP was adopted in February 2015 with rule changes in effect May 1, 2015 and May 1, 2017.

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- Brown, K.B., B. Price, L. Lee, S. Baker, and S. Mirabilio. 2017. An evaluation of bycatch reduction technologies in the North Carolina shrimp trawl fishery. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 40 p.
- Brown, K.B., B. Price, L. Lee, S. Baker, and S. Mirabilio. 2018. Technical solutions to reduce bycatch in the North Carolina Shrimp Trawl Industry. North Carolina Department of Environment and Natural Resources, Division of Marine Fisheries, Morehead City, NC. 50 p.
- NCDMF (North Carolina Division of Marine Fisheries). 2006. North Carolina Shrimp Fishery Management Plan. North Carolina department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. Morehead City, NC. 384 pp.
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STATE-MANAGED SPECIES – SHRIMP

TABLES

Table 1. Harvest (pounds) and pounds per trip of shrimp (three species combined) by RCGL gear from 2002 through 2008 (NCDMF 2015).

| Year | Pounds | Pounds/trip |
|------|---------|-------------|
| 2002 | 101,766 | 19.1 |
| 2003 | 50,961 | 18.5 |
| 2004 | 43,698 | 9.3 |
| 2005 | 32,542 | 13.4 |
| 2006 | 49,362 | 20.3 |
| 2007 | 33,778 | 15.2 |
| 2008 | 54,359 | 22.3 |
| Mean | 52,352 | 16.8 |

STATE-MANAGED SPECIES – SHRIMP

Table 2. Program 120 annual sampling for brown shrimp from core stations in May and June combined. Number of samples (stations), brown shrimp arithmetic catch per unit effort (CPUE) as the number of shrimp per station, standard error, standard deviation, coefficient of variation (CV), minimum number caught at a station, maximum number caught at a station, total number caught, and proportional standard error (PSE), 1988-2017.

| Year | Number of stations | CPUE (No. shrimp/tow) | Standard error | Standard deviation | CV | Minimum number per station | Maximum number per station | Total number of shrimp | PSE |
|------|--------------------|--------------------------|----------------|--------------------|-------|----------------------------|----------------------------|------------------------|-----|
| 1988 | 209 | 21.2 | 3.2 | 46.3 | 218.0 | 0 | 348 | 4,440 | 15 |
| 1989 | 207 | 29.2 | 5.4 | 77.7 | 265.8 | 0 | 775 | 6,050 | 18 |
| 1990 | 206 | 44.2 | 6.8 | 98.0 | 222.0 | 0 | 1,094 | 9,098 | 15 |
| 1991 | 207 | 48.6 | 5.4 | 77.2 | 158.9 | 0 | 520 | 10,055 | 11 |
| 1992 | 210 | 25.8 | 5.0 | 72.9 | 282.2 | 0 | 664 | 5,428 | 19 |
| 1993 | 205 | 23.8 | 4.4 | 62.3 | 262.0 | 0 | 348 | 4,876 | 18 |
| 1994 | 205 | 29.9 | 4.3 | 61.4 | 205.2 | 0 | 459 | 6,134 | 14 |
| 1995 | 208 | 38.6 | 5.7 | 82.5 | 213.7 | 0 | 615 | 8,032 | 15 |
| 1996 | 207 | 34.8 | 6.4 | 91.9 | 264.2 | 0 | 696 | 7,199 | 18 |
| 1997 | 207 | 25.6 | 6.2 | 89.8 | 350.5 | 0 | 856 | 5,304 | 24 |
| 1998 | 208 | 13.0 | 2.8 | 40.0 | 306.7 | 0 | 369 | 2,712 | 21 |
| 1999 | 206 | 49.7 | 7.5 | 108.3 | 218.1 | 0 | 675 | 10,233 | 15 |
| 2000 | 209 | 56.8 | 7.1 | 102.1 | 179.8 | 0 | 759 | 11,865 | 12 |
| 2001 | 209 | 42.8 | 6.3 | 91.0 | 212.6 | 0 | 717 | 8,947 | 15 |
| 2002 | 208 | 59.7 | 6.9 | 99.4 | 166.5 | 0 | 793 | 12,414 | 12 |
| 2003 | 208 | 31.2 | 4.3 | 62.3 | 199.9 | 0 | 563 | 6,484 | 14 |
| 2004 | 208 | 24.9 | 4.0 | 57.6 | 231.1 | 0 | 334 | 5,185 | 16 |
| 2005 | 208 | 23.2 | 4.4 | 62.8 | 270.8 | 0 | 551 | 4,820 | 19 |
| 2006 | 208 | 25.9 | 3.4 | 49.7 | 191.9 | 0 | 308 | 5,383 | 13 |
| 2007 | 208 | 18.5 | 1.9 | 27.2 | 147.2 | 0 | 170 | 3,845 | 10 |
| 2008 | 208 | 95.7 | 13.4 | 193.9 | 202.6 | 0 | 1,718 | 19,908 | 14 |
| 2009 | 208 | 60.3 | 8.2 | 117.7 | 195.3 | 0 | 1,001 | 12,540 | 14 |
| 2010 | 208 | 75.2 | 13.2 | 190.0 | 252.5 | 0 | 1,622 | 15,651 | 18 |
| 2011 | 208 | 52.2 | 7.4 | 106.8 | 204.7 | 0 | 930 | 10,852 | 14 |
| 2012 | 208 | 40.1 | 4.3 | 61.5 | 153.2 | 0 | 343 | 8,347 | 11 |
| 2013 | 208 | 27.5 | 4.4 | 63.3 | 229.8 | 0 | 459 | 5,726 | 16 |
| 2014 | 208 | 35.0 | 4.5 | 64.5 | 184.3 | 0 | 409 | 7,276 | 13 |
| 2015 | 208 | 103.8 | 25.9 | 373.2 | 359.6 | 0 | 5,053 | 21,587 | 25 |
| 2016 | 208 | 19.9 | 3.2 | 46.8 | 235.0 | 0 | 319 | 4,146 | 16 |
| 2017 | 208 | 18.9 | 3.6 | 52.0 | 274.5 | 0 | 467 | 3,940 | 19 |

STATE-MANAGED SPECIES – SHRIMP

Table 3. The N.C. Marine Fisheries Commission selected management strategies, and implementation status to reduce bycatch as mandated by Amendment 1.

| Management Strategy | Implementation Status |
|---|---|
| Status quo (continue to prohibit otter trawls in the New River special secondary nursery area above the Highway 172 Bridge). | Rule change required in 15A NCAC 03J .0208; Rule change in effect on May 1, 2015. |
| Allow hand cast netting of shrimp in all closed areas and increase the limit to four quarts, with heads on per person. | Rule change required in 15A NCAC 03L .0105; Rule change in effect on May 1, 2015. |
| Status quo on a license requirement to fish a cast net for shrimp. | No action required |
| Upon federal adoption of TEDs in skimmer trawls, the division will support the federal requirement. | No action required |
| Establish a permitted live shrimp bait fishery and for DMF to craft the guidelines and permit fees after reviewing permitted operations in other states, and to allow live bait fishermen with a permit to fish until 12 p.m. (noon) on Saturday. | Based on review of other state operations, future rule changes will be required and include 15A NCAC 03J .0104, 03L .0102, 03O .0105, 03O .0503; Rule change in effect on May 1, or June 1, 2017. |
| Allow any federally certified BRD in all internal and offshore waters of NC. | Existing proclamation authority; Proclamation issued with complete list of BRDs, SH-2-2015 |
| Update the scientific testing protocol for the state’s BRD certification program. | Plans to update the testing protocols to use the federal standards. |
| <p>Convene a stakeholder group to initiate industry testing of minimum tail bag mesh size, T-90 panels, skylight panels, and reduced bar spacing in TEDs to reduce bycatch to the extent practicable with a 40 percent target reduction.</p> <ul style="list-style-type: none"> • Upon securing funding, testing in the ocean and internal waters will consist of three years of data using test nets compared to a control net with a Florida fish eye, a federally approved TED and a 1.5-inch mesh tail bag. • Results should minimize shrimp loss and maximize reduction of bycatch of finfish. Promising configurations will be brought back to the commission for consideration for mandatory use. • The stakeholder group may be partnered with the division and Sea Grant. • Members should consist of fishermen, net/gear manufacturers and scientific/gear specialists. | Stakeholder group convened in 2015 and industry testing completed in 2017. Results presented MFC in May 2018. Proclamation to be issued to requiring the use of one of four gear combinations tested by the workgroup that achieve at least 40 percent finfish bycatch, effective July 1, 2019. Plans to continue shrimp industry workgroup and explore funding options for more studies. |
| Require either a T-90/square mesh tailbag or other applications of square mesh panels (e.g., skylight panel), reduced bar spacing in a TED, or another federal or state certified BRD in addition to existing TED and BRD requirements in all skimmer and otter trawls. | Existing proclamation authority Rule change required in 15A NCAC 03I .0101; Rule change in effect on May 1, 2015. Proclamation issued for second BRD requirement to begin on June 1, 2015, SH-2-2015, http://portal.ncdenr.org/web/mf/proclamation-sh-02-2015 |

STATE-MANAGED SPECIES – SHRIMP

| Management Strategy | Implementation Status |
|---|---|
| Status quo on effort management (no change in season, weekend, or night time fishing). | No action required |
| In order to put a cap on fleet capacity as a management tool, establish a maximum combined headrope length of 220 feet in all internal coastal waters where there is no existing maximum combined headrope requirements with a two-year phase out period. | Rule change required in 15A NCAC 03L .0103; Rule change in effect on May 1, 2015. |
| Prohibit shrimp trawling in the IWW channel from Sunset Beach to the SC state line, including Eastern Channel, lower Calabash River and Shallotte River. | Rule change required in 15A NCAC 03R .0114; Rule change in effect May 1, 2015. |
| Recommend the MFC Habitat and Water Quality Advisory Committee to consider changing designation of special secondary nursery areas that have not been opened to trawling since 1991 to permanent secondary nursery areas. | Rule changes required in 15A NCAC 03R .0104 and 03R .0105; Rule change in effect May 1, 2015. |
| Establish a permitted live bait shrimp fishery and allow live bait fishermen with a permit to fish until 12 p.m. (noon) on Saturday | Rule changes required in 15A NCAC 03O .0503; Rule change in effect May 1, 2017. |

FIGURES

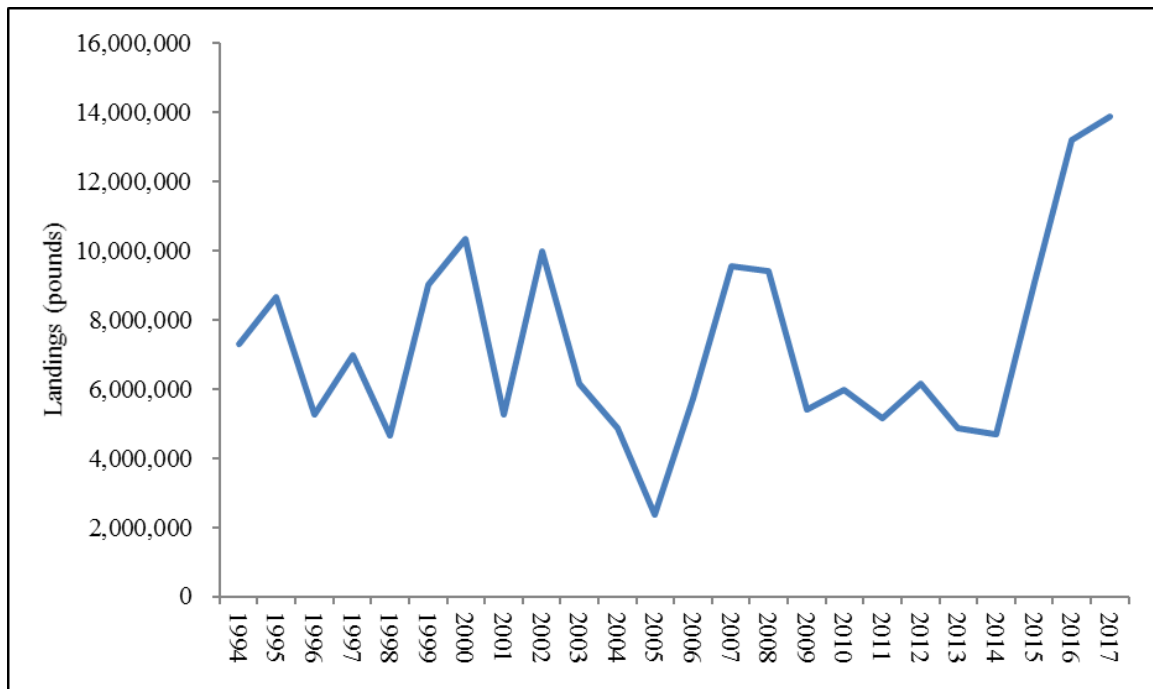


Figure 1. Annual shrimp landings (pounds) from all three shrimp species combined in North Carolina, 1994-2017. Data from the NCDMF Trip Ticket Program.

STATE-MANAGED SPECIES – SHRIMP

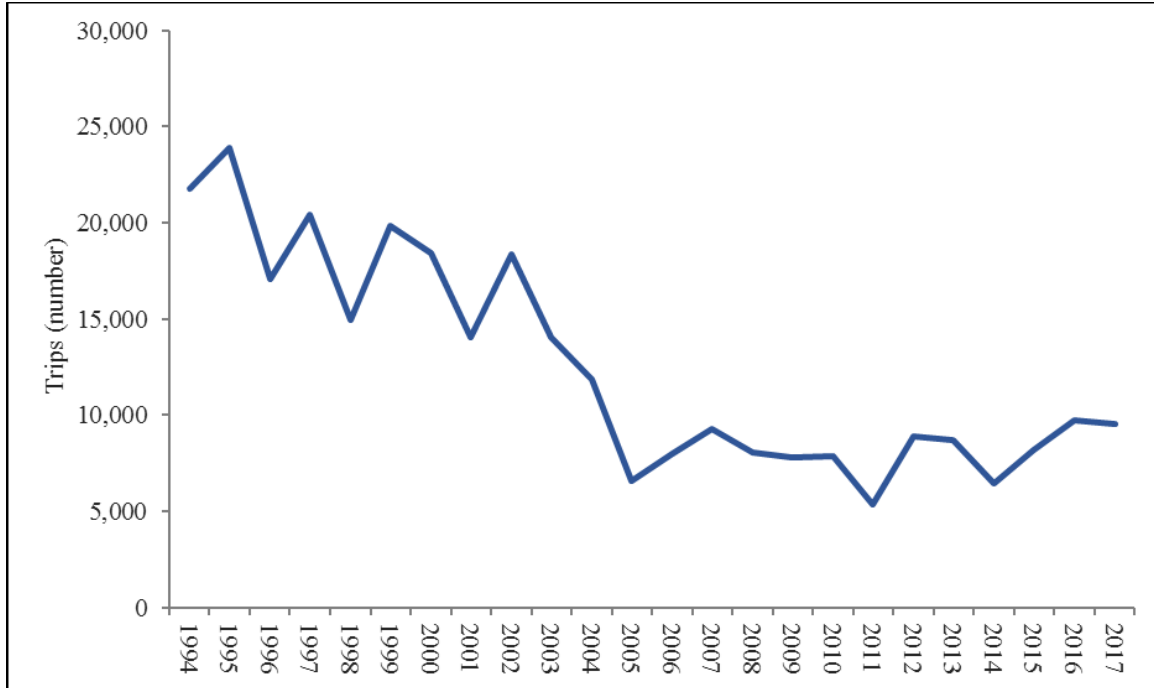


Figure 2. Annual number of trips reported for all three species combined in inside and ocean waters, 1994-2017. Data from the NCDMF Trip Ticket Program.

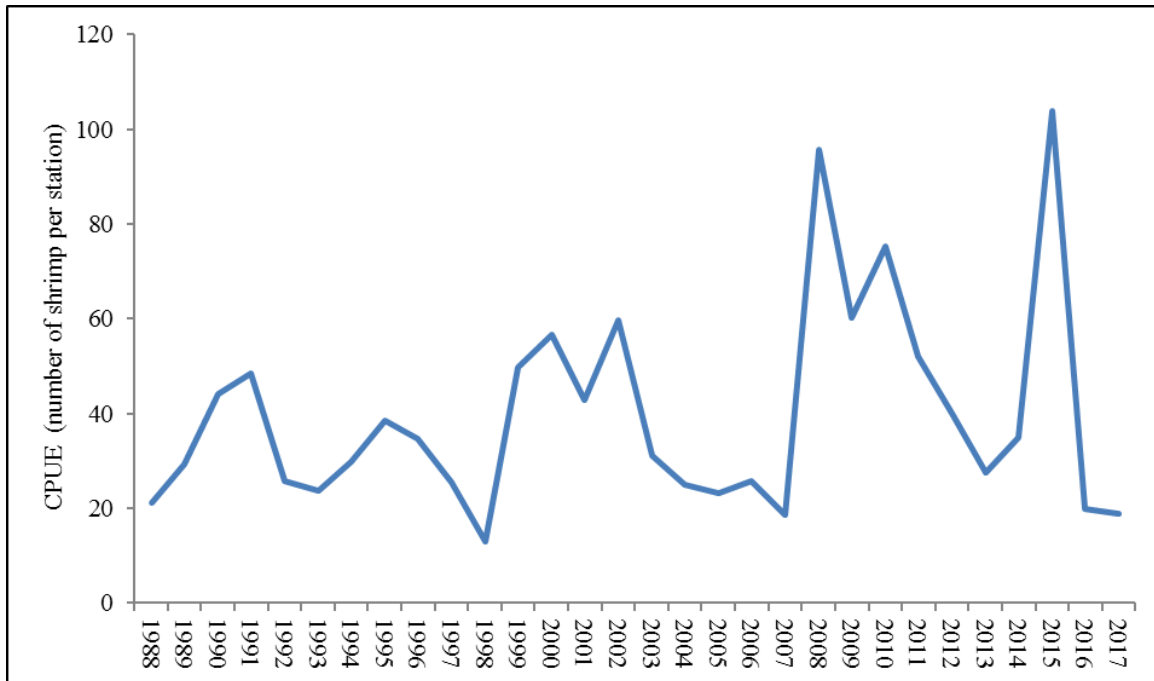


Figure 3. Annual catch per unit effort (number of shrimp per station) of brown shrimp from Program 120 estuarine trawl survey, 1988-2017.

STATE-MANAGED SPECIES – SHRIMP

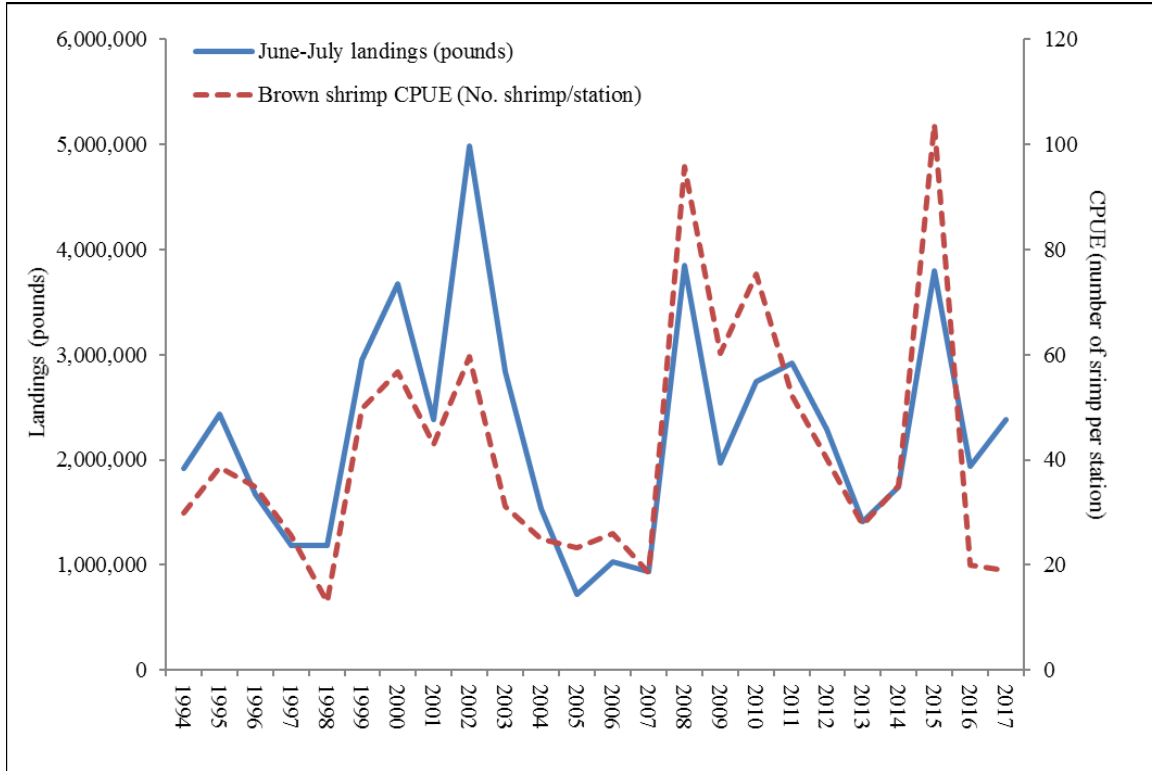


Figure 4. Comparison of shrimp commercial landings in the months of June and July to the brown shrimp Program 120 catch per unit effort (number of shrimp per station), 1994-2017.

STATE-MANAGED SPECIES – SOUTHERN FLOUNDER

FISHERY MANAGEMENT PLAN UPDATE SOUTHERN FLOUNDER AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | February 2005 |
| Amendments: | Amendment 1 – February 2013 |
| Revisions: | None |
| Supplements: | Supplement A to the 2005 FMP – February 2011 Supplement A to Amendment 1 – November 2015 |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | January 2023 |

A five-year review of the N.C. Southern Flounder Fishery Management Plan (FMP) began January 2018, immediately following a peer review workshop evaluating the 2018 stock assessment. At the end of the peer review workshop, the Southern Flounder Review Panel accepted the pooled-sex run of the ASAP model presented at the Review Workshop as a valid basis of management for at least the next five years, with the expectation that the model will be updated with data through 2017 to provide the best, most up to date estimate of stock status for management. The reviewers also noted that management advice based on the 2015 terminal year would be out of date by the time it could be implemented and that expected changes to recreational catch estimates (MRIP) should be incorporated into the assessment model and management response. Moving forward, the division's intent is to update the approved ASAP pooled-sex model using data through 2017. The division also plans to include updated MRIP estimates if they are available as scheduled in July. This update will move forward while continuing to work through the development of Amendment 2 to the Southern Flounder Fishery Management Plan.

Until Amendment 2 is approved by the MFC, management of southern flounder falls under Amendment 1 and Supplement A to Amendment 1. Actions to achieve sustainable harvest in Amendment 1 include: 1) accept management measures to reduce protected species interactions as the management strategy for achieving sustainable harvest in the commercial Southern flounder fishery; 2) increase the recreational minimum size limit to 15 inches and decrease the creel limit to six fish. Amendment 1 also set new sustainability benchmarks at 25% Spawning Potential Ratio (SPR) (threshold) and 35% SPR (target).

STATE-MANAGED SPECIES – SOUTHERN FLOUNDER

Supplement A to Amendment 1 was approved at the November 2015 NCMFC meeting. Management actions approved include: increasing the minimum commercial size limit to 15 inches, increasing the minimum mesh size for gill nets to six-inch stretched mesh (ISM), closing the commercial gill net and recreational fisheries on October 15, closing the commercial gig fishery once the pound net fishery closes, a 38% reduction to the pound net fishery based on the 2011-2015 average landings, and to increase the escape panels in flounder pound nets to five and three-quarters inch. All management actions were effective January 1, 2016. However, an injunction was granted in October 2016 stopping the Division from enacting some of the management actions. The recreational closure on October 15, the commercial closure of the gig fishery, and the 38% reduction in pound net landings based on the 2011-2015 average did not occur.

Management Unit

The Amendment 1 and Supplement A to Amendment 1 to the North Carolina Fishery Management Plan management unit was defined as North Carolina coastal and joint waters. However, due to increased information relative to genetic identification and tagging studies the unit stock for the 2018 stock assessment was changed to include all waters from North Carolina through the East coast of Florida.

Goal and Objectives

Until the goals and objectives of Amendment 2 are approved by the MFC, the goals and objectives of Amendment 1 remain. The goal of Amendment 1 to the North Carolina Southern Flounder FMP is to end overfishing and rebuild the spawning stock for long-term sustainable harvest and maintain the integrity of the stock. To achieve this goal, the following objectives must be met:

1. Ensure that the spawning stock biomass of southern flounder is adequate to produce recruitment levels necessary to increase spawning stock biomass and expand age distribution.
2. Implement management measures that will achieve sustainable harvest.
3. Promote harvesting practices that minimize bycatch.
4. Continue to develop an information program to educate the public and elevate their awareness of the causes and nature of problems in the southern flounder stock, its habitat and fisheries, and explain the rationale for management efforts to sustain the stock.
5. Address social and economic concerns of all user groups, including issues such as user conflicts.
6. Promote the protection, restoration, and enhancement of habitats and environmental quality for the conservation of the southern flounder population.

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7. Initiate, enhance, and/or continue studies to improve the understanding of southern flounder population ecology and dynamics.
8. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the southern flounder fishery.

STATUS OF THE STOCK

Life History

Southern flounder (*Paralichthys lethostigma*) are a bottom dwelling species of the left eyed flounder family found in the Atlantic Ocean and estuaries from northern Mexico to Virginia. This species is one of three commonly caught left eyed flounder in North Carolina; Southern flounder, Gulf flounder (*Paralichthys albigutta*), and Summer flounder (*Paralichthys dentatus*). This species supports important commercial and recreational fisheries along the U.S. South Atlantic and Gulf coasts and are particularly important to fisheries in North Carolina. The biological unit stock for southern flounder inhabiting North Carolina waters may include fish from other southern states based on evidence from tagging and genetic studies, as well as differences in aging structures, which indicate one single unit stock of southern flounder from North Carolina to Florida. Evidence also suggests some adult southern flounder return to the estuaries after spawning in the ocean, while others remain in the ocean. Tagged fish are typically recaptured south of original tagging locations and often in other states once in the ocean. Limited data from South Carolina and Georgia tagging programs suggest a low probability of adult movement from South Carolina or Georgia to North Carolina waters.

Data collected from fall fisheries by the North Carolina Division of Marine Fisheries suggests that with the onset of maturity, fish of both sexes migrate out of inlets to ocean waters in the fall. Southern flounder can produce approximately 3 million eggs per female in multiple spawning events in a season, and spawning is thought to take place between November and April. Larval southern flounder pass through inlets within 30 to 45 days of hatching and settle throughout the sounds and rivers in the winter and early spring. Nearly half of female flounder are thought to be mature by ages 1 and 2 (at approximately 16 inches). Fish collected in the ocean tend to be larger and older with females attaining larger sizes. The largest southern flounder observed in North Carolina was a 33 inch long female and a 20 inch long male. The maximum observed age was 9 for a female and 9 for a male; southern flounder captured in North Carolina represent the oldest ages observed throughout the species range.

Juvenile and adult southern flounder are bottom dwelling and typically feed by camouflaging themselves and ambushing their prey with a quick upward lunge. Southern flounder diets switch to fish when they are between 3 and 4 inches long. Adult southern flounder feed almost exclusively on other fish, but will consume shrimp as well.

Stock Status

Following the recommendation of the peer review panel, the southern flounder working group recommended that the stock size threshold and target be defined in terms of Spawning Stock Biomass (SSB) associated with the fishing mortality target and threshold. Based on the results of the January 2018 stock assessment, the probability that fishing mortality in 2015 is above the

STATE-MANAGED SPECIES – SOUTHERN FLOUNDER

threshold value of 0.46 is 53%, whereas there is a 95% chance the fishing mortality in 2015 is above the target value of 0.31. The probability that the SSB in 2015 is below the threshold or target value (3,984 and 5,411 mt, respectively) is 100%. Therefore, the current status of the southern flounder stock is overfished and overfishing is occurring.

Stock Assessment

The 2009 stock assessment used a statistical catch-at-age model run using the Age Structured Assessment Program (Takade 2009). Results showed the stock to be overfished with overfishing occurring throughout the time series. These were the most recent assessment results included in Amendment 1. The 2014 Southern Flounder Stock Assessment used a statistical catch-at-age model run using Stock Synthesis (NCDMF 2015). Upon review of the assessment, external peer reviewers and the NCDMF determined the model could not fully account for stock mixing during spawning, nor quantify migration of southern flounder to and from North Carolina waters. Consequently, the assessment was not accepted for determining stock status. As a result, a multistate southern flounder stock assessment was developed and included data and expertise of state agency staff from North Carolina, South Carolina, Georgia, and Florida, as well as researchers from the University of North Carolina at Wilmington and Louisiana State University. The multistate assessment was an attempt to further address the geographical distribution of the unit stock and was peer reviewed in December 2017. This assessment used a statistical catch-at-age model run using the Age Structured Assessment Program (Lee et. al. 2018). The Southern Flounder Review Panel accepted the pooled-sex run of the ASAP model presented at the Review Workshop and was approved as a valid basis of management for at least the next five years, with the expectation that the model will be updated with data through 2017 to provide the best, most up to date estimate of stock status for management. The reviewers also noted that management advice based on the 2015 terminal year would be out of date by the time it could be implemented and that expected changes to recreational catch estimates (MRIP) should be incorporated into the assessment model and management response. Moving forward, the division's intent is to update the approved ASAP pooled-sex model using data through 2017 with the expectation that the updated model be completed by the fall of 2018. The division also plans to include updated MRIP estimates if they are available as scheduled in July.

STATUS OF THE FISHERY

Current Regulations

Commercial: 15-inches total length (TL) minimum size limit in internal and ocean waters, 6 ISM minimum mesh size for gill nets, closed season in internal waters from December 1-31; no trip limits in internal waters and a 100 pound trip limit in ocean waters unless the individual has a License to Land Flounder from the Atlantic Ocean.

Recreational: 15-inches TL minimum size limit, four-fish creel limit for all joint and coastal waters, and year-round season.

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At the NCMFC's November 2015 business meeting they adopted a supplement to the FMP which instituted several new rule changes effective January 1, 2016. Please check the NCDMF's website for a summary of the actions <http://portal.ncdenr.org/web/mf/nr-50-2015-mfc-flounder>.

Commercial Landings

All landings reported as caught in inshore waters are considered to be southern flounder by the NCDMF Trip Ticket Program. Most southern flounder landings are from gill nets and pound nets, although gigs and other inshore gears (e.g., trawls) catch flounder in smaller numbers. Historically, pound nets were the dominant gear but landings from gill nets were higher in 1994-2013 (Figure 1). Peak commercial landings occurred in 1994. Since 1994, pound net landings decreased greatly, while gill net landings remained relatively high until 2010. Decreases in gill net landings from 2010 to 2012 were mainly due to lower landings in the Albemarle Sound. The Sea Turtle Settlement Agreement (2010) added regulations to gill nets in portions of the state, resulting in lower effort in many areas, however, the Albemarle Sound was mostly unaffected by these regulations. The Albemarle Sound is typically where the majority of southern flounder gill net harvest occurs. In 2013, gill net harvest increased greatly in the Albemarle Sound, but decreased in Pamlico Sound and Core Sound; pound net landings also increased greatly in 2013. Since 2014, gill net harvest has decreased in all areas of the state, especially in the Albemarle Sound due to widespread gill net closures to avoid catches of red drum and closures due to protected species interactions. Pound net harvest surpassed gill net harvest 2014 through 2017 (Figure 1). Gig harvest of southern flounder has generally increased, especially since 2010. Harvest by other commercial gears has generally decreased to its lowest point in 2017 and currently makes up a small portion of commercial harvest. Commercial harvest is the highest in fall months.

Trends in commercial trips have generally followed landings trends (Figure 2). Trips include the number of trip ticket records with landings reported; some trips may represent more than one day of fishing. The majority of trips that harvest flounder are from gill nets. Gill net trips have been variable around a decreasing trend since 2010. Pound net trips were decreasing until 2002, since they have been variable on a lower level. Giggling trips have been variable around an increasing trend since 2010.

Recreational Landings

Recreational harvest of southern flounder is mainly by hook and line and gigs, with a small amount of harvest by spearfishing or Recreational Commercial Gear License (RCGL) gears. NCDMF does not have information on long-term trends of the gig fishery. This is because the Marine Recreational Information Program (MRIP) rarely encounters gig fishermen. A DMF mail-based survey of giggling that began in 2010 indicates the gig harvest from 2010-2017 averaged 23% of the recreational harvest (with hook and line harvest making up the remainder). Hook and line harvest can be split into ocean and inshore harvest, with most southern flounder harvested inshore (Figure 3). Hook and line harvest peaked in 2010. Recreational harvest is highest during summer months.

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Trends in recreational trips are somewhat difficult to interpret because they represent all paralicthid flounder species commonly caught in North Carolina (southern, summer and Gulf). This is because anglers simply report targeting ‘flounder’ rather than a particular species of flounder. Trips can be defined in several ways, but in this document all trips that harvested or released any paralicthid flounder species were included. Trends in trips and harvest are roughly similar throughout most of the time-series, but trips have been declining since 2013 while harvest has been variable. (Figure 4).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored through fishery-dependent sampling conducted by the division since 1982. Data collected in this program allow the size and age distribution of southern flounder to be characterized by gear/fishery. Several NCDMF sampling programs collect biological data on commercial and recreational fisheries that catch southern flounder. The primary programs that collect length and age data for harvested southern flounder include: 461 (gill net and seine), 476 (gig and spear), 432 (pound net) and 437 (long haul seine). Programs 466 and 570 collect length data on harvested and discarded flounder. Other commercial sampling programs focusing on fisheries that do not target southern flounder rarely collect biological data. The NCDMF sampling of the recreational fishery through the MRIP collects length data on southern flounder. The NCDMF mail-based gigging survey collects harvest data for the recreational gig fishery, but does not collect length or age data. Age data from the recreational fishery are collected mainly via voluntary angler donations through the NCDMF Carcass Collection Program.

There were no clear trends in commercial length and age data from 2005 to 2017 (Table 1). Annual mean lengths were fairly consistent; however, an increase in mean length was observed due to the 2016 change in minimum commercial size regulation, increasing to 15-inches.

There were no clear trends in recreational length data from 2005 to 2017 (Table 2). Annual mean lengths were fairly consistent and 2017 was similar to previous years.

Fishery-Independent Monitoring

Several NCDMF independent sampling programs collect biological data on southern flounder. The primary surveys that collect length data for southern flounder and that were evaluated as indices of abundance in recent stock assessments were: 120 (Estuarine Trawl Survey), 195 (Pamlico Sound Survey), 135 (Albemarle Sound Independent Gill Net Survey and 915 (Pamlico Sound Independent Gill Net Survey). Age data primarily is collected in Program 915, although the other three surveys do collect age data. Methodology for analyzing trends in catch-per-unit-effort (CPUE) for each survey changed with the 2018 stock assessment when generalized linear models (GLMs) were used to calculate relative yearly abundance index values. These indices were not updated for this report, as an update to the stock assessment is under way and final GLM values have not been finalized. As a result, nominal CPUE values have been include in this report.

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There were no clear trends in fishery-independent length and age data from 2005 to 2017 (Table 3). Annual mean lengths were fairly consistent and 2016 had the second largest mean length in the time-series. However, the number of fish measured in 2016 was the lowest of any year from 2005 to 2017.

Data collected by Program 915 were used for an index of general (juvenile and adult) abundance in the January 2018 stock assessment. The survey is designed to characterize the size and age distribution for key estuarine species in Pamlico Sound and its major river tributaries. Sampling began in Pamlico Sound in 2001 and was expanded to the current sampling area (including tributaries) in 2003. Each array of nets consists of floating gill nets in 30-yard segments of 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, and 6.5-inch stretched mesh, for a total of 240 yards of nets. Catches from an array of gill nets comprise a single sample; two samples (one shallow, one deep) totaling 480 yards of gill net are completed each trip. Gill nets are typically deployed within an hour of sunset and fished the following morning. Efforts are made to keep all soak times within 12 hours. All gill nets are constructed with a hanging ratio of 2:1. Gill net sets are determined using a random stratified survey design, based on area and water depth. Each region is overlaid with a one-minute by one-minute grid system (equivalent to one square nautical mile) and delineated into shallow (less than six feet) and deep (greater than six feet) strata. Deep strata were not included in data analysis for this report. Sampling in Pamlico Sound is divided into two regions: Region 1, which includes areas of eastern Pamlico Sound adjacent to the Outer Banks from southern Roanoke Island to the northern end of Portsmouth Island; and Region 2, which includes Hyde County bays from Stumpy Point Bay to Abel's Bay and adjacent areas of western Pamlico Sound. Each of the two regions is further stratified into four similar sized areas, denoted by either Hyde or Dare and numbers one through four. The rivers are divided into four areas in the Neuse River, three areas in the Pamlico River, and one area for the Pungo River. Although the survey is conducted in all months except January, only July-September data were used to analyze CPUE trends because these months had the peak catches of southern flounder. The survey was expanded to include areas in the southern portion of the state in 2008, but these data were not analyzed for the index due to the short time-series. The abundance index for Program 915 peaked in 2010 and the low point was in 2016 for the time-series analyzed (2003-2017) and has a decreasing trend (Table 4; Figure 5).

Data collected by Program 135 was not used as an index of general (juvenile and adult) abundance in the January 2018 stock assessment but continues to provide an additional data source to monitor trends in the population. Beginning in 1990, Program 135 has conducted gill net sets in waters of Albemarle Sound. The survey was designed to monitor the striped bass population. The survey follows a random stratified design, stratified by geographic area. This survey divides the Albemarle region into six sample zones that are further subdivided into one-mile square quadrants with an average of 22 quadrants per zone. Four arrays of twelve meshes (2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 8.0, 10.0-inch stretch) of gill nets are set in each quadrant by the fishing crew, two arrays are sinking gill nets and two are floating. One unit of effort is defined as each 40-yard net fished for 24 hours. The abundance index for Program 135 peaked in 1992 and the low points were in 2011, 2016 and 2017 for the time-series analyzed (1991-2017; Table 4; Figure 5).

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Data collected by Program 120 were used for a Juvenile Abundance Index (JAI) in the January 2018 stock assessment. The Estuarine Trawl Survey (Program 120) is a fishery-independent multispecies monitoring program that has been ongoing since 1971 in the months of May and June. One of the key objectives of this program is to provide a long-term data base of annual juvenile recruitment for economically important species. This survey samples fixed stations, a set of 104 core stations with additional stations as needed. The core stations are sampled from western Albemarle Sound south through the South Carolina border each year without deviation one sample for each station each month during the months of May and June. This survey targets juvenile finfish, blue crabs, and Penaeid shrimp. A two-seam 10 and one-half foot headrope trawl with a one-fourth inch mesh in the body and one-eighth inch mesh in the tailbag is used. A one-minute tow is conducted covering a distance of 75 yards. All species collected are sorted, identified, and a total number is recorded for each species. For target species, a subset of at least 30 to 60 individuals is measured. Environmental data is collected, including salinity, dissolved oxygen, temperature, wind speed and direction. Data from this survey were used to produce a southern flounder JAI from 1991 to 2017. The JAI for Program 120 peaked in 1996 and the low point was in 2016 for the time-series analyzed (1991-2017) and shows a variable trend (Table 4; Figure 6).

Data collected by Program 195 were not used as a JAI in the January 2018 stock assessment but continues to provide an additional data source to monitor trends in the population. Program 195 conducts trawls using a random-stratified survey design in waters of Pamlico Sound and major river tributaries in June and September. Only data from September were used for the JAI in the 2014 stock assessment. Stations are randomly selected from strata based upon depth and geographic location. Randomly selected stations are optimally allocated among the strata based upon all previous sampling in order to provide the most accurate abundance estimates (PSE <20). Tow duration is 20 minutes; using double rigged demersal mongoose trawls (9.1m headrope, 1.0m X 0.6m doors, 2.2-cm bar mesh body, 1.9-cm bar mesh cod end and a 100-mesh tailbag extension. Data from this survey were used to produce a southern flounder JAI from 1991 to 2017. The JAI for Program 195 peaked in 1996 and the low point was in 1998 for the time-series analyzed (1991-2017; Table 4; Figure 6).

MANAGEMENT STRATEGY

Until Amendment 2 is approved for management by the MFC, Southern flounder are managed under Amendment 1 and Supplement A to Amendment 1 to the Southern Flounder FMP, adopted in February 2013. Amendment 1 established the threshold SPR of 25% and the target SPR of 35% and implemented management measures for the commercial and recreational fisheries (Table 5). Actions to achieve sustainable harvest in Amendment 1 include: 1) accept management measures to reduce protected species interactions as the management strategy for achieving sustainable harvest in the commercial southern flounder fishery; 2) increase the recreational minimum size limit to 15 inches and decrease the creel limit to six-fish. Since the adoption of Amendment 1, the 2014 Southern Flounder Stock Assessment was completed. Upon review of the assessment, external peer reviewers and the NCDMF determined the model could not fully account for stock mixing during spawning and quantify migration of southern flounder to and from North Carolina waters. Consequently, the assessment was not accepted for determining stock status. Due to concerns for the health of the stock based on abundance trends

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and the percentage of immature fish in the harvest, in February 2015 the NCMFC requested a supplement be developed for reducing harvest in the southern flounder fishery.

Supplement A to Amendment 1 was approved at the November 2015 MFC business meeting. Management actions approved included: 1) increasing the minimum commercial size limit to 15 inches; 2) increasing the minimum mesh size for gill nets to 6 ISM; 3) closing the commercial gill net and recreational fisheries on October 15; 4) closing the commercial gig fishery once the pound net fishery closes, a 38% reduction to the pound net fishery based on the 2011-2015 average landings; and 5) an increase to five and three-quarter inch escape panels. All management actions were effective January 1, 2016. However, an injunction was granted in October 2016, preventing the NCDMF from enacting some of the management actions. The commercial gill net and recreational closure on October 15, the commercial closure of the gig fishery, and monitoring the 38% reduction in pound net landings based on the 2011-2015 average did not occur.

RESEARCH NEEDS

The management strategies and implementation status from Amendment 1 and Supplement A of the N.C. Southern Flounder FMP can be found in Table 5. The following research recommendations were included in Amendment 1; status of need is provided in parentheses:

- Investigate the feasibility of a quota as a management tool for the commercial southern flounder fishery (underway).
- Annual survey of the recreational gig fishery (mail-based survey underway, dockside survey still needed).
- Further research on southern flounder that remain in the ocean after the spawning season (tagging studies underway, but other studies may be needed).
- Determine the exact locations of spawning aggregations of southern flounder in the ocean (tagging studies underway, but other studies may be needed).
- Continued otolith microchemistry research to gain a better understanding of ocean residency of southern flounder (more research needed).
- Tagging study of southern flounder in the ocean to gain a better understanding of migration patterns into the estuaries (underway).
- Update the southern flounder maturity schedule (completed).
- Fishery dependent sampling of the commercial spear fishery for flounder in the ocean (some sampling done under NCDMF sampling, but more may be needed).
- Harvest estimates and fishery dependent sampling of the recreational spear fishery for flounder in the ocean (not done except what MRIP encounters).
- Increased fish house sampling of the Currituck Sound flounder gill net and pound net fisheries (sampling has increased, more may be needed).
- Increased at-sea observer trips with gill netters and pound netters in Currituck Sound (underway for gill nets, pound net observing needed).
- Reestablish a RCGL survey to obtain harvest, discard, and effort information (needed).
- Establish an at-sea observer program of the RCGL fishery (needed).
- Formulate a bycatch estimate of southern flounder from crab pots (more research needed).

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- Further research on degradable materials to determine which material works best in a given water body and how other parameters, such as microbial activities and the effects of light penetration impact degradation rates and performance of the crab pot (progress unknown).
- Further research on flatfish escapement devices that minimize undersized flounder bycatch and maximize the retention of marketable blue crabs (needed).
- Further research on factors that impact release mortality of southern flounder in the recreational hook and line fishery (more research needed).
- Research on deep hooking events of different hook types and sizes on southern flounder (needed)
- Population dynamics research for all Atlantic protected species (some research completed, more is needed).
- Continued gear research in the design of gill nets and pound nets to minimize protected species interactions (some research completed, more may be needed).
- Development of alternative gears to catch southern flounder (some research completed, more may be needed).
- Further research on the size distribution of southern flounder retained in pound nets with 5.75-inch and 6-inch escape panels (some research completed, more is needed).
- Research on the species composition and size distribution of fish and crustaceans that escape pound nets through 5.75-inch and 6-inch escape panels (some research completed, more is needed).
- Coast wide at-sea observations of the flounder pound net fishery (needed).
- Discard mortality estimates of southern flounder from pound nets (needed).
- Continue at-sea observations of the large mesh gill net fishery, especially outside of the PSGNRA, including acquiring biological data on harvest and discards (underway).
- Increase the number of large mesh gill net catches sampled in areas such as Albemarle Sound and the Newport River (sampling has increased, more may be needed).

Research recommendations from the January 2018 stock assessment:

- Develop a survey that will provide estimates of harvest and discards for the recreational gig fisheries in North Carolina, South Carolina, Georgia, and Florida
- Conduct sampling of the commercial and recreational ocean spear fishery harvest and discards
- Develop a survey that will estimate harvest and discards from commercial gears used for recreational purposes
- Develop a survey that will provide estimates of harvest and discards from gears used to capture southern flounder for personal consumption
- Improve estimates of the B2 component (catches, lengths, and ages) for southern flounder from the MRIP
- Collect additional discard data (ages, species ratio, lengths, fates) from other gears (in addition to gill nets) targeting southern flounder (pound net, gigs, hook-and-line, trawls)
- Develop and implement consistent strategies for collecting age and sex samples from commercial and recreational fisheries and fisheries-independent surveys to achieve desired precision for stock assessment
- Complete an age validation study using known age fish

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- Implement a tagging study to estimate emigration, movement rates, and mortality rates throughout the stock's range
- Expand, improve, or add inshore and offshore surveys of southern flounder to develop indices for future stock assessments
- Expand, improve, or add fisheries-independent surveys of the ocean component of the stock
- Collect age and maturity data from the fisheries-independent SEAMAP Trawl Survey given its broad spatial scale and potential to characterize offshore fish
- Conduct studies to better understand ocean residency of southern flounder
- Determine locations of spawning aggregations of southern flounder
- Develop protocol for archiving and sharing data on gonads for microscopic observation of maturity stage of southern flounder for North Carolina, South Carolina, Georgia, and Florida
- Examine the variability of southern flounder maturity across its range and the effects this may have on the assessment model
- Investigate how environmental factors (wind, salinity, temperatures, or oscillations) may be driving the stock-recruitment dynamics for southern flounder
- Promote data sharing and research cooperation across the South Atlantic southern flounder range (North Carolina, South Carolina, Georgia, and Florida)
- Consider the application of areas-as-fleets models in future stock assessments given the potential spatial variation (among states) in fishery selectivity and fleet behavior in the southern flounder fishery
- Consider the application of a spatial model to account for inshore and ocean components of the stock as well as movements among states

The peer review panel concluded that the working group's research recommendations were appropriate and endorsed all of them. In addition to identifying some research needs as high priority, the peer review panel offered the following additional research recommendations:

- Conduct studies to quantify fecundity and fecundity-size/age relationships in Atlantic southern flounder
- Work to reconcile different state-level/regional surveys to better explain differences in trends
- Develop a recreational CPUE (e.g., from MRIP intercepts or the Southeast Regional Headboat Survey if sufficient catches are available using a species guild approach to identify trips, from headboat logbooks, etc.) as a complement to the more localized fishery independent indices
- Explore reconstructing historical catch and catch-at-length data prior to 1989 to provide more contrast in the removals data
- Study potential species interactions among Paralichthid flounders to explain differences in population trends where they overlap

FISHERY MANAGEMENT PLAN RECOMMENDATION

At its August 2015 business meeting the NCMFC approved the FMP schedule that maintained the timeline for a scheduled review of the southern flounder FMP to begin in 2018.

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At its Aug. 18, 2016 business meeting, the NCMFC approved a motion to begin the review of the FMP as soon as a valid stock assessment is available. A coastwide stock assessment for southern flounder, including data from North Carolina, South Carolina, Georgia, and Florida, was completed in January 2018 with an update expected to be completed during the fall of 2018. This update is a necessary result of an external peer review of the January 2018 stock assessment conducted in December 2017.

LITERATURE CITED

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- NCDMF (North Carolina Division of Marine Fisheries). 2015. Stock Assessment of Southern Flounder, *Paralichthys lethostigma*, in North Carolina Waters. North Carolina Department of Environment and Natural Resources. North Carolina Division of Marine Fisheries. SAP-SAR-2015-01. 297 pp.
- Lee, L.M., S.D. Allen, A.M. Flowers, and Y. Li (editors). 2018. Stock assessment of southern flounder (*Paralichthys lethostigma*) in the South Atlantic, 1989–2015. Joint report of the North Carolina Division of Marine Fisheries, South Carolina Department of Natural Resources, Georgia Coastal Resources Division, Florida Fish and Wildlife Research Institute, University of North Carolina at Wilmington, and Louisiana State University. NCDMF SAP-SAR-2018-01. 425 p.

TABLES

Table 1. Southern flounder total length (mm) and age data for NCDMF commercial fishery sampling programs (includes harvest and some discard information).

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured | Modal Age | Minimum Age | Maximum Age | Total Aged |
|------|-------------|----------------|----------------|----------------|-----------|-------------|-------------|------------|
| 2005 | 402 | 46 | 793 | 28,972 | 2 | 0 | 7 | 83 |
| 2006 | 414 | 131 | 796 | 39,572 | 3 | 0 | 6 | 80 |
| 2007 | 413 | 90 | 745 | 23,768 | 2 | 0 | 5 | 94 |
| 2008 | 404 | 38 | 710 | 39,302 | 2 | 0 | 7 | 212 |
| 2009 | 405 | 92 | 719 | 33,403 | 2 | 1 | 6 | 34 |
| 2010 | 415 | 130 | 724 | 27,176 | 2 | 1 | 5 | 33 |
| 2011 | 409 | 123 | 770 | 32,000 | 3 | 1 | 6 | 90 |
| 2012 | 408 | 100 | 756 | 29,865 | 2 | 0 | 6 | 38 |
| 2013 | 399 | 16 | 804 | 33,776 | 1 | 1 | 5 | 245 |
| 2014 | 403 | 21 | 721 | 26,354 | 2 | 0 | 4 | 408 |
| 2015 | 403 | 51 | 754 | 19,717 | 1 | 0 | 5 | 330 |
| 2016 | 421 | 141 | 696 | 14,712 | 0 | 0 | 4 | 246 |
| 2017 | 421 | 86 | 770 | 14,775 | 0 | 0 | 5 | 418 |

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Table 2. Southern flounder total length (mm) and age data for NCDMF recreational fishery sampling.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured | Modal Age | Minimum Age | Maximum Age | Total Aged |
|------|-------------|----------------|----------------|----------------|-----------|-------------|-------------|------------|
| 2005 | 433 | 334 | 672 | 202 | 3 | 1 | 6 | 112 |
| 2006 | 427 | 246 | 789 | 343 | 3 | 1 | 6 | 188 |
| 2007 | 437 | 355 | 610 | 220 | 2 | 1 | 8 | 137 |
| 2008 | 441 | 338 | 698 | 311 | 3 | 1 | 6 | 79 |
| 2009 | 431 | 304 | 661 | 306 | 2 | 1 | 4 | 45 |
| 2010 | 429 | 270 | 710 | 754 | 2 | 1 | 7 | 127 |
| 2011 | 447 | 347 | 651 | 478 | 2 | 1 | 6 | 91 |
| 2012 | 449 | 361 | 758 | 400 | 2 | 1 | 6 | 57 |
| 2013 | 440 | 338 | 695 | 390 | 3 | 1 | 5 | 47 |
| 2014 | 432 | 347 | 654 | 198 | 2 | 1 | 7 | 42 |
| 2015 | 439 | 365 | 615 | 175 | 3 | 1 | 6 | 36 |
| 2016 | 442 | 363 | 628 | 224 | 2 | 0 | 5 | 123 |
| 2017 | 426 | 350 | 665 | 215 | 2 | 0 | 7 | 140 |

Table 3. Southern flounder total length (mm) and age data for NCDMF fishery-independent sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured | Modal Age | Minimum Age | Maximum Age | Total Aged |
|------|-------------|----------------|----------------|----------------|-----------|-------------|-------------|------------|
| 2005 | 198 | 7 | 644 | 3,769 | 2 | 0 | 4 | 516 |
| 2006 | 219 | 12 | 583 | 3,560 | 3 | 0 | 4 | 539 |
| 2007 | 190 | 12 | 570 | 3,812 | 1 | 0 | 5 | 513 |
| 2008 | 242 | 7 | 680 | 4,270 | 1 | 0 | 5 | 816 |
| 2009 | 251 | 24 | 689 | 3,230 | 1 | 0 | 5 | 414 |
| 2010 | 227 | 13 | 583 | 4,168 | 1 | 0 | 5 | 1,072 |
| 2011 | 294 | 26 | 712 | 2,604 | 1 | 0 | 6 | 720 |
| 2012 | 258 | 30 | 655 | 4,878 | 1 | 0 | 3 | 1,112 |
| 2013 | 229 | 20 | 684 | 3,534 | 1 | 0 | 6 | 678 |
| 2014 | 236 | 22 | 634 | 2,339 | 1 | 0 | 3 | 802 |
| 2015 | 230 | 21 | 622 | 2,133 | 1 | 0 | 3 | 463 |
| 2016 | 270 | 42 | 765 | 1,426 | 1 | 0 | 3 | 404 |
| 2017 | 236 | 35 | 571 | 2,238 | 1 | 0 | 3 | 620 |

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Table 4. Annual nominal abundance index values for southern flounder as catch per unit effort and standard error (SE) in N.C. Division of Marine Fisheries independent surveys (programs 120, 195, 135 and 915). Indices for programs 120 and 195 are considered juvenile (young-of-year) abundance indices.

| Year | P915 Index | P915 SE | P135 Index | P135 SE | P195 Index | P195 SE | P120 Index | P120 SE |
|------|---------------|------------|---------------|------------|---------------|------------|---------------|------------|
| 1991 | | | 0.17 | 0.01 | 0.6 | 0.2 | 1.13 | 0.17 |
| 1992 | | | 0.18 | 0.02 | 4.83 | 1.3 | 2.49 | 0.30 |
| 1993 | | | 0.15 | 0.01 | 3.81 | 1.1 | 2.93 | 0.38 |
| 1994 | | | 0.08 | 0.01 | 3.33 | 1.2 | 1.79 | 0.24 |
| 1995 | | | 0.11 | 0.01 | 2.83 | 0.7 | 1.69 | 0.24 |
| 1996 | | | 0.03 | 0 | 9.65 | 2.0 | 7.82 | 0.95 |
| 1997 | | | 0.1 | 0.01 | 3.1 | 0.8 | 2.74 | 0.29 |
| 1998 | | | 0.08 | 0.01 | 0.37 | 0.1 | 0.90 | 0.15 |
| 1999 | | | 0.04 | 0 | 1.91 | 0.5 | 2.49 | 0.30 |
| 2000 | | | 0.05 | 0.01 | 0.77 | 0.2 | 3.74 | 0.43 |
| 2001 | | | 0.1 | 0.01 | 0.82 | 0.3 | 4.38 | 0.46 |
| 2002 | | | 0.14 | 0.01 | 3.28 | 1.5 | 4.49 | 0.56 |
| 2003 | 3.41 | 0.35 | 0.03 | 0 | 2.94 | 0.8 | 6.31 | 1.01 |
| 2004 | 3.11 | 0.34 | 0.09 | 0.01 | 1.28 | 0.2 | 3.89 | 0.46 |
| 2005 | 2.64 | 0.25 | 0.08 | 0.01 | 3.25 | 1.0 | 3.05 | 0.38 |
| 2006 | 1.84 | 0.29 | 0.13 | 0.01 | 1 | 0.3 | 2.63 | 0.33 |
| 2007 | 1.44 | 0.17 | 0.16 | 0.01 | 1.07 | 0.3 | 3.64 | 0.39 |
| 2008 | 2.97 | 0.35 | 0.17 | 0.01 | 0.94 | 0.5 | 2.40 | 0.33 |
| 2009 | 2.04 | 0.27 | 0.12 | 0.01 | 1.28 | 0.3 | 1.93 | 0.26 |
| 2010 | 3.57 | 0.46 | 0.05 | 0.01 | 1.14 | 0.3 | 5.03 | 0.66 |
| 2011 | 2.33 | 0.35 | 0.02 | 0 | 0.6 | 0.2 | 1.09 | 0.19 |
| 2012 | 2.22 | 0.22 | 0.08 | 0.01 | 4.44 | 1.9 | 3.07 | 0.39 |
| 2013 | 2.57 | 0.24 | 0.1 | 0.01 | 1.05 | 0.3 | 2.64 | 0.33 |
| 2014 | 1.81 | 0.19 | 0.05 | 0 | 0.64 | 0.2 | 1.86 | 0.30 |
| 2015 | 1.32 | 0.23 | 0.04 | 0 | 2.46 | 0.4 | 1.67 | 0.27 |
| 2016 | 1.14 | 0.15 | 0.02 | 0 | 0.73 | 0.3 | 0.53 | 0.11 |
| 2017 | 1.34 | 0.15 | 0.02 | 0 | 6.02 | 2.2 | 1.03 | 0.16 |

STATE-MANAGED SPECIES – SOUTHERN FLOUNDER

Table 5. Management action taken as a result of Amendment 1 and Supplement A to the Southern Flounder FMP.

| MANAGEMENT STRATEGY | OUTCOME |
|--|--|
| <p><u>Commercial</u>: Accept management measures to reduce protected species interactions as the management strategy for achieving sustainable harvest in the commercial southern flounder fishery. Specific minimum measures for the flounder gill net fishery are provided in Issue Paper 10.1.1 (page 129). <u>Recreational</u>: Increase the minimum size limit to 15 inches and decrease the creel limit to six fish-20.2% harvest reduction</p> | <p><u>Commercial</u>: No Action Required <u>Recreational</u>: Proclamation FF-29-2011 (refer to Supplement A to the 2005 FMP)</p> |
| <p>Status quo and address research recommendations</p> | <p>No Action Required</p> |
| <p>Status quo (implement mediation and proclamation authority to address user conflicts with large mesh gill nets)</p> | <p>No Action Required</p> |
| <p>Status quo (200-yard minimum distance between pound nets and gill nets)</p> | <p>No Action Required</p> |
| <p>Status quo and address research recommendations</p> | <p>No Action Required</p> |
| <p>Status quo and expand research on flatfish escape devices and degradable panels under commercial conditions to other parts of the state</p> | <p>No Action Required</p> |
| <p>Status quo and expand research on factors impacting the release mortality of southern flounder and on deep hooking events of different hook types and sizes</p> | <p>No Action Required</p> |
| <ul style="list-style-type: none"> • Request funding for state observer program • Apply for Incidental Take Permit for large mesh gill net fishery • Continue gear development research to minimize protected species interactions | <p>No Action Required</p> |
| <p>Status quo minimum mesh size for escape panels (5.5-inch stretched mesh) and recommend further research on 5.75-inch stretched mesh escape panels</p> | <p>No Action Required</p> |
| <p>Status quo minimum mesh size (5.5 inches stretched mesh)</p> | <p>No Action Required</p> |
| <p>Increase minimum mesh size to harvest southern flounder to 6.0-inch stretched mesh Increase minimum size limit for commercial fisheries to 15 inches</p> | <p>Proclamation FF-3-2016 (refer to Supplement A to Amendment 1 of the 2005 FMP)</p> |
| <p>Increase minimum mesh size for escape panels to 5.75-inch stretched mesh</p> | <p>Proclamation M-34-2015 (refer to Supplement A to Amendment 1 of the 2005 FMP)</p> |
| <p>Reduce daily bag limit for recreational harvest of southern flounder from 6 fish to 4 fish</p> | <p>Proclamation FF-4-2017 (refer to Addendum XXVIII to ASMFC Summer Flounder, Scup, Black seabass FMP)</p> |

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FIGURES

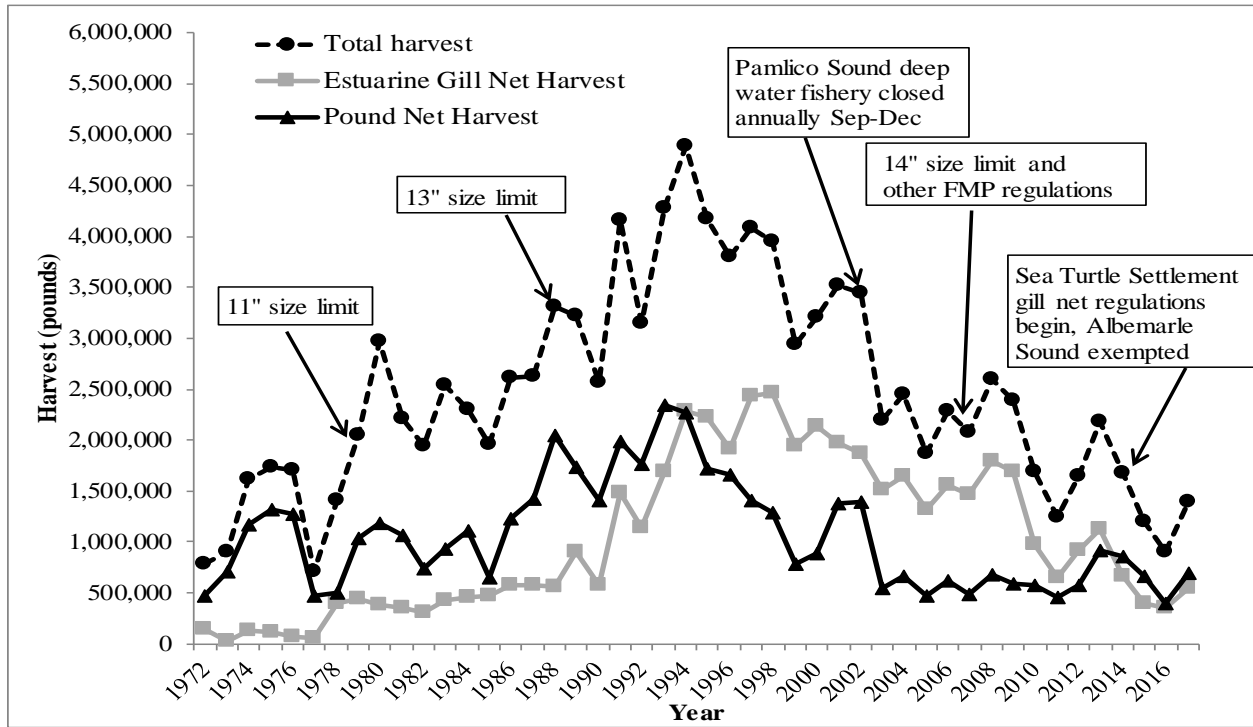


Figure 1. Southern flounder harvest (pounds) for total commercial fishery and top two gears (gill nets and pound nets) from N.C. Trip Ticket Program 1972-2017 with major fishery regulation changes.

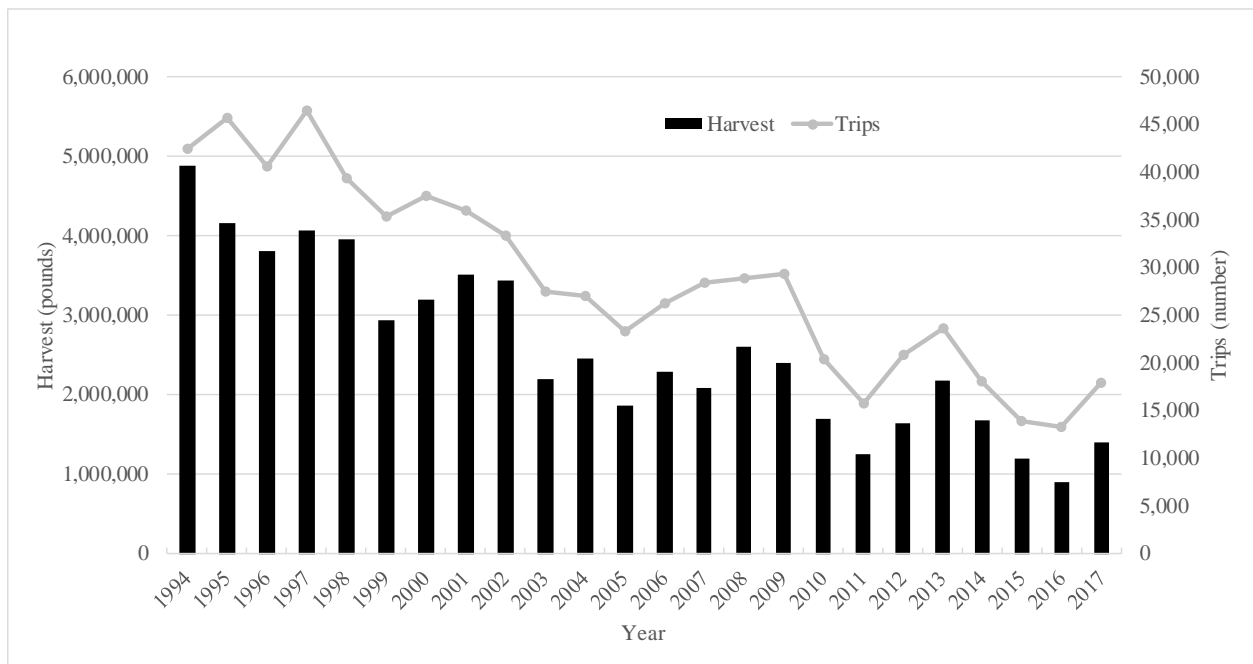


Figure 2. Southern flounder commercial trips (numbers) and harvest (pounds) from N.C. Trip Ticket Program, 1994-2017.

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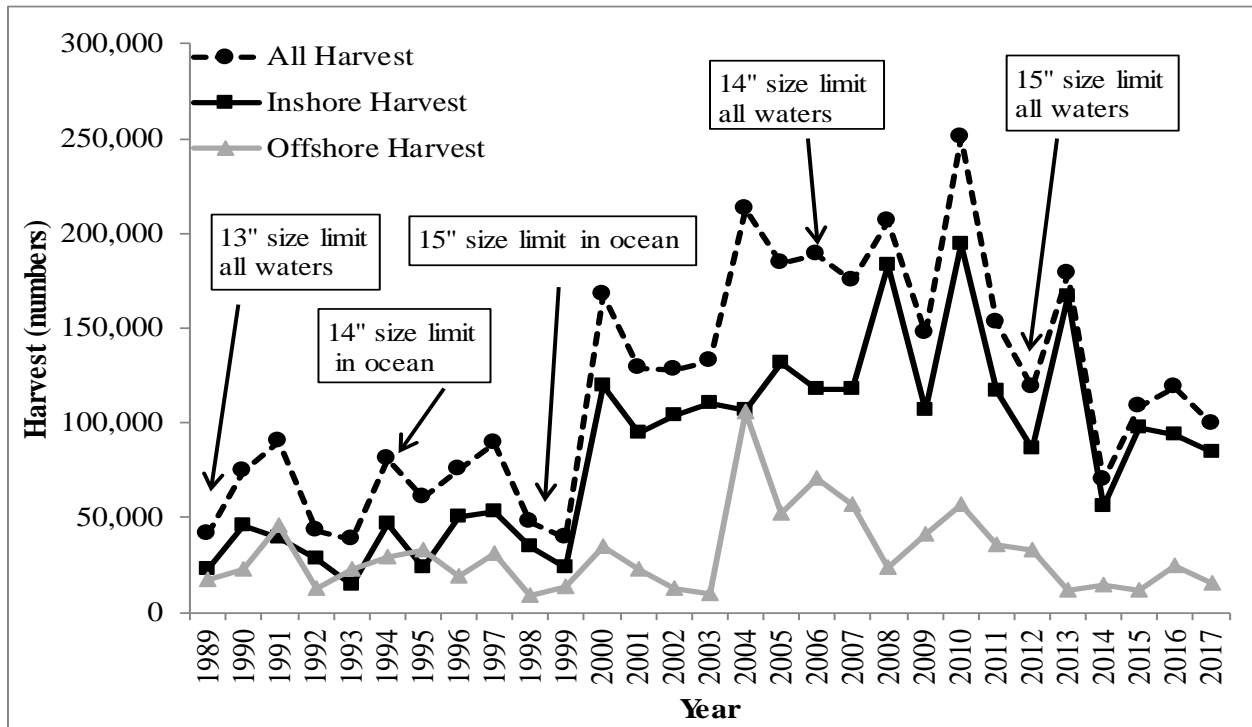


Figure 3. Southern flounder recreational hook and line harvest in numbers of fish from MRIP data 1989-2017 and major fishery regulation changes.

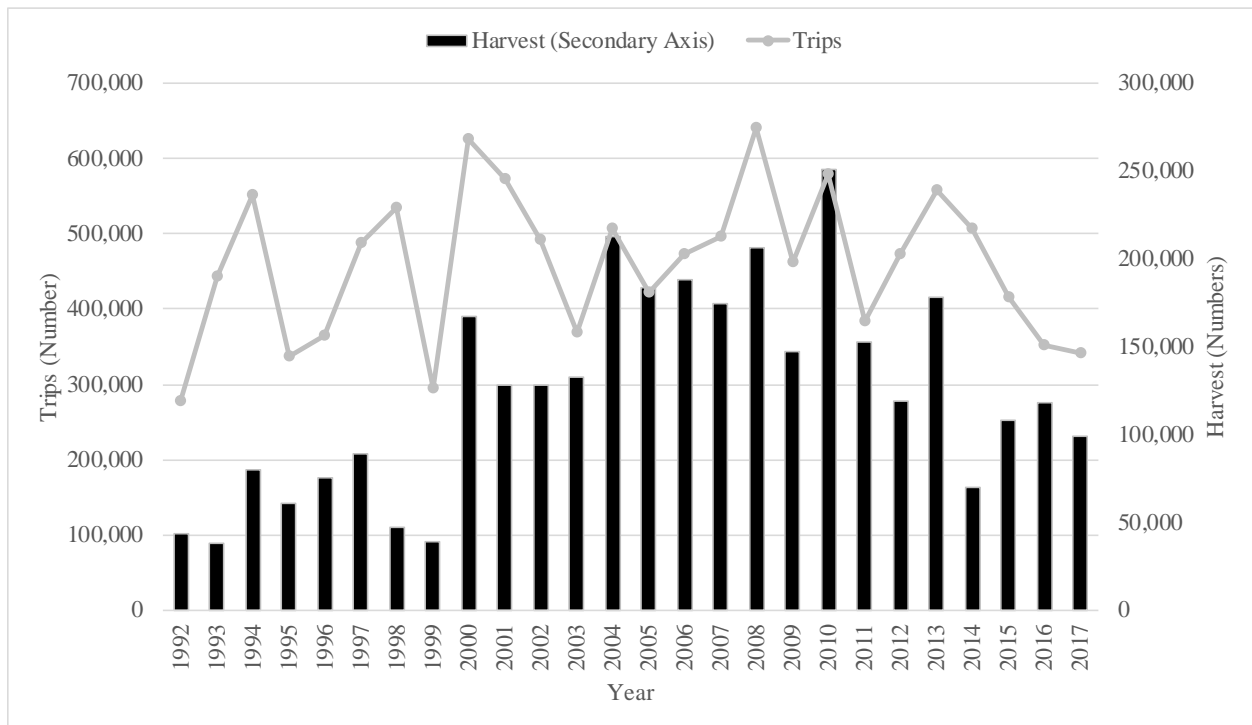


Figure 4. Recreational hook and line harvest (in numbers of fish) and all trips that harvested or released paralicthid flounder species, from MRIP data 1992-2017. Data from prior to 2004 were calibrated to align with MRIP estimates post-2004.

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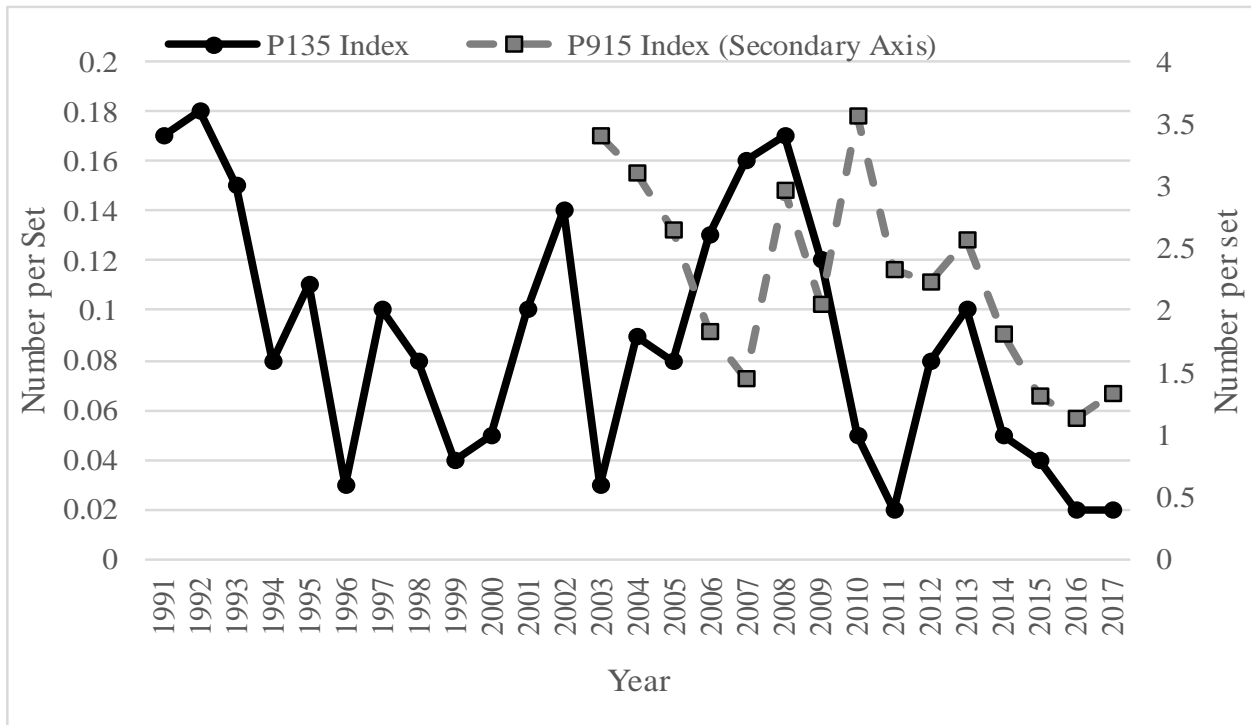


Figure 5. Annual nominal abundance index values for southern flounder (juveniles and adults) caught in the Pamlico Sound Independent Gill Net Survey (P915) and Striped Bass Independent Gill Net Survey (P135).

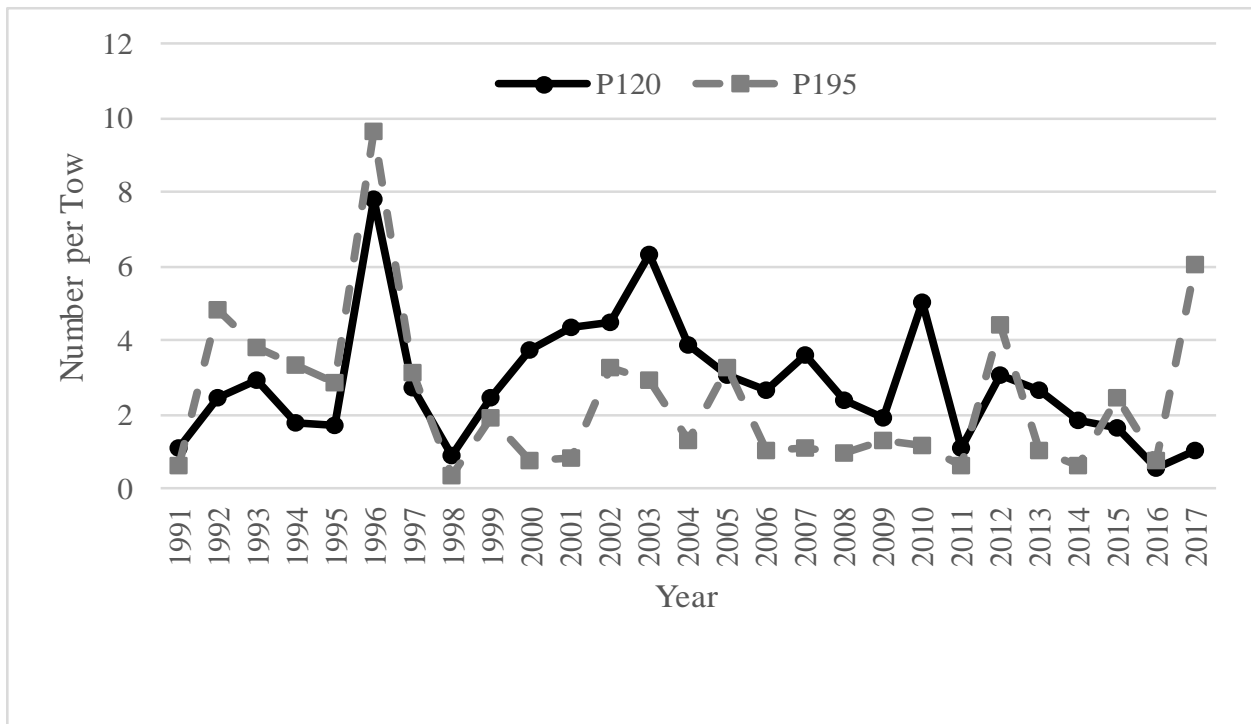


Figure 6. Annual nominal abundance index values for southern flounder (juveniles and adults) caught in the Pamlico Sound Survey (P195) and the Estuarine Trawl Survey (P120).

STATE-MANAGED SPECIES – SPOTTED SEATROUT

FISHERY MANAGEMENT PLAN UPDATE – SCHEDULE CHANGE RECOMMENDED SPOTTED SEATROUT AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | February 2012 |
| Amendments: | None |
| Revisions: | None |
| Supplements: | Supplement A to the 2012 FMP – February 2014 |
| Information Updates: | None |
| Schedule Changes: | N/A |
| Next Benchmark Review: | Late 2018 |

Spotted seatrout (*Cynoscion nebulosus*) are managed under the authority of two state and one interstate fishery management plans (FMP). The North Carolina Marine Fisheries Commission (NCMFC) currently manages spotted seatrout under the North Carolina Spotted Seatrout FMP (NCDMF 2012) and Supplement A to the 2012 FMP (NCDMF 2014a). Supplement A maintains short-term measures in the spotted seatrout fishery (40% reduction at 14-inch total length minimum size) to address several sources of uncertainty in the 2009 stock assessment through acquisition and assessment of additional data. This supplement examined sources of uncertainty in the assessment, the rationale for not implementing on schedule the North Carolina Spotted Seatrout FMP February 2014 management measures, and presented possible interim management measures. At the February 2014 NCMFC meeting the commission voted to maintain short-term management measures in the spotted seatrout fishery (Proclamation FF-38-2014: 14-inch minimum size, 75-fish commercial trip limit with weekend closures in joint waters except in Albemarle and Currituck sounds; Proclamation FF-39-2014: 14-inch minimum size, four-fish recreational bag limit). These measures will remain in effect until an amendment is completed.

As required in the approved 2012 FMP, a stock assessment was completed on schedule (2014-2015), peer reviewed, approved for management, and was presented to the NCMFC at its May 2015 business meeting. A new benchmark stock assessment will begin in late 2018 and incorporate data through the 2017 fishing year. The North Carolina Division of Marine Fisheries (NCDMF) is on schedule to review the current state FMP for spotted seatrout beginning in 2019 and determine if changes to management are needed through the FMP amendment process.

STATE-MANAGED SPECIES – SPOTTED SEATROUT

The Atlantic States Marine Fisheries Commission (ASMFC) manages spotted seatrout in all Atlantic States who have a declared interest in the species. In addition to the state FMP, the ASMFC manages spotted seatrout under the Omnibus Amendment to the Interstate Fishery Management Plans for Spanish Mackerel, Spot, and Spotted Seatrout (ASMFC 2011). The goals for the Omnibus Amendment are to bring the FMPs for the three species under the authority of the ASMFC Interstate Fishery Management Program Charter, and bringing compliance requirements to each state. Because the intent of the Omnibus amendment was to bring the ASMFC spotted seatrout FMP into compliance with the new ASMFC charter, management measures were not adjusted and the identified objectives and compliance requirements to the states of the Omnibus Amendment are the same as Amendment 1 to the ASMFC spotted seatrout FMP (ASMFC 1990) and are as follows:

- Manage the spotted seatrout fishery restricting catch to mature individuals (12-inch minimum size).
- Manage the spotted seatrout stock to maintain sufficiently-high spawning stock biomass (20% SPR).
- Develop research priorities that will further refine the spotted seatrout management program to maximize the biological, social, and economic benefits derived from the spotted seatrout population.

To ensure compliance with interstate requirements, North Carolina also manages this species 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).

Management Unit

The management unit for the North Carolina Spotted Seatrout FMP (NCDMF 2012) includes all spotted seatrout within the coastal and joint waters of North Carolina. The unit stock, or population unit, for North Carolina’s assessment of spotted seatrout include all spotted seatrout caught in North Carolina and Virginia. Virginia landings were included in the stock assessment of spotted seatrout because of the high rate of mixing observed between North Carolina and Virginia.

Goal and Objectives

The goal of the North Carolina Spotted Seatrout FMP (NCDMF 2012) is to determine the status of the stock and ensure long-term sustainability for the spotted seatrout stock in North Carolina. To achieve this goal, it is recommended that the following objectives be met:

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1. Develop an objective management program that provides conservation of the resource and sustainable harvest in the fishery.
2. Ensure the spawning stock is of sufficient capacity to prevent recruitment-overfishing.
3. Address socio-economic concerns of all user groups.
4. Restore, improve, and protect important habitats that affect growth, survival, and reproduction of the North Carolina spotted seatrout stock.
5. Evaluate, enhance, and initiate studies to increase understanding of spotted seatrout biology and population dynamics in North Carolina.
6. Promote public awareness regarding the status and management of the North Carolina spotted seatrout stock.

STATUS OF THE STOCK

Life history

Spotted seatrout range from Massachusetts to southern Florida and the Bahamas on the U.S. Atlantic Coast and continue through the Gulf of Mexico to the Yucatan Peninsula, Mexico. They inhabit shallow coastal and estuarine waters throughout their range and are considered a euryhaline species. In North Carolina, the current state record was recorded at 12.3 pounds in 1961. The maximum reported age of spotted seatrout is 9 years in North Carolina for both male and female fish. Most spotted seatrout in North Carolina are mature by age 1 and 7.9 inches for males and 9.6 inches for females. All males are mature at 12 inches and females at 15 inches. Spawning in North Carolina occurs from April to October with peak spawn around May. Spawning occurs within the first few hours after sunset and a single fish is capable of spawning multiple times (batch spawners) throughout the season. In Florida, it has been observed that during peak spawning, spotted seatrout older than 3 years old may spawn every two days while younger fish may spawn as frequently as every four days. Estimates of the number of eggs a female can produce in a year from the Southeast and Gulf Coasts vary, based on size and age and range, from 3 million to 20 million per year.

Stock Status

The 2014 North Carolina spotted seatrout stock assessment (NCDMF 2014b) indicated that the spotted seatrout stock in North Carolina and Virginia is not overfished and overfishing is not occurring. Reference points (SSB and F) for determining stock status were calculated from the assessment using the SPR thresholds (20% SPR) and targets (30% SPR) defined in the spotted seatrout FMP (NCDMF 2012). The model estimated $SSB_{20\%}$ at 394 metric tons and $SSB_{30\%}$ at 623 metric tons with a model terminal year (2012) SSB estimate of 2,513,270 pounds. Based on these results, the stock is not currently overfished ($SSB_{2012} < SSB_{20\%}$) and has not been overfished during the 1991 to 2012 time period (Figure 1). Fishing mortality reference points estimated from the model were $F_{20\%}$ at 0.656 and $F_{30\%}$ at 0.422 with a terminal year estimate of F at 0.401, close to the F target, but still below, suggesting that overfishing is not occurring ($F_{2012} < F_{20\%}$; Figure 2).

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Stock Assessment

The 2014 assessment of the spotted seatrout in North Carolina and Virginia was conducted using a Stock Synthesis model that incorporated data collected from commercial and recreational fisheries, two fishery-independent surveys, and a tagging study (NCDMF 2014b). This approach differs from the previous NCDMF assessment of spotted seatrout, which was applied to data available from 1991 through 2008. The previous assessment used the ASAP2 statistical catch-at-age model and data more limited in both area and time. The previous model relied primarily upon fishery-dependent data, one fishery-independent index, and included age data only from the North Carolina portion of the stock.

The Stock Synthesis model has been thoroughly vetted through the stock assessment community and peer reviewed literature. The time period used for the assessment was 1991 through 2012 and relied on expanded fishery-independent data sources, including age data from the Virginia portion of the stock, a juvenile abundance index, and tag-return data from research conducted by North Carolina State University (Ellis 2015). The fishing year was changed from a calendar year to a biological year (defined as March 1 through February 28 or 29) to allow the model to incorporate cold stun mortalities within a single fishing year instead of across two calendar years. The maximum age was decreased from 12 years (previous assessment) to nine as the 12-year maximum was based on scale ages not otoliths. Only ages derived from otoliths were used in the current assessment.

Tagging data from Ellis' (2015) study was included in the model but did not have a significant influence on results. Multiple model configurations were attempted to account for varying natural mortality ranging from direct tagging estimates to estimates based on water temperature correlations: however, no model configuration incorporating varying natural mortality would produce results (converge). Ellis' (2015) data did provide further evidence of the highs and lows associated with spotted seatrout natural mortalities and the need for a custom model that can incorporate these highly variable mortality rates. The NCDMF recognized the need to develop a model that will accept variable natural mortality estimates. Developing a custom model that can incorporate variable natural mortality was added as a research recommendation and the NCDMF will continue to investigate this during the next benchmark assessment.

The results of this assessment suggest the age structure of the spotted seatrout stock has been expanding during the last decade. However, an abrupt decline is evident in the model's estimate of recruitment after 2010, although this is not mirrored in the empirical survey data. Spawning stock biomass (SSB) increased to its maximum in 2007 but has since declined to close to the time series average. In 2012, estimated SSB was 2,513,270 pounds, which is greater than the currently defined threshold for assessing whether the stock is overfished ($SSB_{30\%}=868,621$ pounds; Figure 1). Fishing mortality has varied without apparent trend, but periods of high fishing mortality seem to coincide with the decline in spawning stock biomass and may be attributed to cold stun events. The 2012 estimate of fishing mortality was 0.40, which is less than the fishing mortality threshold ($F_{20\%}=0.66$), indicating that the stock is not experiencing overfishing; however, the 2012 estimate of fishing mortality (0.40) is very near the target fishing mortality of $F_{30\%}=0.42$ (Figure 2).

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The current stock assessment will be updated with data through 2017 for the scheduled plan review starting in 2019.

STATUS OF THE FISHERY

Current Regulations

The NCDMF currently allows the recreational harvest of spotted seatrout seven days per week with a minimum size limit of 14-inches total length (TL) and a daily bag limit of four fish. The commercial harvest is limited to a daily limit of 75 fish with a minimum size limit of 14-inches TL). It is unlawful for a commercial fishing operation to possess or sell spotted seatrout for commercial purposes taken from Joint Fishing Waters of the state from midnight on Friday to midnight on Sunday each week; the Albemarle and Currituck sounds are exempt from this weekend closure. In the event of a catastrophic cold stun, the NCDMF has the authority to close the fishery until the following spawning period.

Commercial Landings

Commercial landings from 2017 (299,875 pounds) exceeded the 10-year average for the fishery (Table 1; Figure 3). Annual landings over the last 10-year period have averaged 246,010 pounds but have varied by almost 300,000 pounds (2011 and 2013). During the early to mid-1990s, landings in the ocean and estuarine areas were more similar than in the remainder of the time series (1995-2015) in which estuarine landings have dominated. The primary gear of harvest are estuarine gill nets (set, drift, and run around).

Recreational Landings

Recreational data are collected through an angler based survey program, the Marine Recreational Information Program (MRIP), and are reported in various harvest types with associated sampling error. Estimated recreational harvest (Type A + B1) of spotted seatrout in 2017 was 580,849 pounds (PSE = 12.5%) and 339,523 fish (PSE = 13.1%), similar to the 10 year averages of 609,318 pounds and 359,351 fish (Table 1; Figure 3). Estimated recreational releases in 2017 (1,122,503 fish; PSE = 13.1%) were below the 10 year average of 1,440,047 fish (Table 1).

The North Carolina Saltwater Fishing Tournament recognizes anglers for landing and/or releasing fish of exceptional size or rarity by issuing citations that document the capture for the angler. The Division collects information on the date, size, and location of these catches to monitor trends in the recreational fishery. Citations awarded through the North Carolina Saltwater Fishing Tournament for spotted seatrout have varied by year since 2008 and have averaged 242 citations over the period (Table 2). The number of awarded citations in 2017 increased from the previous year to 464, the highest recorded since 2007. The number of release citations (fish over 24 inches that are released) awarded almost doubled the previous year's count and accounted for the largest number of citations issued since the program began issuing release citations in 2008 (Table 2).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fish houses are sampled monthly to provide length, weight, and age data to describe the commercial fisheries. This information is used to characterize the commercial fishery for stock assessments and to monitor trends in the size and age of fish being removed from the stock. The number of fish sampled by division staff at commercial fish houses has varied over time due to annual variability in landings of the fishery, however; mean, minimum, and maximum lengths of spotted seatrout have not varied much between years for the commercial fishery (Table 3). The average sizes of fish landed by the commercial fishery is typically larger than the recreational fishery and is primarily driven by the larger maximum size observed in the commercial landings. The bulk of spotted seatrout landings by the commercial fishery (93%) come from the ocean and estuarine gill net fishery with gigs (5.5%) and all other gears (1.5%) accounting for the rest.

Recreational catch is almost exclusively hook-and-line with few fish being landed by gigs. The average size of fish measured from the recreational fishery has increased over the last 10 years, most likely due to an increase in the minimum size limit from 12-inches (304 mm) to 14-inches (355 mm) in late 2009 (Table 3). The average size of fish caught by the recreational fishery in 2017 was 426 mm, which is similar to the average size of 429 mm over the last eight years since the minimum size was increased. The maximum size of fish in 2017 was 655 mm, an increase of 25 mm over the eight-year average.

Fishery-Independent Monitoring

The NCDMF utilizes numerous independent monitoring programs to provide indices of juvenile (Program 120) and adult (Program 915) abundance to include in stock assessments. Program 120, the North Carolina Estuarine Trawl Survey, is a fishery independent multispecies monitoring program that has been ongoing since 1971 in the months of May, June and July. One of the key objectives of this program is to provide a long-term data base of annual juvenile recruitment for economically important species. This survey samples a fixed set of 104 core stations with additional stations as needed. The core stations are sampled from western Albemarle Sound south to the South Carolina border each year without deviation two times in the months of May and June. An additional set of 27 spotted seatrout juvenile stations in Pamlico Sound and its major tributaries are sampled during the months of June and July. Data from the seatrout specific stations is used to generate an index of relative abundance of age zero spotted seatrout. The resulting Catch Per Unit Effort (CPUE) index, which is the average number of fish per tow, for the current 10-year time series remained somewhat constant with no significant trends in CPUE but with peaks in 2008, 2012, and 2013, suggesting relatively higher recruitment in those years (Figure 4). The 2017 Program 120 spotted seatrout CPUE was below the 10-year average. Low juvenile abundance of spotted seatrout typically occurs in years where adult abundance is high and spikes in the juvenile index are often observed in years after severe cold stun events.

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The NCDMF started a fishery independent gill net survey (Program 915) in 2001 to generate a long-term database of age composition and to develop indices of abundance for numerous commercial and recreationally important finfish species, including spotted seatrout. The survey utilizes a stratified random sampling scheme of multi-mesh sized gill nets designed to characterize the size and age distribution for key estuarine species in Pamlico Sound and help managers assess the spotted seatrout stocks without relying solely on commercial and recreational fishery dependent data. Three regions that encompass most of the estuarine waters in North Carolina are sampled monthly from February to December. Pamlico Sound stations include waters on the backside of the barrier islands and the bays of Hyde and Dare counties. Over the last 10 years, CPUE from Pamlico Sound have remained steady with an upward trend over the last two years (Figure 5). Central river stations that include Pamlico, Pungo and Neuse Rivers have had a general declining trend in CPUE (Figure 6). Southern river stations, which include the Cape Fear and New rivers, CPUE varied without trend over the time series (Figure 7).

Spotted seatrout collected during the independent gill net survey are sampled for length frequency and age to generate age length keys useful for assessment and stock monitoring. Since the inception of the program in 2001, 3,672 spotted seatrout have been aged from collections. Because sampling for the independent gill net survey is standardized based on gear, effort, and habitat sampled, ages from the program can be used to track cohorts as they recruit to the fishery. Healthy populations should display a range of ages throughout larger size classes and not exhibit a truncation of age classes. Over the last six years, ages of spotted seatrout collected from the independent gill net survey have been evenly spread across most size classes with above legal size fish (> 14-inches or 354 mm) ranging in age from one to seven years (Figure 8).

Spotted seatrout ages are also collected from numerous NCDMF fishery independent and dependent sources. To date, a total of 17,781 otoliths from spotted seatrout have been aged, the preferred method, since 1991 (Table 4). With the exception of 2003, the minimum age of sampled spotted seatrout has been age zero for every year the NCDMF has recorded this information. Maximum ages have varied every year and has ranged from age five to age nine. Modal ages, which give an indication of the age of the largest cohort in the fishery, has mostly been age one.

MANAGEMENT STRATEGY

Reduce F to maintain a 20% spawning potential ratio which will increase the likelihood of sustainability through an expanded age structure and an increase in the spawning stock biomass. This strategy should provide a greater cushion for the population that would likely lead to faster recovery of the population after cold stun events, which can lead to mass mortalities in the winter months potentially affecting the number of mature fish available to spawn the following spring. Consider revising reference points after the stock is reassessed in the next plan review based on the response of the population to the management measures selected in the initial FMP. The Director will maintain authority to intervene in the event of a catastrophic cold stun event and do what is necessary in terms of temporary closures by water body (Table 5 and 6).

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RESEARCH NEEDS

The following research needs were compiled from those listed in the 2012 North Carolina Spotted Seatrout FMP. Improved management of spotted seatrout is dependent upon research needs being met. Research needs are not listed in order of priority.

- Develop a juvenile abundance index to gain a better understanding of a stock recruitment relationship – (ongoing, using program 120 since 2004)
- Research the feasibility of including measures of temperature or salinity into the stock recruitment relationship – (not completed)
- Determine batch fecundity estimates for North Carolina spotted seatrout – (ongoing; CRFL project 2F40-F035)
- Size specific fecundity estimates for North Carolina spotted seatrout – (ongoing; CRFL project 2F40-F035)
- Area specific spawning surveys could help in the delineation of area specific closures to protect females in spawning condition – (not completed)
- Investigation of the relationship of temperature with both adult and juvenile mortality – (started in 2015, monitoring temperatures in over wintering habitat of spotted seatrout: CRFL project 2F40-F024)
- Incorporate cold stun event information into the modeling of the population – (unsuccessfully attempted using stock synthesis model, will be investigated further during next benchmark stock assessment)
- Estimate or develop a model to predict the impact of cold stun events on local and statewide spotted seatrout abundance – (unsuccessfully attempted using stock synthesis model, will be investigated further during next benchmark stock assessment).
- Obtain samples (length, age, weight, quantification) of the cold stun events as they occur – (obtained samples in 2001, 2014, and 2015; length, weight, sex, age; unable to quantify extent of kills)
- Define overwintering habitat requirements of spotted seatrout – (not conducted)
- Determine factors that are most likely to influence the severity of cold stun events in North Carolina, and separate into low and high salinity areas – (Tim Ellis and the spotted seatrout Plan Development Team worked on this but were unable to incorporate into models; Ellis et. al (2017))
- Investigate the distribution of spotted seatrout in nursery and non-nursery areas – (not completed)
- Further research on the possible influences of salinity on release mortality of spotted seatrout – (ongoing; CRFL project 2F40-F017, evaluation of tagging and discard mortality component)
- Survey of fishing effort in creeks with conflict complaints – (not completed)
- Determine targeted species in nursery areas and creeks with conflict complaints – (not completed)
- Microchemistry, genetic, or tagging studies are needed to verify migration patterns, mixing rates, or origins of spotted seatrout between North Carolina and Virginia – (Tim Ellis data (2008-2013); CRFL project 2F40-F017, NC Multi Species Tagging Study 2014 – present; NCSU study CRFL grant 2F40-F022)

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- Tagging studies to verify estimates of natural and fishing mortality – (Tim Ellis data (2008-2013); CRFL project 2F40-F017, NC Multi Species Tagging Study 2014 – present)
- Tagging studies to determine if there are localized populations within the state of North Carolina (e.g., a southern and northern stock) – (Tim Ellis data (2008-2013); CRFL project 2F40-F017, NC Multi Species Tagging Study 2014 - present)
- A longer time series and additional sources of fishery-independent information – (longer series available as well as Program 915 survey for rivers and southern portion of state)
- Increased observer coverage in a variety of commercial fisheries over a wider area – (ongoing)
- Expand nursery sampling to include SAV bed sampling in high and low salinity areas during the months of July through September – (not completed)
- Evaluate the role of shell hash and shell bottom in spotted seatrout recruitment and survival, particularly where SAV is absent – (not completed)
- Evaluate the role of SAV in the spawning success of spotted seatrout – (not completed)

FISHERY MANAGEMENT PLAN RECOMMENDATIONS

The Marine Fisheries Commission approved the 2017 FMP schedule in August 2017, including this schedule change for spotted seatrout to begin in 2019, two years later than originally planned. This is due to staff workload for the review of the Southern Flounder Fishery Management Plan, the early review of the Estuarine Striped Bass Fishery Management plan, and the unscheduled review of the Blue Crab and Shrimp Fishery Management Plans. A stock assessment was completed on spotted seatrout in North Carolina and Virginia in 2014 and indicated the stock was in good shape and removals were considered sustainable for the long-term benefit of the stock. Data through 2017 do not indicate anything to the contrary. A new benchmark stock assessment will be completed before the next scheduled plan review.

STATE-MANAGED SPECIES – SPOTTED SEATROUT

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STATE-MANAGED SPECIES – SPOTTED SEATROUT

TABLES

Table 1. Recreational harvest (number of fish released and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of spotted seatrout from North Carolina for the period 2008 - 2017.

| Year | Recreational | | Weight (lb) | Commercial | Total Weight Harvested (lb) |
|------|----------------|-----------|-------------|----------------|-----------------------------|
| | Number of fish | | | Harvested (lb) | |
| | Released | Harvested | Harvested | Harvested (lb) | |
| 2008 | 880,560 | 654,435 | 1,005,548 | 304,430 | 1,309,978 |
| 2009 | 1,213,526 | 608,790 | 954,845 | 320,247 | 1,275,092 |
| 2010 | 1,684,872 | 195,065 | 407,534 | 202,647 | 610,181 |
| 2011 | 1,916,249 | 215,922 | 403,517 | 75,239 | 478,756 |
| 2012 | 1,646,512 | 500,522 | 817,551 | 265,016 | 1,082,567 |
| 2013 | 1,427,410 | 369,265 | 649,158 | 367,648 | 1,016,806 |
| 2014 | 960,570 | 234,045 | 433,978 | 242,245 | 676,223 |
| 2015 | 1,776,280 | 87,396 | 148,926 | 128,762 | 277,688 |
| 2016 | 1,771,989 | 388,544 | 691,277 | 253,991 | 945,268 |
| 2017 | 1,122,503 | 339,523 | 580,849 | 299,875 | 880,724 |

Table 2. Total number of awarded citations for spotted seatrout (>24 inches total length for release or > five lb landed) from the North Carolina Saltwater Fishing Tournament for the time period 2008-2017.

| Year | Total Citations | Release Citations ⁺ | % Release |
|------|-----------------|--------------------------------|-----------|
| 2008 | 428 | 5 | 1.2 |
| 2009 | 434 | 14 | 3.2 |
| 2010 | 168 | 16 | 9.5 |
| 2011 | 37 | 3 | 8.1 |
| 2012 | 143 | 5 | 3.5 |
| 2013 | 162 | 21 | 13.0 |
| 2014 | 197 | 18 | 9.1 |
| 2015 | 176 | 16 | 9.1 |
| 2016 | 214 | 44 | 20.1 |
| 2017 | 464 | 81 | 17.5 |

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Table 3. Mean, minimum, and maximum lengths (total length, mm) of spotted seatrout measured from the commercial and recreational fisheries for the period 2008-2017.

| Year | Commercial | | | | Recreational | | | |
|------|-------------|----------------|----------------|-----------------------|--------------|----------------|----------------|-----------------------|
| | Mean Length | Minimum Length | Maximum Length | Total Number Measured | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 437 | 43 | 770 | 4,893 | 397 | 293 | 674 | 790 |
| 2009 | 427 | 71 | 749 | 5,534 | 407 | 230 | 661 | 779 |
| 2010 | 448 | 290 | 784 | 3,372 | 448 | 315 | 630 | 336 |
| 2011 | 421 | 223 | 706 | 1,082 | 431 | 313 | 615 | 638 |
| 2012 | 419 | 187 | 791 | 4,216 | 415 | 330 | 612 | 939 |
| 2013 | 425 | 46 | 723 | 5,661 | 428 | 256 | 598 | 863 |
| 2014 | 441 | 139 | 719 | 3,184 | 436 | 332 | 660 | 379 |
| 2015 | 467 | 225 | 786 | 2,485 | 425 | 325 | 634 | 152 |
| 2016 | 438 | 240 | 805 | 2,873 | 427 | 329 | 639 | 647 |
| 2017 | 444 | 193 | 835 | 2,768 | 426 | 295 | 655 | 864 |

Table 4. Modal age, minimum age, maximum age, and number aged for spotted seatrout collected through NCDMF sampling programs from 1991 through 2016.

| Year | Modal Age | Minimum Age | Maximum Age | Number Aged |
|------|-----------|-------------|-------------|-------------|
| 1991 | 1 | 0 | 7 | 707 |
| 1992 | 1 | 0 | 6 | 594 |
| 1993 | 1 | 0 | 6 | 698 |
| 1994 | 1 | 0 | 9 | 701 |
| 1995 | 1 | 0 | 5 | 653 |
| 1996 | 1 | 0 | 6 | 1,010 |
| 1997 | 1 | 0 | 6 | 730 |
| 1998 | 1 | 0 | 9 | 781 |
| 1999 | 1 | 0 | 6 | 877 |
| 2000 | 1 | 0 | 7 | 566 |
| 2001 | 1 | 0 | 5 | 426 |
| 2002 | 1 | 0 | 7 | 715 |
| 2003 | 1 | 1 | 7 | 433 |
| 2004 | 1 | 0 | 6 | 600 |
| 2005 | 1 | 0 | 5 | 731 |
| 2006 | 1 | 0 | 8 | 974 |
| 2007 | 2 | 0 | 8 | 706 |
| 2008 | 1 | 0 | 7 | 619 |
| 2009 | 2 | 0 | 6 | 663 |
| 2010 | 1 | 0 | 6 | 646 |
| 2011 | 1 | 0 | 6 | 429 |
| 2012 | 1 | 0 | 5 | 598 |
| 2013 | 2 | 0 | 5 | 641 |
| 2014 | 1 | 0 | 7 | 555 |
| 2015 | 2 | 0 | 5 | 401 |
| 2016 | 1 | 0 | 5 | 457 |
| 2017 | 1 | 0 | 7 | 870 |

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Table 5. Summary of the NCMFC management strategies and their implementation status for the 2012 N.C. Spotted Seatrout FMP.

| Management Strategy | Implementation Status |
|---|---|
| 50% reduction in harvest needed, six fish bag limit, 14-inch minimum size limit, and weekend closure for commercial gears year round (no possession on weekends). | Accomplished; Proclamation authority |
| A maximum of two fish over 24 inches for recreational fishermen | Proclamation authority |
| The small mesh gill net attendance requirement is extended to include weekends, December through February | Accomplished |
| Development of a mutual aid agreement between NCDMF Marine Patrol and WRC Wildlife Enforcement Officers for Inland fishing waters | Accomplished |
| Move forward with the mediation policy process to resolve conflict between spotted seatrout fishermen | Conflict resolution process established under Rule 15A NCAC 03I .0122. |
| Remain status quo with the assumption that the Director will intervene in the event of a catastrophic event and do what is necessary in terms of temporary closures by water body | Repealed Rule 15A NCAC 03M .0504 and used proclamation authority in 15A NCAC 03M .0512; Beginning in May 2017 re-established spotted seatrout Rule 15A NCAC 03M .0522 due to ASMFC considering retiring Interstate Spotted Seatrout FMP |
| More extensive research on cold stun events by NCDMF, Universities, etc. | Ongoing |

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Table 6. Summary of the NCMFC management strategies and their implementation status for Supplement A to the 2012 N.C. Spotted Seatrout FMP adopted in 2014.

| Management Strategy | Implementation Status |
|--|--------------------------------|
| 2014: 14-inch minimum size limit, four recreational bag limit, 75 fish commercial trip limit, no gill nets in joint waters on weekends, unlawful for a commercial operation to possess or sell spotted seatrout taken from joint waters on weekends. | Proclamation authority |
| 2014: 14-inch minimum size limit, three fish recreational bag limit with a December 15- January 31 closure, 25 fish commercial trip limit (no closure) | Delay in management strategy |
| If a cold stun occurs close spotted seatrout harvest through June 1 and retain four fish recreational bag limit and 75 fish commercial trip limit | Proclamation authority |
| Revisit the Spotted Seatrout FMP in three years to determine if sustainable harvest measures are working | On schedule to begin July 2017 |

FIGURES

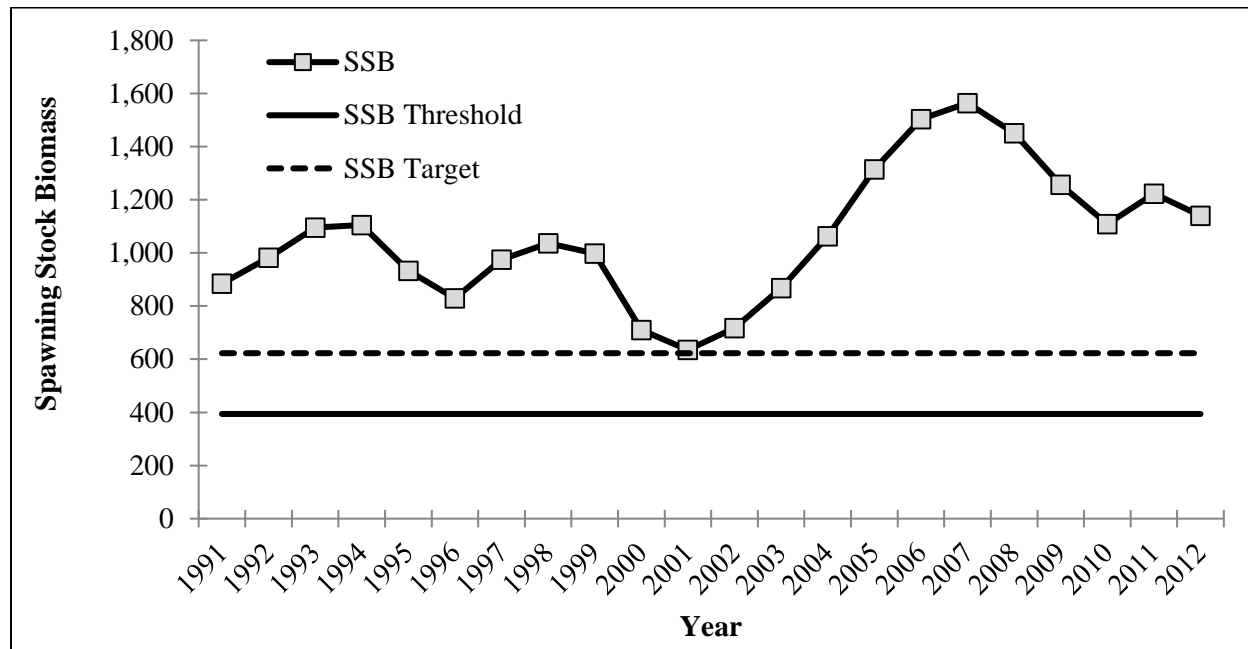


Figure 1. Annual predicted spawning stock biomass compared to estimated SSB_{Threshold} (SSB_{20%}) and SSB_{Target} (SSB_{30%}), 1991-2012. 2012 is the terminal year for the last spotted seatrout stock assessment (NCDMF 2014).

STATE-MANAGED SPECIES – SPOTTED SEATROUT

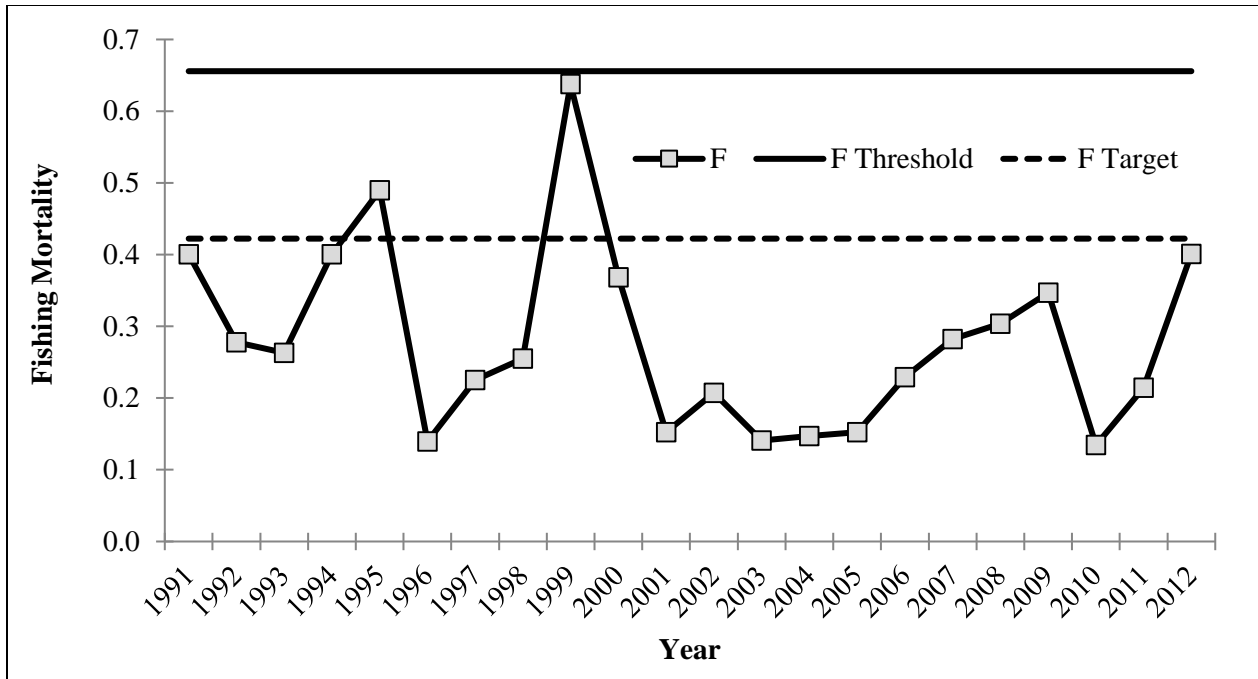


Figure 2. Annual predicted fishing mortality rates (numbers-weighted, ages 1–4) compared to estimated $F_{Threshold}$ ($F_{20\%}$) and F_{Target} ($F_{30\%}$), 1991-2012. 2012 is the terminal year for the last spotted seatrout stock assessment (NCDMF 2014).

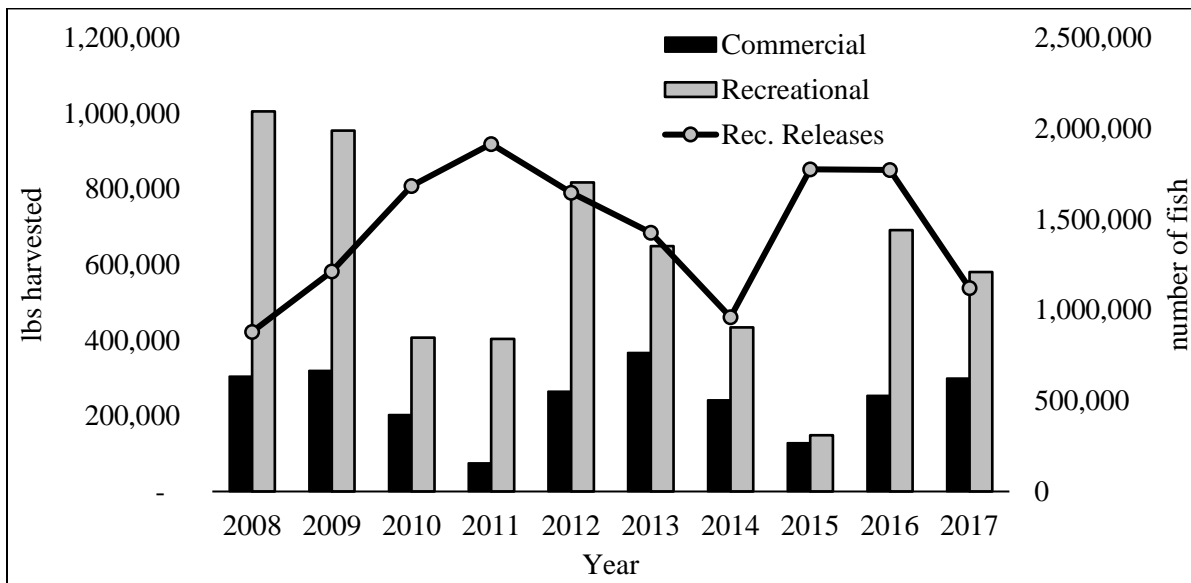


Figure 3. Commercial landings (pounds) reported through the North Carolina Trip Ticket Program and recreational landings (Type A + B1; pounds) and releases (Type B2; number of fish) estimated from the Marine Recreational Information Program survey for North Carolina from 2008 - 2017.

STATE-MANAGED SPECIES – SPOTTED SEATROUT

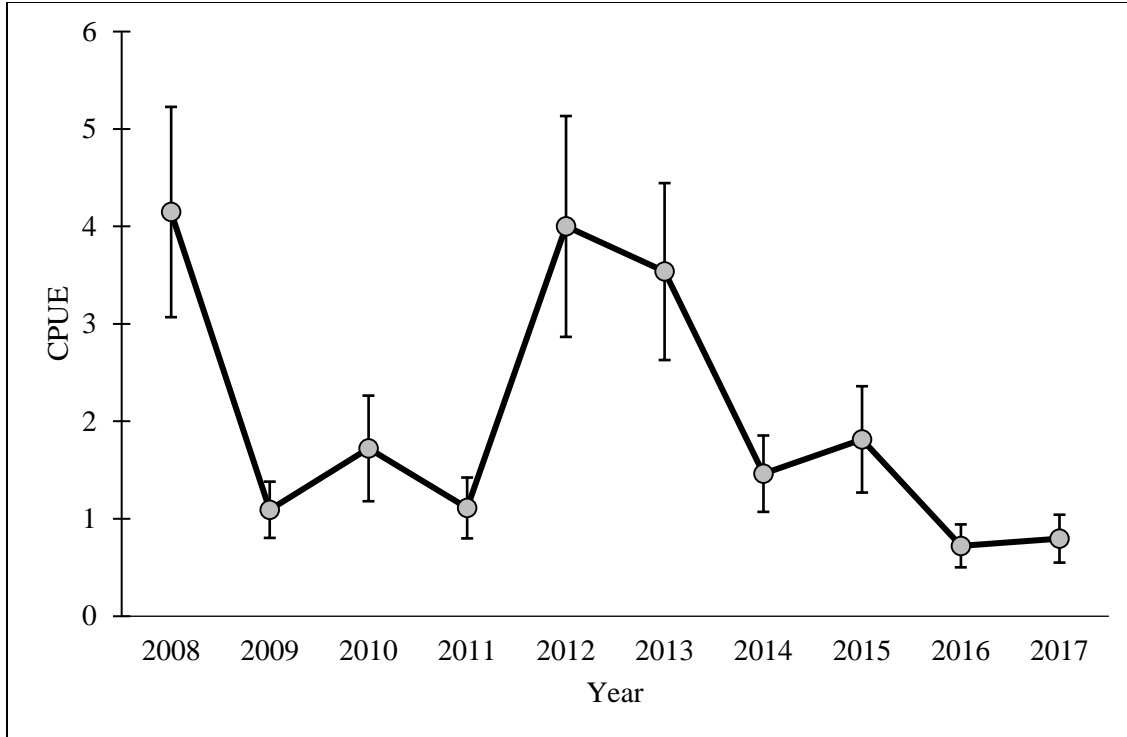


Figure 4. Catch per unit effort (CPUE; fish per-tow) from the North Carolina Estuarine Trawl Survey (Program 120) during June and July, 2008-2017. Error bars represent ± 1 standard error.

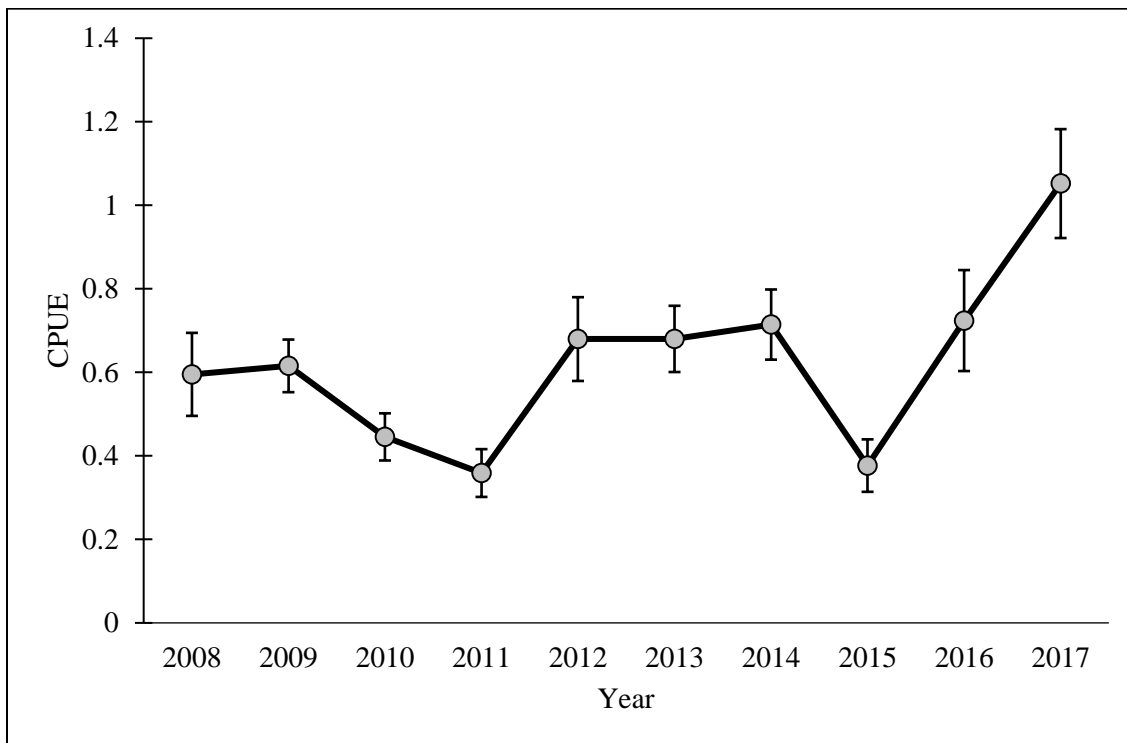


Figure 5. Catch per unit effort (CPUE; fish per station set) of spotted seatrout collected from Program 915 in Pamlico Sound, 2008 - 2017. Error bars represent ± 1 standard error.

STATE-MANAGED SPECIES – SPOTTED SEATROUT

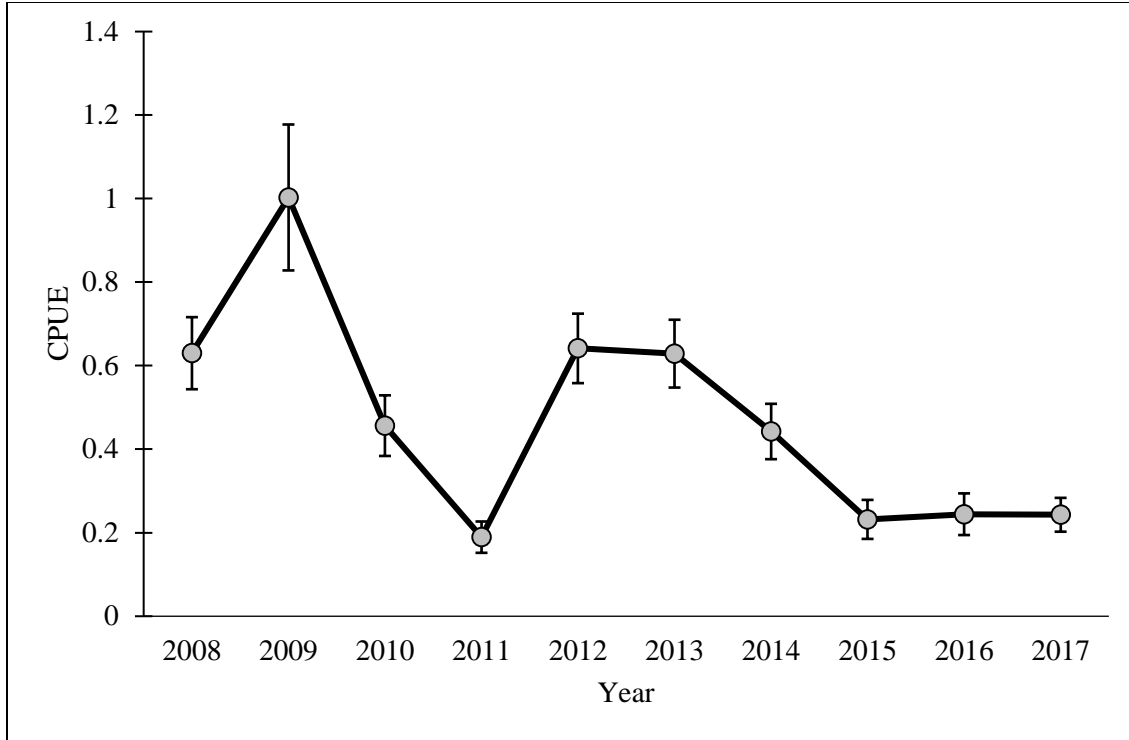


Figure 6. Catch per unit effort (CPUE; fish per station set) of spotted seatrout collected from Program 915 in Pungo, Pamlico, and Neuse Rivers, 2008 - 2017. Error bars represent ± 1 standard error.

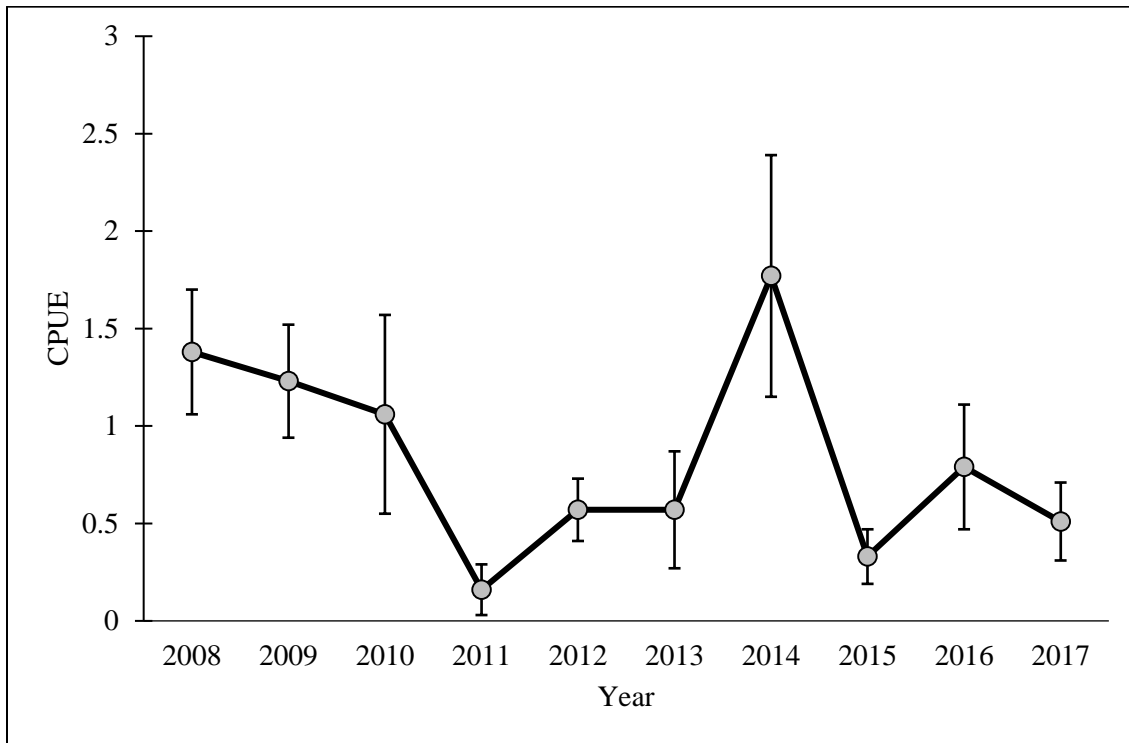


Figure 7. Catch per unit effort (CPUE; fish per station set) of spotted seatrout collected from Program 915 in New and Cape Fear Rivers, 2008 - 2017. Error bars represent ± 1 standard error.

STATE-MANAGED SPECIES – SPOTTED SEATROUT

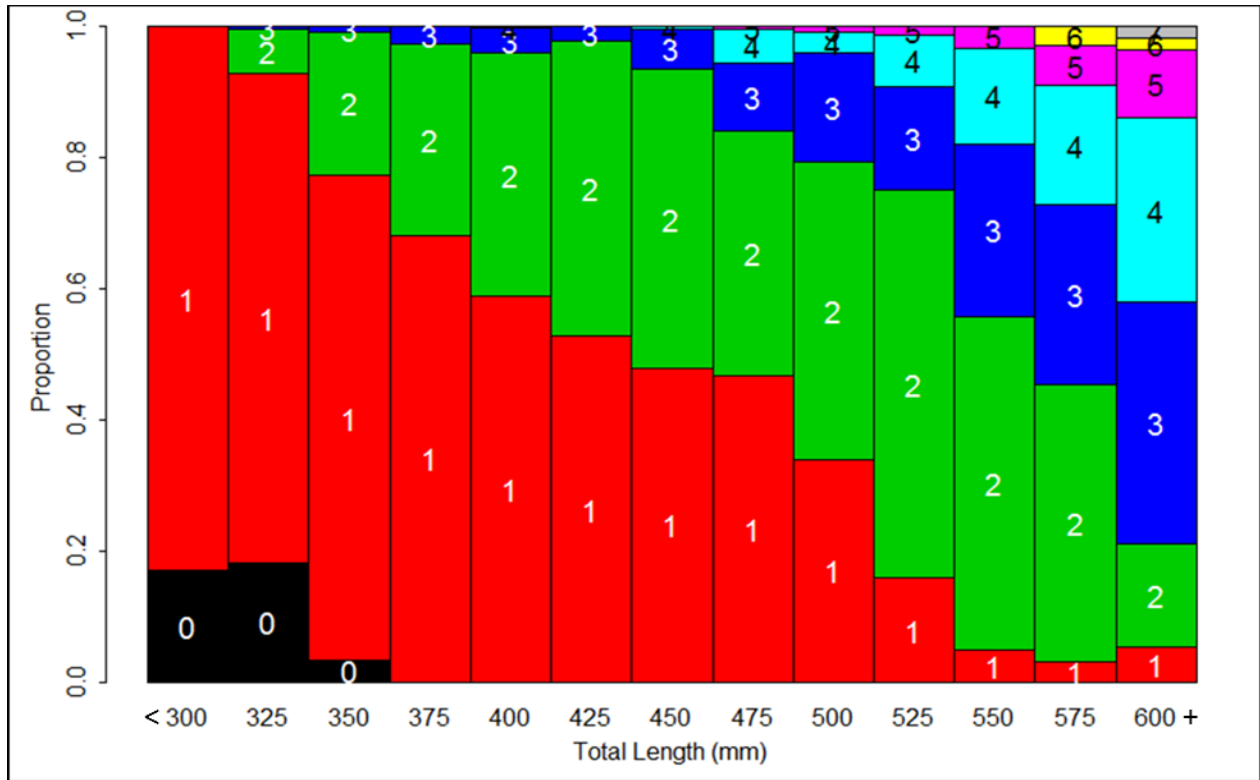


Figure 8. Proportion of ages by size class (25 mm size bins) of all spotted seatrout collected from the Fishery Independent Gill Net Survey (Program 915) and aged by NCDMF, 2012-2017.

STATE-MANAGED SPECIES – STRIPED MULLET

FISHERY MANAGEMENT PLAN UPDATE STRIPED MULLET AUGUST 2018

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|-----------------------------|
| Original FMP Adoption: | April 2006 |
| Amendments: | Amendment 1 – November 2015 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | July 2020 |

The North Carolina Striped Mullet Fishery Management Plan (FMP) was adopted in April 2006. The management plan established minimum and maximum landings triggers of 1.3 million pounds and 3.1 million pounds, respectively. If landings fall below the minimum trigger, the North Carolina Division of Marine Fisheries (NCDMF) would initiate further analysis of the data to determine if the decrease in landings is attributed to stock decline, decreased fishing effort, or both. If landings exceed 3.1 million pounds, the NCDMF would initiate analysis to determine if harvest is sustainable and assess what factors are driving the increase in harvest. The striped mullet FMP established a possession limit of 200 mullets (white and striped in aggregate) per person in the recreational fishery.

Amendment 1 to the N.C. Striped Mullet FMP was adopted in November 2015 and rules were implemented in April 2016. Issues addressed in Amendment 1 included: 1) resolution of Newport River gill net attendance, 2) addressing user group conflicts, and 3) updating the management framework for the N.C. striped mullet stock. Amendment 1 updated the minimum and maximum commercial landings triggers to 1.13 and 2.76 million pounds, respectively, that would warrant a closer examination of data. Amendment 1 maintains the 200 mullet possession limit per person in the recreational fishery.

Management Unit

Coastal and joint waters of North Carolina.

STATE-MANAGED SPECIES – STRIPED MULLET

Goal and Objectives

The goal of Amendment 1 to the North Carolina Striped Mullet FMP is to manage the striped mullet fishery to preserve the long-term viability of the resource, maintain sustainable harvest, maximize social and economic value, and consider the needs of all user groups. The following objectives will be used to achieve this goal:

1. Use a management strategy that provides for conservation of the striped mullet resource and promotes sustainable harvest while considering the needs of all user groups.
2. Promote the protection, enhancement, and restoration of habitats and water quality necessary for the striped mullet population.
3. Minimize conflict among user groups, including non-fishing user groups and activities.
4. Promote research to improve the understanding of striped mullet population dynamics and ecology to improve management of the striped mullet resource.
5. Initiate, enhance, and/or continue studies to collect and analyze the socio-economic data needed to properly monitor and manage the striped mullet fishery.
6. Promote public awareness regarding the status and management of the North Carolina striped mullet stock.

STATUS OF THE STOCK

Life History

Striped mullet are found in a wide range of depths and habitats, but primarily inhabit freshwater to estuarine environments until a spawning migration into the ocean occurs during the fall (Able and Fahay 1998; Pattillo et al. 1999; Cardona 2000; Whitfield et al. 2012). Striped mullet serve as an ecological link between some of the smallest aquatic organisms and the highest-level predators in the marine food chain. Striped mullet feed on microorganisms such as bacteria and single-celled algae found on aquatic plants, in mud, silt, and sand and in decaying plant material (Odum 1968; Moore 1974; Collins 1985a; Larson and Shanks 1996; Torras et al. 2000). In turn, striped mullet are prey to top predators such as birds, fish, sharks and porpoises (Breuer 1957; Thomson 1963; Collins 1985a; Barros and Odell 1995; Fertl and Wilson 1997). Striped mullet are highly fecund (upwards of 4 million eggs for a large female; Bichy 2000) and spawn in large aggregations near inlets to offshore areas (Collins and Stender 1989). Spawning individuals have been reported from September to March; however, peak spawning activity occurs from October to early December (Bichy 2000).

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Stock Status

The most recent assessment of the North Carolina striped mullet stock was completed in 2013 utilizing data from 1994-2011 (NCDMF 2013). The results of the stock assessment indicated spawning stock biomass increased from 2003 through 2007 but declined through 2011. Recruitment also declined in the latter portion of the time series, though a slight increase was observed in 2011. Fishing mortality (F) increased toward the end of the time series, but F in the terminal year ($F_{2011} = 0.437$) was below both the fishing mortality target ($F_{35\%} = 0.566$) and threshold ($F_{25\%} = 0.932$). Based on the assessment results, the stock was not undergoing overfishing in 2011. A poor stock-recruit relationship resulting in unreliable biomass based reference points prevented determining if the stock was overfished.

In 2016, striped mullet commercial landings were 965,198 pounds which is 15 percent less than the minimum commercial landings trigger established by Amendment 1. The decline in commercial landings occurred in conjunction with declines in relative abundance of striped mullet from fishery independent surveys. In July 2017, the NCDMF initiated further analysis of striped mullet data as outlined in Amendment 1 and is in the process of updating the striped mullet stock assessment model with data through 2017 to determine the current status, in relation to overfishing, of the striped mullet stock.

Stock Assessment

The striped mullet stock was modeled using Stock Synthesis text version 3.24f (Methot 2000, 2011; NFT 2011; Methot and Wetzel 2013), which was also used to calculate reference points (NCDMF 2013). The Stock Synthesis model can incorporate information from multiple fisheries, multiple surveys, and both length and age composition data. The structure of the model allows for a wide range of model complexity depending upon available data. The strength of the model is it explicitly models both the dynamics of the population and the processes by which one observes the population and its fisheries. That is, the comparison between the model and the data is kept close to the natural basis of the observations, instead of manipulating the observations into the format of a simpler model. Another important advantage is the model allows for (and estimates) selectivity patterns for each fishing fleet and survey.

STATUS OF THE FISHERY

Current Regulations

There are no size restrictions, but as of July 1, 2006 there is a 200 mullet (white and striped aggregate) daily possession limit per person in the recreational fishery and the mutilated finfish rule was modified to exempt mullet used as bait.

Commercial Landings

Historically, seines and gill nets are the two primary gear types used in the striped mullet commercial fishery, with most commercial landings prior to 1978 coming from the seine fishery. Gill nets replaced seines as the dominant gear type in the striped mullet commercial fishery in

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1979. Because the commercial fishery primarily targets striped mullet roe, the fishery is seasonal with the highest demand and landings occurring in the fall when large schools of striped mullet form during their spawning migration to the ocean. Striped mullet are targeted commercially using runaround gill nets in the estuarine waters of North Carolina with most landings occurring in the fall. Most striped mullet commercial landings from beach seines occur during the Bogue Banks stop net fishery. The stop net fishery has operated under fixed seasons and net and area restrictions since 1993. Stop nets are limited in number (four), length (400 yards), and mesh sizes (minimum eight inches outside panels, six inches middle section). Stop nets are only permitted along Bogue Banks (Carteret County) in the Atlantic Ocean from October 1 to November 30. However, the stop net season was extended to include December 3 to December 17 in 2015 due to minimal landings of striped mullet (Proclamation M-28-2015). Due to the schooling nature of striped mullet the beach seine fishery has the potential to be, and historically has been, a high volume fishery with thousands of pounds landed during a single trip.

Since 1994 striped mullet landings have ranged from a low of 965,198 pounds in 2016 to a high of 2,829,086 pounds in 2000 (Figure 1). From 2003 to 2009 landings were stable between 1,598,617 and 1,728,607 pounds before increasing to 2,082,832 pounds in 2010. Since 2010, landings have fluctuated annually between approximately 1.5 and 2 million pounds before declining significantly in 2015 and again in 2016, dropping below the minimum commercial landings trigger established by Amendment 1 by 164,802 pounds in 2016. Commercial landings in 2017 were 1,362,073 pounds, which is a 396,875 pound increase from 2016 commercial landings.

Recreational Landings

The federal Marine Recreational Information Program (MRIP) is primarily designed to sample anglers who use rod and reel as the mode of capture. Since most striped mullet are caught with cast nets for bait, striped mullet recreational harvest data are imprecise. In addition, angler misidentification between striped mullet and white mullet is also common, and bait mullet are usually released by anglers before visual verification by creel clerks and therefore are not identified to the species level in the MRIP data (Catch Type B). Because of imprecise estimates, MRIP data are not considered to be a reliable source for estimates of recreational striped mullet harvest and catch.

In October 2011, NCDMF began a mail survey to develop catch and effort estimates for recreational cast net and seine use. The mail survey was established as a direct response to a lack of precision in MRIP estimates for difficult to sample or overlooked recreational fisheries and activities. The survey does not distinguish between striped and white mullet and all data should be interpreted with caution because the ratio of striped mullet to white mullet in the recreational catch will differ between seasons and areas of the state. Recreational cast net effort directed toward mullet is generally highest from July through October and decreased between 2016 and 2017 (Table 1). Mullet harvest and total catch is also highest from July through October and increased between 2016 and 2017. Number of releases increased between 2016 and 2017.

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Striped mullet harvest data from the Recreational Commercial Gear License (RCGL) were collected from 2002 to 2008. The program was discontinued in 2009 due to lack of funding and the minimal contributions from RCGL to overall harvest. From 2002 through 2008 an average of 41,512 pounds of striped mullet were harvested per year using a RCGL (Table 2).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

The total number of striped mullet measured in fishery dependent programs between 2005 and 2017 ranged from 4,480 to 13,263, with the lowest number measured in 2017 (Table 3). Mean length varied little, generally falling between 343 and 364 millimeters fork length (FL), with the lowest mean length occurring in 2007 (343.2 millimeters FL). Minimum and maximum lengths generally fell within a small range, though in 2011 the minimum was 166 millimeters FL which is much lower than the minimum in other years (Table 3).

From 2004 through 2017 the size range of striped mullet captured in the commercial fishery ranged from 160 to 730 millimeters FL (Figure 2). Modal length was 290 millimeters FL in the 2004-2007 time block, 370 millimeters FL in the 2008-2011 time block, 370 to 390 millimeters FL 2012-2015 time block and 380 millimeters FL in the 2016-2017 time block. The length frequency distribution began to truncate during the 2012-2015 time block and truncated further in the 2016-2017 time block. Modal age of striped mullet in the commercial fishery was two in every time block (Figure 3). Age two striped mullet generally comprise between 40 to 45 percent of the commercial catch. Few striped mullet over age three are captured in North Carolina commercial fisheries.

Fishery-Independent Monitoring

Modal age was two in all years except 2005 when the modal age was one, and in 2017 when modal age was 1-2 (Table 4). Minimum age was zero in every year except 2010 when the minimum age was one. Maximum age ranged from six in 2012, 2014, and 2015 to 15 in 2017. From 2005 through 2008 the maximum age was 10, in 2009 the maximum age was 13, and in 2011 the maximum age was 14.

The striped mullet electrofishing survey also known as Program 146 (P146) was initiated in 2003 to produce a fisheries-independent index of relative abundance for striped mullet. Twelve sampling stations were established among four sites (three stations per site) in the Neuse River and its tributaries, with each station samples once per month from January through April and from October through December. To provide the most relevant striped mullet index from the striped mullet electrofishing survey, data were limited to those collected during January through April, when striped mullet were most abundant in the Neuse River. Since the survey primarily catches adult striped mullet, juveniles were excluded from analysis. A sample represents all the fish collected over a 500 m transect. Striped mullet catch-per-unit-effort (CPUE) was stable at approximately 100 fish per sample from 2005 through 2009 before peaking in 2011 (Figure 4). Striped mullet CPUE dropped significantly in 2012, potentially due to hurricanes, before increasing to near the time series average in 2013 and 2014. Striped mullet CPUE declined in

STATE-MANAGED SPECIES – STRIPED MULLET

2015 to approximately 45 fish per sample, declined again in 2016 to 20 fish per sample and remained low in 2017 at 26 fish per sample.

From 2004 through 2017 the size range of striped mullet captured during the January to April portion of P146 sampling generally ranged from 120 to 550 millimeters FL (juveniles excluded; Figure 5). Modal length was 280 millimeters FL in the 2004-2007 time block, 260 millimeters FL in the 2008-2011 time block, 270 millimeters FL in the 2012-2015 time block and 310 millimeters FL in the 2016-2017 time block. The length frequency distribution began to truncate during the 2012-2015 time block and truncated further in the 2016-2017 time block. Modal age of striped mullet from P146 was two during the 2004-2007 time block, one during the 2008-2011 time block, one during the 2012-2015 time block, and two during the 2016-2017 time block (Figure 6). Few striped mullet over age two are captured during P146 sampling.

The fisheries independent gill net Survey, also known as Program 915 (P915), has sampled in Hyde and Dare Counties since 2001 and the Neuse, Pamlico, and Pungo rivers since 2003. Sampling in the Cape Fear and New rivers was added in 2008, and sampling in Carteret County was added in 2018. To provide the most relevant striped mullet index from the independent gill net survey data were limited to samples from shallow river areas (Pamlico, Pungo and Neuse rivers) during October-November, where and when most striped mullet occurred. The survey primarily catches adult striped mullet, so juveniles were excluded from analysis. From 2004-2014 striped mullet CPUE generally fluctuated between 7-16 striped mullet per sample (Figure 7). Striped mullet CPUE dropped significantly in 2015 to 3.7 and then again in 2016 to a time series low of 3.1 striped mullet per sample. Striped mullet CPUE remained low in 2017 at 3.4 fish per sample.

From 2004 through 2017 the size range of striped mullet captured during the October to November portion of P915 sampling in the Pamlico and Neuse rivers generally ranged from 220 to 600 millimeters FL (juveniles excluded; Figure 8). Modal length was 310 millimeters FL in the 2004-2007, 2008-2011 and 2012-2015 time blocks, and 330 millimeters FL in the 2016-2017 time block. The length frequency distribution began to truncate during the 2012-2015 time block and truncated further in the 2016-2017 time block. Modal age of striped mullet from P915 was two during every time block (Figure 9).

In October 1990, the NCDMF initiated the striped bass independent gill net survey, also known as Program 135 (P135). The survey was designed to monitor the striped bass population in the Albemarle Sound and Roanoke River but also encounters striped mullet. To provide the most relevant striped mullet index from the striped bass independent gill net survey data were limited to those collected from 2.5-inch to 5.5-inch mesh sizes during November through February (fall-winter), when and where the majority of striped mullet occurred. Since the survey primarily catches adult striped mullet, juveniles were excluded from calculations. Data were also limited to those collected in less than 10 feet of water because these samples covered most of the water column. Striped mullet CPUE averaged approximately three fish per set from 1994-2013 before peaking at 15 fish per set in 2014 and 13 fish per set in 2015 (Figure 10). Striped mullet CPUE decreased to a time series low of zero fish per set in 2016 and 2017. Modal length was 300 millimeters FL in the 2003-2007 and 2008-2012 time blocks, and 260 millimeters FL in the

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2013-2017 time block (Figure 11). Since no striped mullet were captured in 2016 or 2017 no lengths were collected.

MANAGEMENT STRATEGY

The management strategy for the striped mullet fisheries in North Carolina is to: 1) optimize resource utilization over the long-term; 2) reduce user group conflicts; and 3) promote public education. The first strategy will be accomplished by protecting critical habitats and monitoring stock status. To address user group conflicts, a rule change was made to limit how much of a waterway may be blocked by runaround, drift, or other non-stationary gill nets. Specific user group conflict issues will continue to be dealt with on a case-by-case basis and management actions will be implemented to address specific fishery related problems. The NCDMF will work to enhance public information and education. Issues addressed in formulating Amendment 1 of the management plan for North Carolina's striped mullet fishery included: 1) resolution of the Newport River gill net attendance and 2) user group conflicts, and 3) updating the management framework for the N.C. striped mullet stock. See Table 5 for a summary of management strategies and outcomes.

Minimum and maximum landings triggers of 1.13 million and 2.76 million pounds have been established to monitor the striped mullet fishery. If landings fall below the minimum landings trigger or exceed the maximum landings trigger the NCDMF will initiate further analysis of the data to determine if a new stock assessment and/or interim management action is needed.

RESEARCH NEEDS

The following research needs were compiled from those listed in Amendment 1.

- Initiate a fishery independent adult striped mullet survey in the Core and Bogue sound areas where approximately 20 percent of the striped mullet harvest occurs – HIGH (independent gill net survey will begin in 2018)
- Develop a reliable fisheries independent index of juvenile abundance – HIGH (Needed)
- Initiate a tagging study to provide estimates of stock size, fishing mortality, and natural mortality that are not dependent on assumptions about steepness – HIGH (Needed)
- Increase the number of age samples from both fisheries dependent and fisheries independent sources – MEDIUM (Ongoing)
- Investigate how catchability of striped mullet by NCDMF Program 146 is affected by variations in salinity and conductivity and expand survey to other coastal rivers and tributaries – MEDIUM (Needed)
- Initiate a study to estimate fecundity and update the current maturity schedule microscopically – MEDIUM (Needed)
- Initiate a survey to estimate RCGL landings of striped mullet to estimate recreational landings, as well as social and economic elements of the striped mullet fishery – MEDIUM (Ongoing through NCDMF)
- Increase sampling of the commercial bait mullet cast net fishery to improve estimates of striped mullet and white mullet harvest – LOW (Needed)

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- Restart fishery independent cast net sampling to improve estimates of the proportion of striped mullet and white mullet in this fishery – LOW (Needed)
- Analyze the data from the CRFL recreational cast net and seine survey to better characterize the recreational striped mullet fishery, including the social and economic elements – LOW (Needed)
- Improve recreational fisheries statistics provided by the Marine Recreational Information Program (MRIP) or some other program to reliably characterize the magnitude and length and age structure of recreational fisheries losses – LOW (Ongoing)
- Initiate a plankton survey covering all inlets to determine inlet use by striped mullet – LOW (Needed)
- Investigate the disappearance of males from the population after age three – LOW (Needed)
- Initiate and acoustic tagging study to determine spatial and temporal variations in habitat use throughout the state to help provide better indices for stock assessments – LOW (Needed)
- Implement public outreach on waste reduction of striped mullet in the commercial and recreational fisheries – LOW (Needed)

FISHERY MANAGEMENT PLAN RECOMMENDATION

Striped mullet commercial landings in 2016 were 965,198 pounds, which is below the minimum commercial landings trigger (1.13 million pounds) established in Amendment 1 of the Striped Mullet Fishery Management Plan. Following the management strategy in Amendment 1, the NCDMF initiated further analysis of all striped mullet data in July 2017 to determine if the decrease in striped mullet commercial landings is attributed to a stock decline, decreased fishing effort, or both.

The division presented preliminary data analysis and recommendations to the North Carolina Marine Fisheries Commission (NCMFC) at its November 2017 business meeting. At that time, the division recommended no management action but stated further analysis of commercial landings, specifically from trips that targeted striped mullet, and developing standardized fishery independent indices to account for the impact of environmental factors would be completed and presented to the NCMFC at their February 2018 business meeting. The division also recommended updating the data time series through 2017 for the commercial landings and fishery independent data to better assess trends in the striped mullet commercial fishery and striped mullet stock abundance.

While commercial landings of striped mullet did increase in 2017 (396,875 pound increase from 2016 commercial landings), compared to historical averages, the trend of depressed striped mullet commercial landings has continued. In further analysis, concerning trends in the commercial fishery were identified including; declines in the number of commercial trips landing striped mullet, declines in average pounds of striped mullet landed per trip, declines in the number of commercial trips targeting striped mullet, and declines in the average pounds of striped mullet landed per targeted trip. Fishery independent indices, including those used in the 2011 striped mullet stock assessment, indicated low abundance of striped mullet from 2015

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through 2017. Standardized fishery independent indices, accounting for environmental variables, also indicated low abundance of striped mullet from 2015 through 2017.

Based on results of the completed data analysis the division concluded that the striped mullet stock had likely declined since completion of the 2013 stock assessment (terminal year 2011). At the February 2018 NCMFC business meeting, the division recommended updating the 2013 stock assessment model to include data through 2017 prior to taking any management action. As an assessment update, there were no changes to model parameters and peer review was not required, as the configuration of the model that previously passed peer review was maintained. Results of the stock assessment update indicate overfishing is not occurring through 2017.

Following completion of the assessment update management options were developed, and the division selected a preferred option. Per the striped mullet FMP, management options were brought to the Finfish, Southern, and Northern advisory committees in July 2018 to receive their input, and their recommendations will be presented to the NCMFC at its August 2018 business meeting. At that meeting, the commission will be asked to decide on management options to be implemented via proclamation authority of the Fisheries Director. Implementing management measures in August 2018 provides adequate time for management measures to be in place prior to the peak of the 2018 fishing season, which occurs in the fall. Any changes to striped mullet management would be made as a revision to the existing plan.

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TABLES

Table 1. Number of trips, number of mullet harvested, number of mullet released, and total number of mullet caught in the recreational cast net fishery estimated from the NCDMF mail survey with associated percent standard error (PSE) by wave, 2012-2017. Estimates with a PSE value greater than 50 are shaded in gray.

| Year | Wave | Total Effort | PSE Effort | Total Harvest | PSE Harvest | Total Releases | PSE Releases | Total Catch | PSE Catch |
|------|----------|--------------|------------|---------------|-------------|----------------|--------------|-------------|-----------|
| 2012 | Jan/Feb | 10,484 | 22.1 | 23,346 | 32.8 | 9,050 | 42.3 | 32,395 | 32.4 |
| | Mar/Apr | 9,734 | 19.8 | 17,055 | 32.0 | 3,931 | 57.2 | 20,986 | 31.8 |
| | May/June | 20,903 | 12.5 | 84,180 | 25.7 | 26,845 | 32.9 | 111,025 | 23.9 |
| | Jul/Aug | 29,725 | 13.8 | 107,409 | 23.7 | 64,453 | 29.6 | 171,862 | 21.3 |
| | Sep/Oct | 29,810 | 11.3 | 135,318 | 19.9 | 72,941 | 16.0 | 208,259 | 15.5 |
| | Nov/Dec | 21,094 | 15.9 | 24,484 | 38.0 | 31,774 | 26.5 | 56,258 | 26.0 |
| 2013 | Jan/Feb | 12,635 | 18.6 | 26,244 | 51.4 | 6,668 | 39.1 | 32,911 | 46.4 |
| | Mar/Apr | 8,642 | 24.1 | 6,915 | 69.5 | 2,741 | 56.4 | 9,656 | 52.2 |
| | May/June | 24,541 | 11.8 | 25,409 | 40.4 | 21,957 | 30.5 | 47,366 | 29.9 |
| | Jul/Aug | 41,197 | 11.3 | 210,888 | 23.4 | 121,012 | 21.7 | 331,900 | 20.1 |
| | Sep/Oct | 25,277 | 16.6 | 33,918 | 46.0 | 39,065 | 26.1 | 72,983 | 31.0 |
| | Nov/Dec | 25,666 | 15.3 | 37,667 | 27.3 | 34,740 | 30.9 | 72,407 | 23.8 |
| 2014 | Jan/Feb | 5,036 | 25.7 | 4,886 | 82.2 | 744 | 70.9 | 5,631 | 73.7 |
| | Mar/Apr | 15,247 | 19.7 | 11,284 | 53.1 | 1,563 | 69.2 | 12,847 | 50.7 |
| | May/June | 28,343 | 13.1 | 39,438 | 33.2 | 22,465 | 23.6 | 61,903 | 24.4 |
| | Jul/Aug | 42,572 | 12.0 | 37,774 | 36.9 | 56,604 | 20.4 | 94,378 | 22.2 |
| | Sep/Oct | 63,250 | 12.7 | 82,343 | 23.2 | 146,886 | 17.3 | 229,229 | 16.0 |
| | Nov/Dec | 24,174 | 14.6 | 29,518 | 29.6 | 24,946 | 25.6 | 54,464 | 21.2 |
| 2015 | Jan/Feb | 6,554 | 26.0 | 11,172 | 52.5 | 2,884 | 54.8 | 14,056 | 48.2 |
| | Mar/Apr | 13,338 | 18.8 | 9,870 | 40.8 | 5,880 | 33.6 | 15,751 | 35.3 |
| | May/June | 49,792 | 12.2 | 103,793 | 22.9 | 48,774 | 26.3 | 152,567 | 19.5 |
| | Jul/Aug | 63,706 | 10.6 | 149,016 | 20.0 | 133,629 | 20.5 | 282,645 | 16.1 |
| | Sep/Oct | 37,938 | 11.0 | 32,683 | 30.0 | 39,298 | 19.8 | 71,981 | 18.2 |
| | Nov/Dec | 24,264 | 17.7 | 34,817 | 36.7 | 34,672 | 25.5 | 69,489 | 25.2 |
| 2016 | Jan/Feb | 11,400 | 28.3 | . | . | 73 | 100.0 | 73 | 100.0 |
| | Mar/Apr | 13,803 | 20.5 | 15,411 | 49.5 | 1,238 | 63.5 | 16,649 | 46.2 |
| | May/June | 35,478 | 14.4 | 28,748 | 37.0 | 40,159 | 31.4 | 68,907 | 26.6 |
| | Jul/Aug | 51,299 | 11.8 | 140,659 | 29.5 | 112,351 | 22.0 | 253,010 | 19.8 |
| | Sep/Oct | 41,928 | 11.9 | 42,855 | 26.5 | 29,109 | 20.7 | 71,964 | 19.7 |
| | Nov/Dec | 33,813 | 16.7 | 43,571 | 46.4 | 33,017 | 32.2 | 76,588 | 37.9 |
| 2017 | Jan/Feb | 6,178 | 25.3 | 5,722 | 65.1 | 994 | 70.9 | 6,716 | 63.1 |
| | Mar/Apr | 17,512 | 15.9 | 20,607 | 35.7 | 13,568 | 30.5 | 34,175 | 30.9 |
| | May/June | 36,167 | 13.4 | 64,209 | 35.4 | 54,339 | 22.3 | 118,548 | 24.6 |
| | Jul/Aug | 55,330 | 13.7 | 92,670 | 23.6 | 95,611 | 18.8 | 188,281 | 17.5 |
| | Sep/Oct | 40,032 | 13.8 | 93,323 | 21.7 | 54,989 | 25.8 | 148,312 | 19.6 |
| | Nov/Dec | 27,478 | 14.4 | 44,132 | 29.9 | 28,040 | 27.3 | 72,172 | 24.3 |

STATE-MANAGED SPECIES – STRIPED MULLET

Table 2. North Carolina RCGL survey estimates of the number of striped mullet harvested, pounds harvested, number released, and total number caught. The RCGL survey was conducted from 2002-2008, funding was discontinued in 2009.

| Year | Number Harvested | Pounds Harvested | Number Released | Total Number |
|------|------------------|------------------|-----------------|--------------|
| 2002 | 66,305 | 64,213 | 6,549 | 72,854 |
| 2003 | 28,757 | 24,774 | 3,514 | 32,270 |
| 2004 | 34,736 | 35,947 | 2,875 | 37,611 |
| 2005 | 35,888 | 36,314 | 3,492 | 39,380 |
| 2006 | 38,175 | 37,385 | 5,352 | 43,527 |
| 2007 | 35,472 | 40,168 | 7,449 | 42,921 |
| 2008 | 51,465 | 51,785 | 9,207 | 60,672 |

Table 3. Mean length, minimum length, maximum length (mm fork length), and total number of striped mullet measured from North Carolina commercial fish house samples, 2005-2017.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2005 | 343.5 | 199 | 574 | 10,270 |
| 2006 | 347.5 | 197 | 563 | 12,108 |
| 2007 | 343.2 | 180 | 698 | 12,188 |
| 2008 | 357.6 | 208 | 612 | 13,263 |
| 2009 | 359.2 | 202 | 568 | 8,241 |
| 2010 | 352.6 | 206 | 577 | 10,991 |
| 2011 | 353.5 | 166 | 561 | 7,751 |
| 2012 | 356.6 | 200 | 565 | 12,833 |
| 2013 | 360.5 | 212 | 617 | 8,535 |
| 2014 | 349.5 | 195 | 610 | 6,527 |
| 2015 | 360.5 | 205 | 632 | 5,923 |
| 2016 | 364.3 | 226 | 612 | 5,661 |
| 2017 | 361.6 | 199 | 726 | 4,480 |

STATE-MANAGED SPECIES – STRIPED MULLET

Table 4. Modal age, minimum age, maximum age and total number of striped mullet aged from fishery independent and fishery dependent sampling, 2004-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2004 | 2 | 0 | 9 | 1,142 |
| 2005 | 1 | 0 | 10 | 654 |
| 2006 | 2 | 0 | 10 | 685 |
| 2007 | 2 | 0 | 10 | 699 |
| 2008 | 2 | 0 | 10 | 771 |
| 2009 | 2 | 0 | 13 | 349 |
| 2010 | 2 | 1 | 8 | 748 |
| 2011 | 2 | 0 | 14 | 633 |
| 2012 | 2 | 0 | 6 | 873 |
| 2013 | 2 | 0 | 7 | 850 |
| 2014 | 2 | 0 | 6 | 855 |
| 2015 | 2 | 0 | 6 | 794 |
| 2016 | 2 | 0 | 8 | 956 |
| 2017 | 1-2 | 0 | 15 | 695 |

Table 5. Summary of management strategies and outcomes from the NCMFC rules adopted in April 2006.

| MANAGEMENT STRATEGY | OUTCOME |
|--|---|
| Implement a recreational harvest limit of 200 mullet per person, per day – currently there are no bag restrictions for mullet. | Completed, MFC Rule April 2006 adoption 15ANCAC 03M.0502 (a), (b) |
| Modify mutilated finfish rule to exempt mullet when used as bait. | 15ANCAC 03M.0101 |

STATE-MANAGED SPECIES – STRIPED MULLET

FIGURES

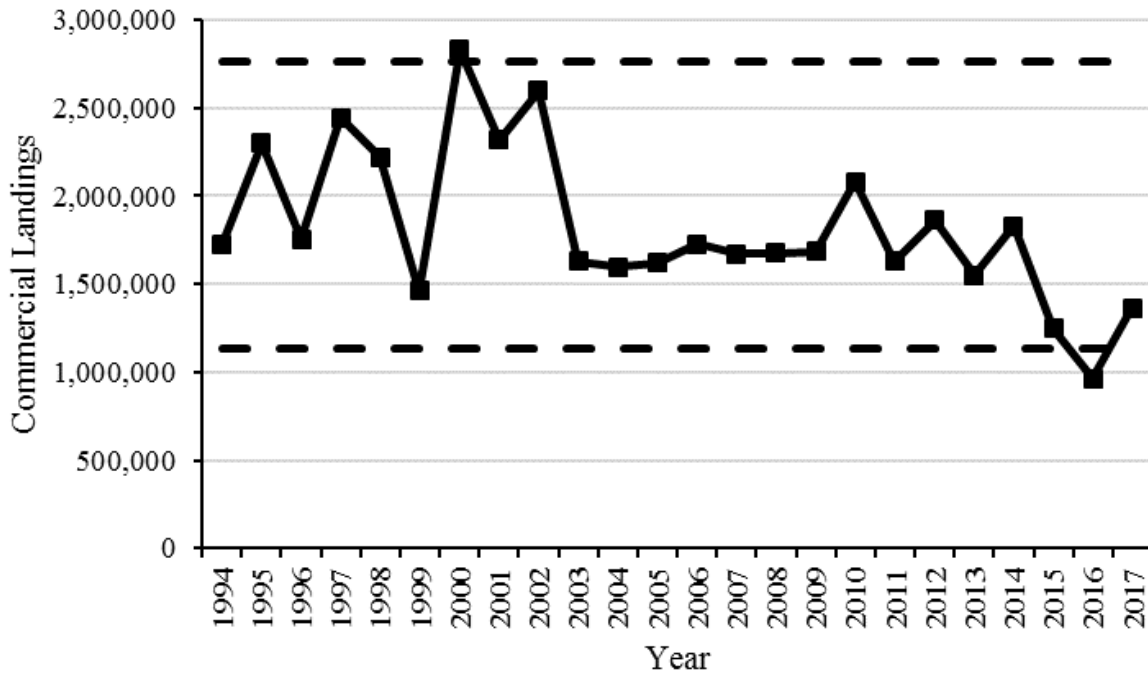


Figure 1. Commercial landings of striped mullet, 1994-2017. Dashed lines represent upper (2.76 million lb.) and lower (1.13 million lb.) landings limits that would trigger a closer examination of data. Landings limits were changed from upper and lower limits of 3.1 million and 1.3 million pounds by Amendment 1 (NCDMF 2014).

STATE-MANAGED SPECIES – STRIPED MULLET

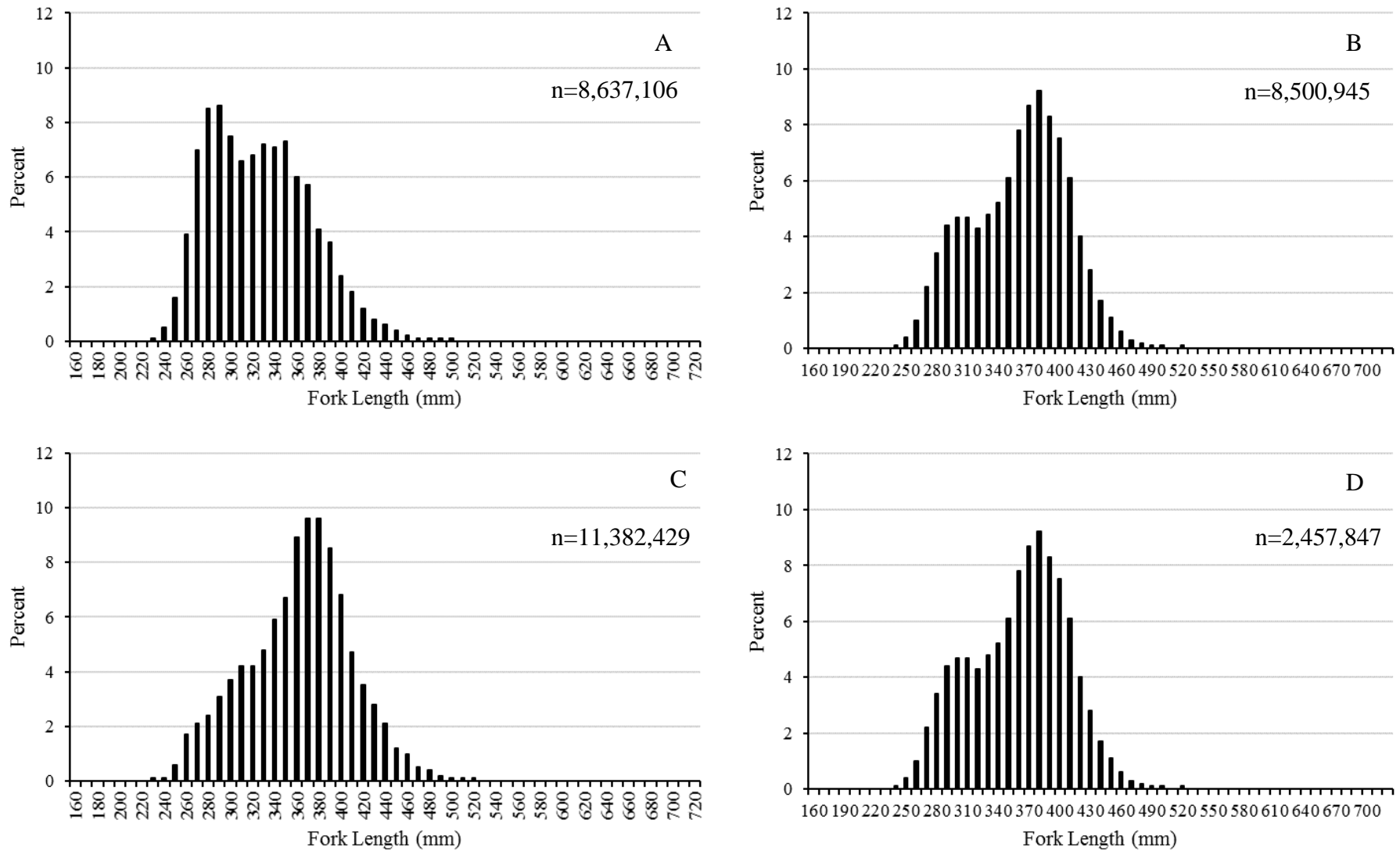


Figure 2. Expanded length-frequency of striped mullet from the commercial fishery based on NCDMF fish house sampling, 2004-2017. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

STATE-MANAGED SPECIES – STRIPED MULLET

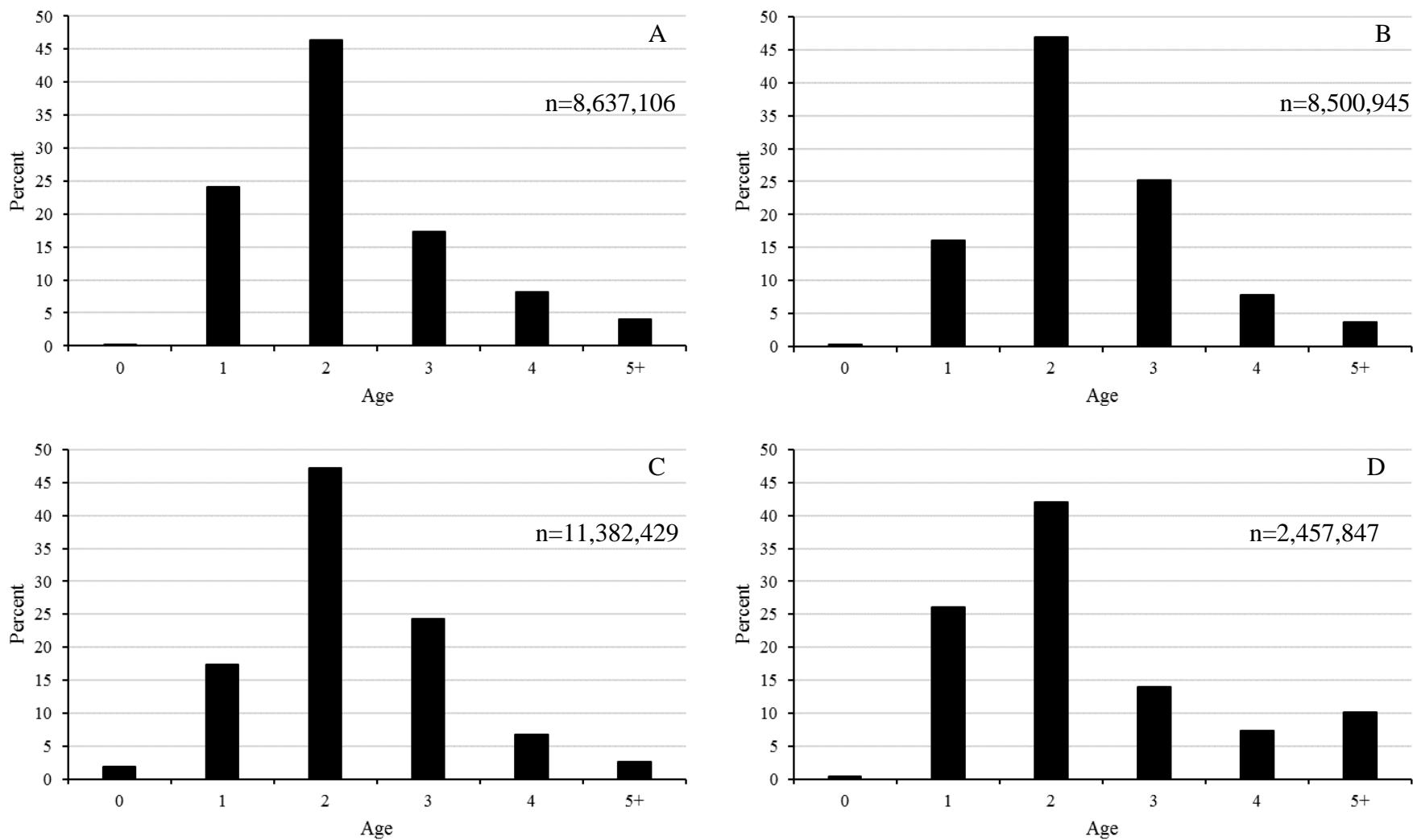


Figure 3. Expanded age-frequency of striped mullet from the commercial fishery based on otolith ages, 2004-2017. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

STATE-MANAGED SPECIES – STRIPED MULLET

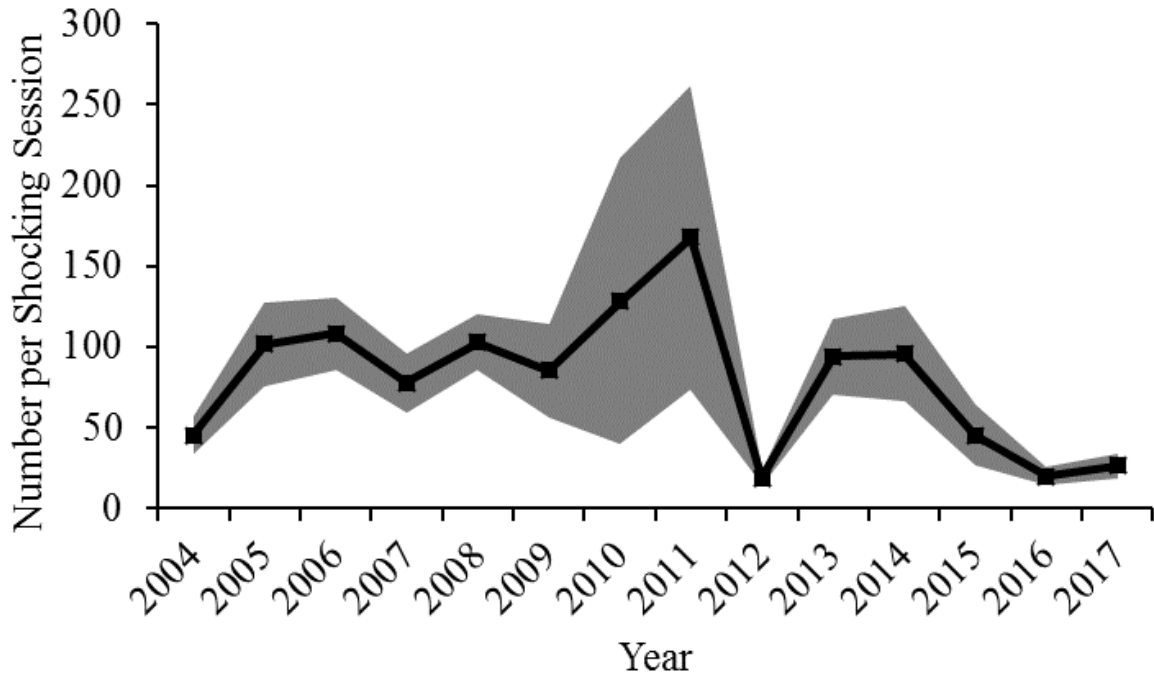


Figure 4. Number of striped mullet per 500 m sampling session from the striped mullet electrofishing survey (P146), 2004-2017. To provide the most relevant index, data were limited to those collected during January through April. The shaded area represents standard error.

STATE-MANAGED SPECIES – STRIPED MULLET

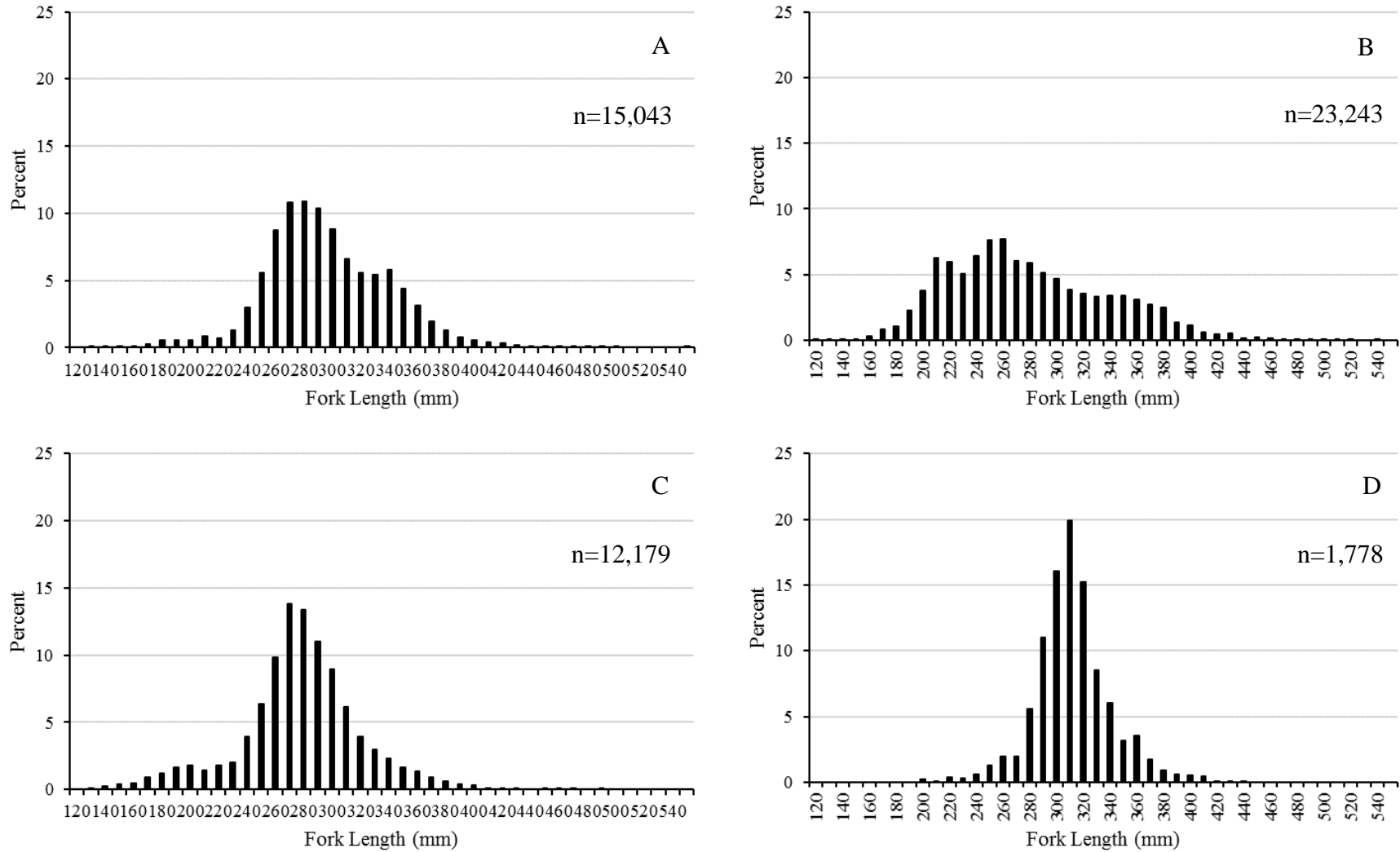


Figure 5. Expanded length-frequency of striped mullet from the striped mullet electrofishing survey (P146), 2004-2017. Lengths include striped mullet collected during January-April. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

STATE-MANAGED SPECIES – STRIPED MULLET

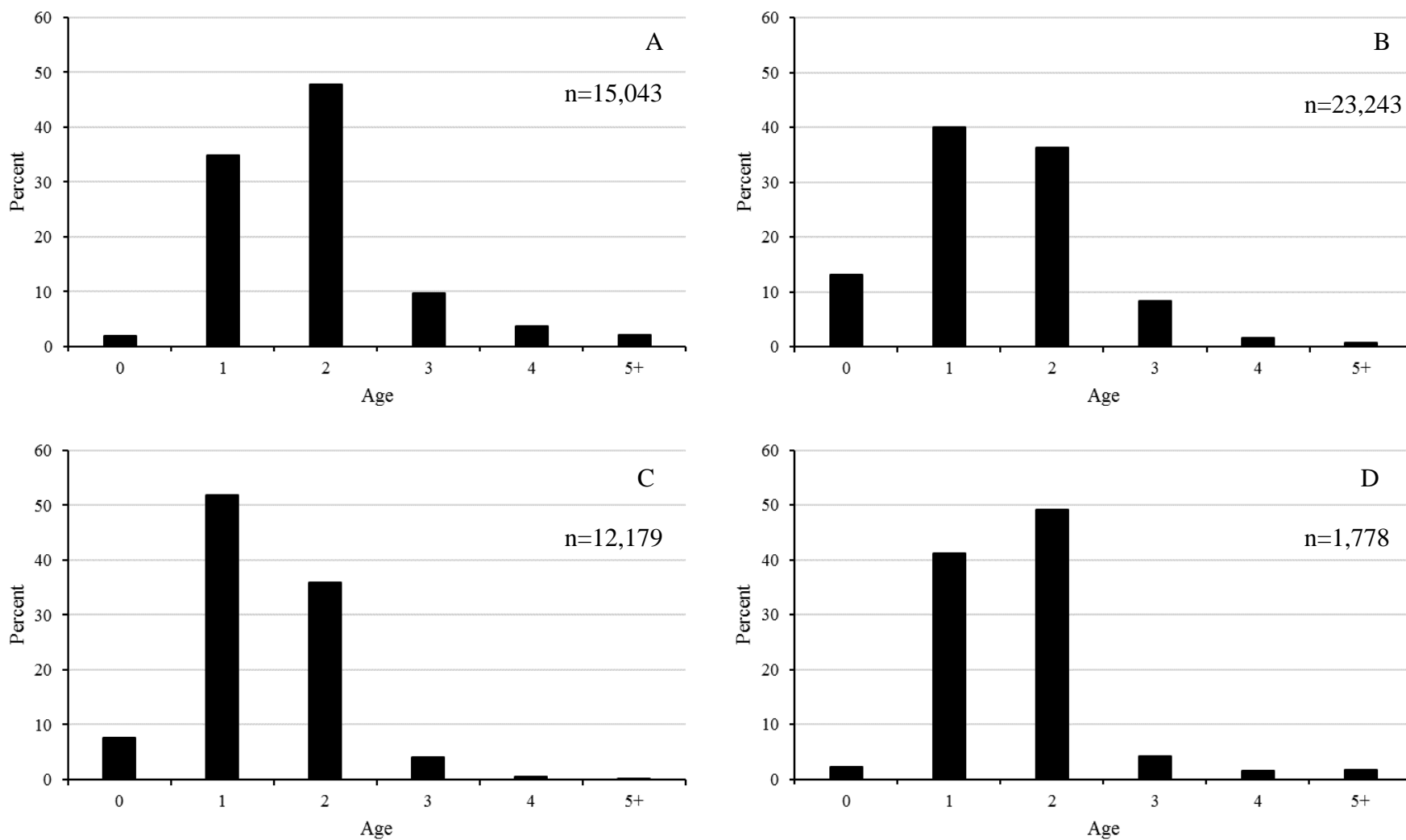


Figure 6. Expanded age-frequency of striped mullet from the striped mullet electrofishing survey (P146) based on otolith ages, 2004-2017. Striped mullet from January-April are included in expansions. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

STATE-MANAGED SPECIES – STRIPED MULLET

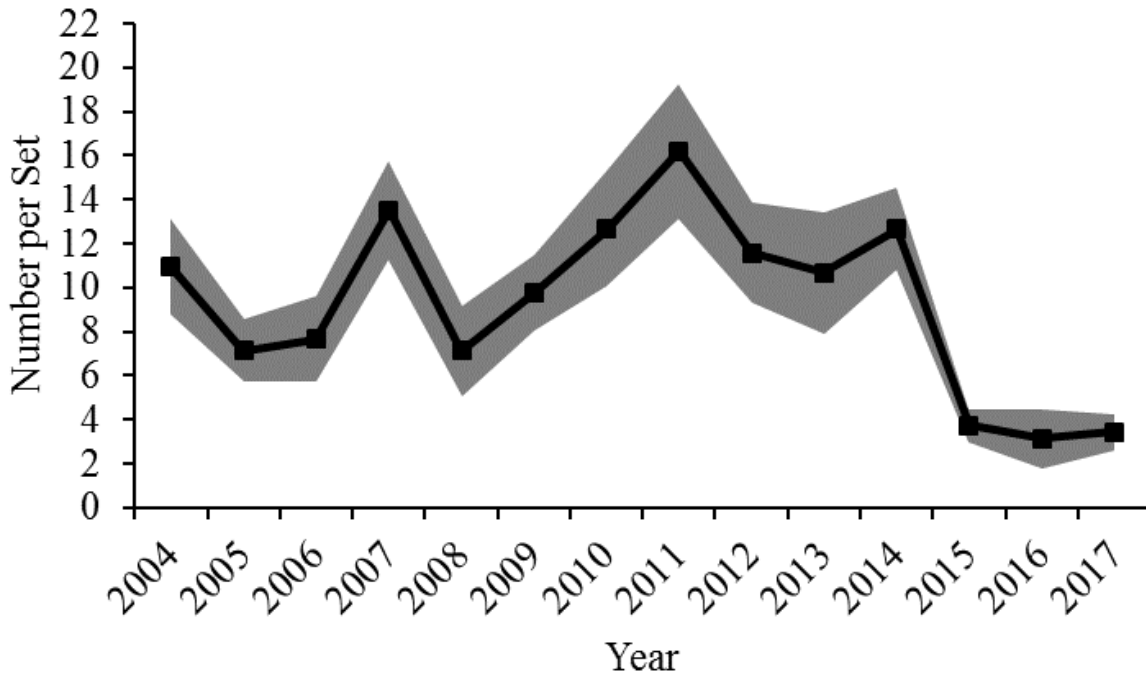


Figure 7. CPUE (number/set) of striped mullet from the independent gill net survey (P915), 2004-2017. To provide the most relevant index, only shallow river (Neuse, Pamlico, Pungo) samples collected during October-November were included. The shaded area represents standard error.

STATE-MANAGED SPECIES – STRIPED MULLET

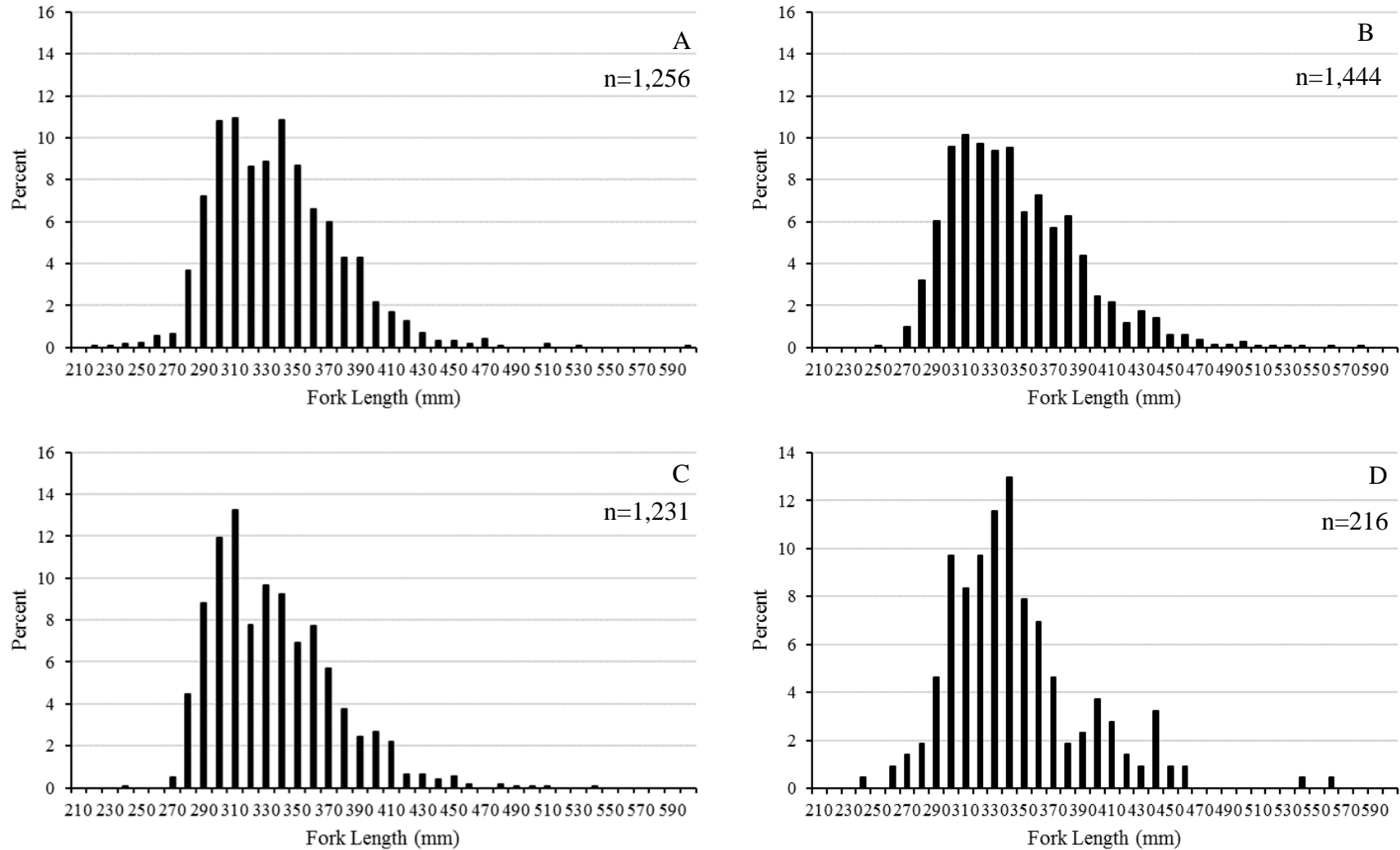


Figure 8. Expanded length-frequency of striped mullet from the independent gill net survey (P915), 2004-2017. Lengths include striped mullet from shallow river (Neuse, Pamlico, Pungo) samples collected during October-November. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

STATE-MANAGED SPECIES – STRIPED MULLET

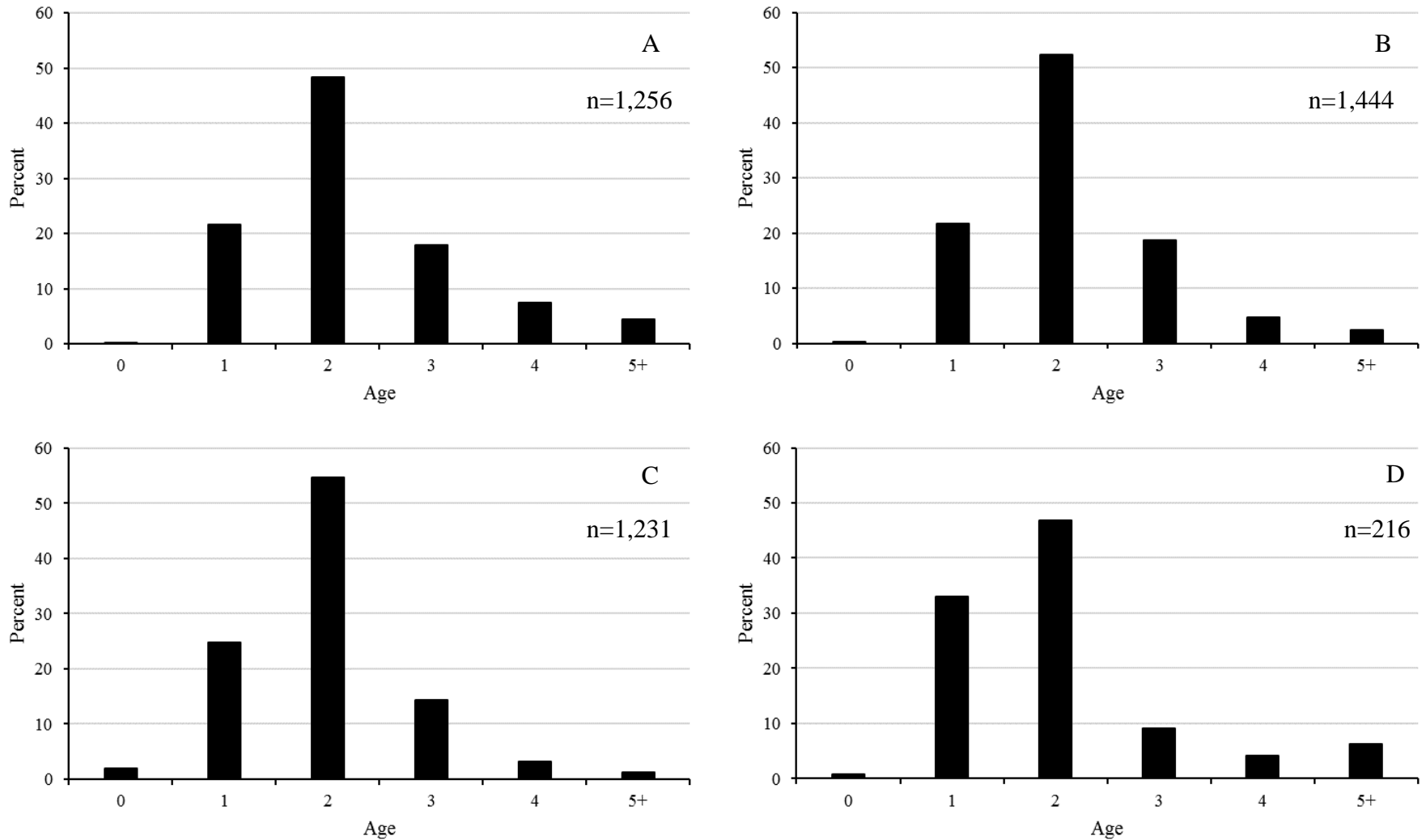


Figure 9. Expanded age-frequency of striped mullet from the independent gill net survey (P915) based on otolith ages, 2004-2017. Striped mullet from shallow river (Neuse, Pamlico, Pungo) samples collected during October-November were included in expansions. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

STATE-MANAGED SPECIES – STRIPED MULLET

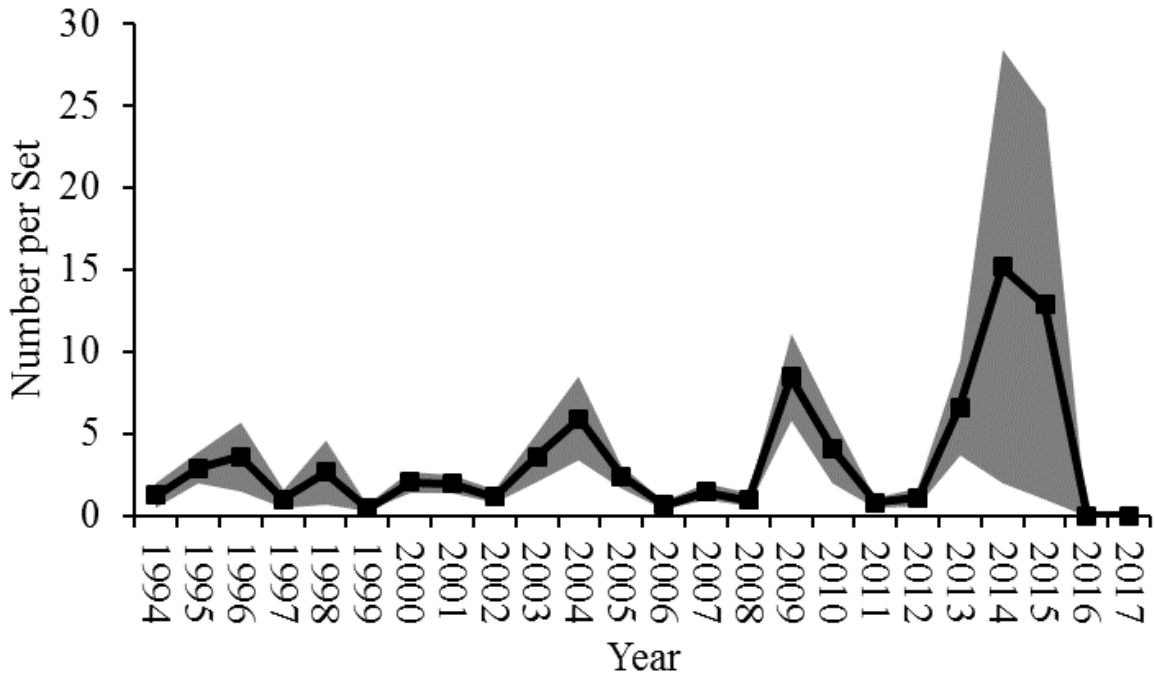


Figure 10. CPUE (number/set) of striped mullet from the striped bass independent gill net survey (P135), 1994-2017. To provide the most relevant index, only shallow river (Neuse, Pamlico, Pungo) samples collected during October-November were included. The shaded area represents standard error.

STATE-MANAGED SPECIES – STRIPED MULLET

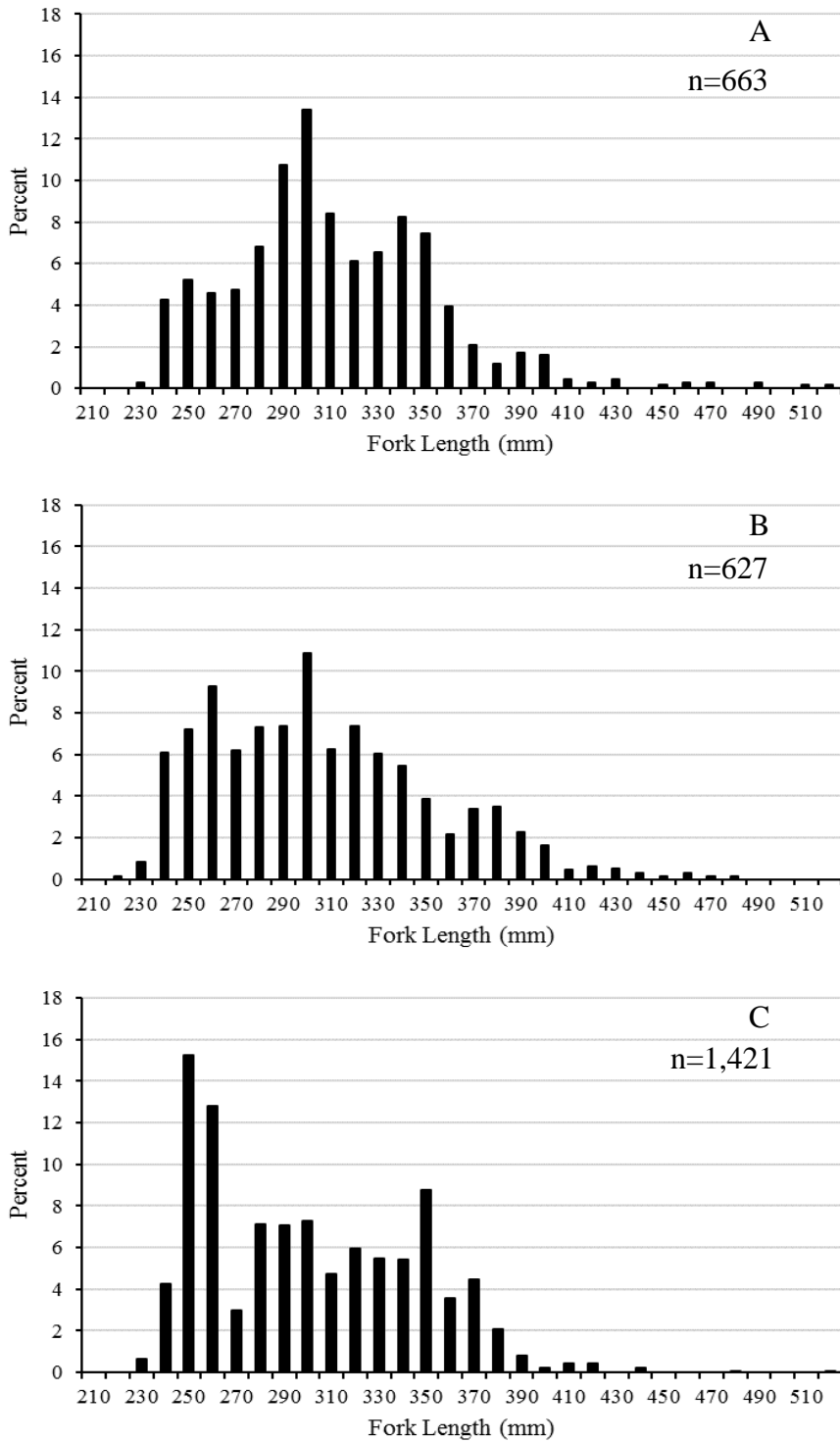


Figure 11. Expanded length-frequency of striped mullet from the fall-winter portion of the striped bass independent gill net survey (P135), 2003-2017. Panel A is 2003-2007; Panel B is 2008-2012; Panel C is 2013-2017. No striped mullet were caught in 2016 or 2017 so no length data is included.

**FISHERY MANAGEMENT PLAN UPDATE
AMERICAN SHAD
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | October 1985 |
| Amendments: | Amendment 1 (April 1999) Amendment 3 (February 2010) |
| Revisions: | Technical Addendum 1 (February 2000) Addendum I (August 2002) |
| Supplements: | Supplement (October 1988) |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | ASMFC started 2018/final results summer 2019 |

The first Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan (FMP) for Shad and River Herrings was adopted in 1985. The FMP did not require any specific management approach or monitoring programs within the management unit, asking only that states provide annual summaries of restoration efforts and ocean fishery activity. It specified four management objectives: regulate exploitation, improve habitat accessibility and quality, initiate programs to introduce alosine stocks into historic waters, and recommend and support research programs. The 1988 Supplement (ASMFC 1988) reassessed the research priorities identified in the original 1985 plan and created a new listing of research priorities.

Amendment 1 (ASMFC 1999) reported that the majority of American shad (*Alosa sapidissima*) stocks were not overfished, but almost all were believed to be at or near historically low levels. Therefore, Amendment 1 required increased annual reporting requirements on juveniles, adult spawning stocks, annual fishing mortality, and habitat. A fishing mortality threshold (overfishing) was defined as a reference point of F_{30} . A fishing mortality rate of F_{30} will result in 30 percent of the maximum spawning potential in the female component of an unfished population. Amendment 1 also implemented the phase-out of the ocean intercept fishery for American shad (effective in 2005). Eliminating the North Carolina ocean intercept fishery was important to controlling harvest to specific river origins.

Technical Addendum 1 (ASMFC 2000) modified several technical errors and provided clarification of several monitoring requirements in Amendment 1.

Addendum I (ASMFC 2002) changed the conditions for marking hatchery-reared alosines. The addendum clarifies the definition and intent of *de minimis* status for the American shad fishery. It also further modifies and clarifies the fishery independent and fishery-dependent monitoring requirements of Technical Addendum 1.

The ASMFC coastwide stock assessment completed in 2007 found that American shad stocks were at all-time lows and did not appear to be recovering to acceptable levels. Therefore, under ASMFC's Amendment 3 to the Interstate FMP for Shad and River Herring, individual states were required to develop Implementation Plans (ASMFC 2010). Implementation Plans consisted of two parts: 1. Review and update of the fishing/recovery plans required under Amendment 1 for the stocks within their jurisdiction; and 2. Habitat plans. North Carolina submitted a fishing/recovery plan that meets the requirements of Amendment 3 and is known as the North Carolina American Shad Sustainable Fishery Plan (SFP) (NCDMF 2011).

To ensure compliance with interstate requirements, North Carolina also manages this species 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).

Management Unit

The management units for American shad are all the migratory American shad stocks of the Atlantic coast of the United States. American shad and hickory shad management authority lies with the ASMFC and is coordinated by Atlantic coastal states from Maine through Florida through approved Sustainable Fishery Management Plans for American Shad. Responsibility for management action in the Economic Exclusive Zone (EEZ), located from three to 200 miles from shore, lies with the Secretary of Commerce through the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) in the absence of a federal FMP.

Goal and Objectives

Migratory stocks of American shad have been managed under the ASMFC since 1985. These species are currently managed under Amendment 3 (American shad) and Amendment 1 (American and hickory shad (*Alosa mediocris*) to the ASMFC FMP, Technical Addendum 1, and Addendum I. Because of the scarcity of data on hickory shad populations, the ASMFC member states decided to focus Amendment I on American shad regulations and monitoring programs. However, the amendment requires states to initiate fishery-dependent monitoring programs for hickory shad while recommending continuance of current fishery-independent programs for

these species. The goal of Amendment 3 is to protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats. To achieve this goal, the plan adopts the following objectives:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.
2. Restore and maintain spawning stock biomass and age structure to achieve maximum juvenile recruitment.
3. Manage for an optimum yield harvest level that will not compromise Objectives 1 and 2.
4. Maximize cost effectiveness to the local, state, and federal governments, and the ASMFC associated with achieving Objectives 1 through 3.

STATUS OF THE STOCK

Life History

American shad are anadromous fish, meaning they spend most of their adult lives at sea, only returning to freshwater in the spring to spawn. Historically, American shad spawned in almost every river and tributary along the East Coast. Shad young leave their home river within the first year and will spend the next few years at sea, schooling in large numbers with shad from other regions and feeding on plankton, small fish, and crustaceans. Upon reaching maturity, at about age 4, they return to the streams they were born in to spawn. Males or "buck shad" return first, followed by females or "roe shad." They spawn usually at night or during overcast days. In the southern range (Cape Fear River to Florida), females release as many as 700,000 eggs during the spawning season, but both males and females normally die after spawning. In the northern range, females typically release 300,000 eggs or less during the spawning season; however, most shad will return to spawn in the following years, with some shad living up to 10 years.

Stock Status

The most recent coastwide stock assessment of American shad stated that populations in the Albemarle Sound and Roanoke River are stable and low, whereas a determination of stock status could not definitively be assigned for the Tar/Pamlico, Neuse and Cape Fear rivers due to limited information (ASMFC 2007).

Stock Assessment

The last coastwide stock assessment for American shad was completed in 2007, which found that stocks are currently at all-time lows and do not appear to be recovering. Recent declines in stock abundance were reported for Maine, New Hampshire, Rhode Island and Georgia, and for the Hudson (NY), Susquehanna (PA), James (VA) and Edisto (SC) Rivers. Low and stable stock abundance was indicated for Massachusetts, Connecticut, Delaware, Chesapeake Bay, the Rappahannock River (VA) and some South Carolina and Florida stocks. The Potomac River

stock has shown rebuilding in recent years of the stock assessment. For North Carolina the stock assessment found that American shad populations in the Albemarle Sound and Roanoke River are stable and low, whereas a determination of stock status could not definitively be assigned for the Tar-Pamlico, Neuse and Cape Fear rivers due to limited information (ASMFC 2007). It should be noted that areas south of Albemarle Sound form a zone where stocks transition from iteroparity (spawns multiple times over the course of its lifetime) to semelparity (spawns once before death), which can also impact the ability to determine stock status.

Primary causes for stock decline were identified, including overfishing, pollution and habitat loss due to dam construction. A peer review panel recommended that current restoration actions should be reviewed and new ones should be identified and applied, and suggested considering a reduction of fishing mortality, enhancement of dam passage and mitigation of dam-related fish mortality, stocking and habitat restoration.

The ASMFC has not conducted a coastwide assessment of hickory shad. The stock assessment update for American shad, currently in progress, will use data through 2017 and is scheduled for completion August 2019.

STATUS OF THE FISHERY

Current Regulations

The NCMFC enacted a rule in 1995, which established a closed season for American shad and hickory shad. It is unlawful to take these species by any method except hook-and-line from April 15 through December 31. The ocean intercept fishery for American shad was closed to all harvest January 1, 2005 (ASMFC 2002).

In the Albemarle, Croatan, Roanoke, and Currituck sounds and tributaries (Albemarle Sound Management Area; ASMA), floating gill nets of 5.25-inch stretch mesh (ISM) to 6.5 ISM, were limited to 1,000 yards and could only be utilized from March 3 through March 24, 2016 and must be fished at least once during a 24-hour period (no later than noon each day). The western portion of Albemarle Sound near the mouth of the Roanoke River (including Roanoke, Cashie, Middle and Eastmost Rivers) is closed to gill netting year-round. The large mesh gill net restrictions were imposed for striped bass conservation but also provided measures of protection for American shad. Gill nets of less than 3.25 ISM were not allowed due to the river herring closure. Gill nets with a mesh length of 3.25 - 4.00 ISM could not exceed 800 yards and were allowed the entire spring. Attendance for small mesh gill nets (3.0 – 4.0 ISM) was required May 18 – November 20. The ASMA was closed to all gill nets except for 3.0 – 4.0 ISM run-around, strike, drop, and drift gill nets until the area was opened September 1, 2015. Gill net attendance was removed in this area on November 20.

In areas outside of the ASMA there is a rule that limits the amount of large mesh (4.0 -6.5 ISM) gill net sets in internal coastal waters to 3,000 yards. To reduce sea turtle interactions, that rule has been suspended in most internal coastal waters and net yardage allowance has been reduced to 2,000 or 1,000 yards in the Tar/Pamlico, Neuse and Cape Fear systems. Nets can be set in lengths no greater than 100 yards and must have at least a 25-yard space between each individual

length of net, except for Management Unit C (Pamlico, Pungo, Bay, and Neuse Rivers). Only single overnight sets are allowed; nets can be set one hour prior to sunset and must be retrieved within one hour of sunrise, with no sets allowed Friday, Saturday or Sunday evenings. Additionally, in certain areas of the Tar/Pamlico and Neuse rivers, gill nets with a mesh size less than 5.0 ISM must be attended at all times.

Commercial Landings

Figure 1 shows all American shad landings in North Carolina from 1972 to 2017. Landings show a decreasing trend through 1990, until average landings leveled off after 2013 with the implementation of the American Shad SFP. Commercial harvest is sporadic and cyclical and annual trends show these changes. Figure 2 describes that landings break down by the four areas of the state, as stated in the NCDMF American Shad SFP. Albemarle Sound accounts for approximately 50 percent, on average, of total state landings (Figure 2).

Recreational Landings

Recreational fishing activity is monitored through coordination with the North Carolina Wildlife Resources Commission (WRC) and the NCDMF, methods were developed to conduct recreational creel surveys on the Roanoke, Tar, Neuse, and Cape Fear rivers starting in 2012, except for Cape Fear River which started in 2013. Recreational landings for American shad are minimal throughout the Albemarle Sound/Roanoke River due to limited to no effort focused on American shad in this system. The Tar/Pamlico, Neuse, and Cape Fear Rivers accounted for approximately 3,012-23,746 fish harvested annually from 2012 to 2017 (Table 1). The bulk of the North Carolina recreational fishery occurs in the Cape Fear River system where substantial effort is targeted on American shad with an estimated average annual harvest of 8,575 fish from 2013 to 2017.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial landings are reported from the NCDMF Trip Ticket Program (TTP). This program requires dealers to complete a trip ticket for each transaction with a fisherman and to submit these reports to the NCDMF monthly.

Table 2 includes mean, minimum and maximum lengths and total number of commercial samples pooled across all gears and areas in the state. Table 3 describes the variation in modal, minimum and maximum ages throughout the dependent sampling from the commercial fishery. The Albemarle Sound area (including Albemarle, Roanoke, Croatan and Currituck sounds and their tributaries) accounts for approximately 50 percent of the state's total harvest, contributing the highest percentage of the in-river fisheries.

Fishery-Independent Monitoring

American shad are monitored using the NCDMF IGNS and NCWRC electrofishing surveys to estimate CPUEs and relative fishing mortality in the Albemarle Sound/Roanoke River area. In other areas of the state, NCWRC conducts electrofishing surveys to estimate abundance and the relative fishing mortality. Table 4 describes the modal, minimum, and maximum age and the number of fish aged from 2008 through 2017 in NCDMF independent surveys.

MANAGEMENT STRATEGY

Shad are managed under Amendment 3 to the ASMFC Interstate FMP for Shad and River Herring. The Amendment requires states and jurisdictions to develop sustainable fishery management plans, which are reviewed by the ASMFC Technical Committee and approved by the ASMFC Shad and Herring Management Board, in order to maintain commercial and recreational fisheries past January 2013. The ASMFC requires that these plans be re-evaluated every five years to update and modify sustainable management measures. The first NCDMF American Shad SFP, effective in 2013 through 2017, identified sustainability parameters for four regions of the state: Albemarle Sound/Roanoke River, Tar/Pamlico, Neuse, and Cape Fear River systems. Sustainability parameters are based on the female portion of the stock because the commercial fishery targets roe shad; roe landings can account for as much as 90 percent of the total American shad landings in a year. The second NCDMF American Shad SFP, approved October 2017 for 2018 through 2022, maintained the original sustainability parameters of relative fishing mortality (F) and abundance indices, but relative F will now be computed by dividing commercial landings by a hind cast 3-year average of a survey index. The previous plan used a centered 3-year average. Proposed thresholds for sustainability parameters are fixed using available survey data through 2017 and will remain fixed during the next 5-year management period.

The NCDMF American Shad SFP is updated annually in September by the American Shad Work Group, which consists of biologist from the NCDMF and the NCWRC, and the next year's season is determined. Annual updates were completed for all areas to determine if any sustainability parameters were exceeding the thresholds. The Tar/Pamlico, Neuse, and Cape Fear River systems have not exceeded any of the thresholds and no management changes were made to those fisheries.

Albemarle Sound/Roanoke River:

The Albemarle Sound/Roanoke River system has three sustainability parameters: female catch per unit effort (CPUE) based on the NCDMF Albemarle Sound Independent Gill Net Survey (IGNS), CPUE based on the North Carolina Wildlife Resources Commission (NCWRC) electrofishing survey, and female relative fishing mortality (F) computed by dividing commercial landings by a hind cast 3-year average of the NCDMF IGNS index. As written in the SFP, exceeding the female CPUE based on IGNS or the female relative F parameters for three consecutive years will trigger management action. The female CPUE based on the NCWRC electrofishing survey will be used in conjunction with a second index for triggering management action.

The Albemarle Sound/Roanoke River system exceeded two thresholds, the female CPUE index based on the NCWRC electrofishing survey and the female relative fishing mortality (F), during

the 2013 commercial fishing season. These parameters exceeding the threshold required management actions to be implemented for the 2014 fishing season. In February 2014, the American Shad Work Group chose to reduce the American shad commercial season in the Albemarle Sound/Roanoke River to March 3-24 to reduce overall commercial landings. The 2015, 2016, and 2017 commercial fishing season continued with the same seasonal dates and updates of sustainability parameters indicate that no thresholds are being exceeded. The recreational season is open year-round. Recreational fishermen can possess 10 American shad and hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only one of the 10 shad may be an American shad.

Figure 3 shows the female CPUE based on the NCDMF IGNS. Figure 4 shows the CPUE based on the NCWRC electrofishing survey. Figure 5 shows the female relative F based on commercial landings and a hind cast three-year average of the NCDMF IGNS index.

Tar/Pamlico system:

The Tar/Pamlico system has two sustainability parameters: female CPUE based on the NCWRC electrofishing survey, and female relative F based on the NCWRC electrofishing survey. The NCDMF American shad SFP set the commercial and recreational seasons and recreational possession limit in 2013. The commercial season is open from February 15 to April 14. The recreational season is open year-round. Recreational fishermen can possess 10 American shad and hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only one of the 10 shad may be an American shad.

Figure 6 shows the female CPUE based on the NCWRC electrofishing survey and figure 7 shows the female relative F based on the NCWRC electrofishing survey.

Neuse system:

The Neuse River system has two sustainability parameters: female CPUE based on the NCWRC electrofishing survey, and female relative F based on the NCWRC electrofishing survey. The NCDMF American shad SFP set the commercial and recreational seasons and recreational possession limit in 2013. The commercial season is open from February 15 to April 14. The recreational season is open year-round. Recreational fishermen can possess 10 American shad and hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only one of the 10 shad may be an American shad.

Figure 8 shows the female CPUE based on the NCWRC electrofishing survey and figure 9 shows the female relative F based on the NCWRC electrofishing survey.

Cape Fear River system:

The Cape Fear River system has two sustainability parameters: female CPUE based on the NCWRC electrofishing survey, and female relative F based on the NCWRC electrofishing survey. The NCDMF American shad SFP set the commercial and recreational seasons and recreational possession limit in 2013. The commercial season is open from February 20 to April

11. The recreational season is open year-round. Recreational fishermen can possess 10 American shad and hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes and only five of the 10 shad may be an American shad.

Figure 10 shows the female CPUE based on the NCWRC electrofishing survey and figure 11 shows the female relative F based on the NCWRC electrofishing survey.

The 2016 update of the SFP sustainability parameters throughout the state demonstrated that all the parameters were within the sustainable targets.

All Other Internal Coastal and Joint Fishing Waters

For all other internal coastal and joint fishing waters not included under a sustainability parameter in the NCDMF American Shad SFP the following commercial and recreational measures were established. The commercial season is open from February 15 to April 14. The recreational season is open year-round. Recreational fishermen can possess 10 American shad and hickory shad, in the aggregate, per person per day taken by hook-and-line or for recreational purposes.

RESEARCH NEEDS

The following list of research needs have been identified to enhance the state or knowledge of the shad and river herring resources, population dynamics, ecology and the various fisheries for alosine species, as found in the ASMFC FMP Amendment 3 and the annual FMP Review (ASMFC 2017).

Stock Assessment and Population Dynamics

- Continue to assess current aging techniques for shad and river herring, using known-age fish, scales, otoliths and spawning marks. Known age fish will be available from larval stocking programs that mark each year class. Conduct biannual aging workshops to maintain consistency and accuracy in aging fish sampled in state programs.
- Investigate the relation between juvenile production and subsequent year class strength for alosine species, with emphasis on the validity of juvenile abundance indices, rates and sources of immature mortality, migratory behavior of juveniles, natural history and ecology of juveniles, and essential nursery habitat in the first few years of life.
- Validate estimates of natural mortality for American shad stocks.
- Establish management benchmarks for data poor river systems identified within the stock assessment.
- Estimate and evaluate sources of mortality for alosine species from bycatch, and bait and reduction fisheries.
- Determine fishery specific catch, harvest, bycatch, and discard reporting rates.
- Estimate and evaluate river specific mortality from upstream and downstream passage of adults and downriver passage of juveniles past migratory barriers.

- Determine which stocks are impacted by mixed stock fisheries (including bycatch fisheries). Methods to be considered could include otolith microchemistry, oxytetracycline otolith marking, and/or tagging.
- Evaluate assumptions critical to in-river tagging programs in Georgia, South Carolina, and Maryland that are used to estimate exploitation rate and population size.
- Develop approaches to estimate relative abundance of spawning stocks in rivers without passage facilities and in rivers with passage facilities with unknown passage efficiencies.
- Evaluate predation by striped bass and other predators as a factor of mortality for alosines. Research predation rates and impacts on alosines.
- Quantify fishing mortality (in-river, ocean bycatch, bait fisheries) for major river stocks after ocean closure of directed fisheries.
- Develop comprehensive and cost effective angler use and harvest survey techniques for use by Atlantic coastal states to assess recreational fisheries for American shad.
- Determine and update biological data inputs used in assessment modeling (fecundity-at-age, mean weight-at-age for both sexes, partial recruitment vector/maturity schedules) for American shad and river herring stocks in a variety of coastal river systems, including both semelparous and iteroparous stocks.
- Evaluate and ultimately validate large-scale hydroacoustic methods to quantify American shad escapement (spawning run numbers) in major river systems. Identify how shad respond (attract/repelled) by various hydroacoustic signals.

Habitat

- Identify ways to improve fish passage efficiency using hydroacoustics to repel alosines from turbine intakes or discharges or pheromones or other chemical substances to attract them to passage entrances. Test commercially available acoustic equipment at existing fish passage facility to determine effectiveness. Develop methods to isolate/manufacture pheromones or other alosine attractants.
- Determine the effects of passage impediments on all life history stages of American shad including turbine mortality and river and barrier specific passage efficiencies. Highest priority would be the lowermost obstruction.
- Develop and implement techniques to determine shad and herring population targets for tributaries undergoing restoration (dam removals, fishways, supplemental stocking, etc.).
- Characterize tributary habitat quality and quantity for alosine reintroductions and fish passage development.
- Determine impacts to American shad populations from changing ocean environment
- Identify and quantify potential American shad spawning and rearing habitat not presently utilized and conduct an analysis of the cost of recovery.
- Develop appropriate Habitat Suitability Index Models for alosine species in the fishery management plan. Possibly consider expansion of species of importance or go with the most protective criteria for the most susceptible species.
- Determine factors that regulate and potentially limit downstream migration, seawater tolerance, and early ocean survival of juvenile alosines.
- Review studies dealing with the effects of acid deposition on anadromous alosines.
- Determine effects of change in temperature and pH for all life stages.

- Determine optimal and tolerance for salinity, dissolved oxygen, pH, substrate, current velocity, depth, temperature, and suspended solids.
- Determine hard limits and range levels for water quality deemed appropriate and defensible for all alosines with emphasis on freshwater migratory, spawning, and nursery areas.
- There has been little research conducted on habitat requirements for hickory shad. Although there are reported ranges of values for some variables, such as temperature or depth, there is no information on tolerances or optimal for all life stages. Research on all life stages is necessary to determine habitat requirements.
- Determine impacts of declining submerged aquatic vegetation beds on juvenile cover and rearing habitat.
- Determine impacts of thermal power generation projects (e.g., nuclear and coal) that withdraw water for cooling (potential entrainment and impingement of fish) and discharge heated water (thermal barriers to migration, habitat degradation) on estuarine juvenile rearing and migration corridors.
- Determine impacts to migrating American shad (both spawning adults and out-migrating juveniles and adults) by proposed in-stream power generation developments such as tidal stream generation that draws energy from currents.
- Determine potential threats and their level of impact to coastal American shad habitat from: marine acidification; pharmaceutical, wastewater, pesticide contamination; 58 invasive species; niche displacement; and global climate change are in need of further study.
- Determine the impacts to migrating American shad (both spawning adults and migrating juveniles) by proposed wind power generation developments in near shore ocean environments.
- Conduct fish passage research and development with the goal of improving the efficiency of existing and future installations of fish passage measures and facilities in order to restore desired access to and utilization of critical American shad spawning and juvenile rearing habitat.
- Conduct studies to determine whether passing migrating adults upstream earlier in the year in some rivers would increase production and larval survival, and opening downstream bypass facilities sooner would reduce mortality of early emigrants (both adult and early-hatched juveniles).
- Conduct studies to determine the effects of dredging on diadromous habitat and migration.

Life History

- Conduct studies on energetics of feeding and spawning migrations of alosines on the Atlantic coast.
- Evaluate impacts of invasive species such as zebra mussels and flathead catfish on larval and juvenile survival.
- Conduct studies of egg and larval survival and development.
- Focus research on within-species variation in genetic, reproductive, morphological, and ecological characteristics, given the wide geographic range and variation at the intraspecific level that occurs in alosines.
- Ascertain how abundance and distribution of potential prey affect growth and mortality of early life stages.

- Conduct research on hickory shad migratory behavior. This may explain why hickory shad populations continue to increase while other alosines are in decline.

Stocking and Hatcheries

- Refine techniques for hormone induced tank spawning of American shad. Secure adequate eggs for culture programs using native broodstock.
- Refine larval marking techniques such that river and year class can be identified when year classes are later recaptured as juveniles or adults.

Socioeconomics

- Conduct and evaluate historical characterization of socio-economic development (potential pollutant sources and habitat modification) of selected alosine rivers along the Atlantic coast.
- Collect information from consumptive and non-consumptive users on: demographic information (e.g., age, gender, ethnicity/race), social structure information (e.g., historical participation, affiliation with NGOs, perceived conflicts), other cultural information (e.g., occupational motivation, cultural traditions related to resource's use), and community information.
- In order to improve the management-oriented understanding of historical stock trends and related assessments, the social and economic history of the river herring fisheries should be documented for time periods equivalent to the stock return level sought by the biological standards and this analysis should including documenting market trends, consumer preferences including recreational anglers, the role of product substitutes such as Atlantic herring and menhaden, and the levels of subsistence fisheries as can be obtained.
- Before recommending, re-authorizing and/or implementing stock enhancement programs for a given river system, it is recommended that state agencies or other appropriate management organization conduct ex-ante socioeconomic cost and benefit (e.g., estimate non-consumptive and existence values, etc.) analysis of proposed stocking programs

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ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – AMERICAN SHAD

TABLES

Table 1. American shad commercial and recreational landings and releases (recreational only) in numbers and pounds for the Central Southern Management Areas (CSMA), 2012*-2017.

| Year | Neuse River | | | Tar-Pamlico River | | | Cape Fear River | | |
|------|----------------|-----------------|------------------|-------------------|-----------------|------------------|-----------------|-----------------|------------------|
| | Recreational | | Commercial | Recreational | | Commercial | Recreational | | Commercial |
| | Harvest (N) | Released (N) | Landings (lb) | Harvest (N) | Released (N) | Landings (lb) | Harvest (N) | Released (N) | Landings (lb) |
| 2012 | 1,017 | 655 | 23,976 | 959 | 4,396 | 12,936 | | | 10,333 |
| 2013 | 1,388 | 2,771 | 17,320 | 2,603 | 10,180 | 9,776 | 20,519 | 34,902 | 24,888 |
| 2014 | 413 | 998 | 11,358 | 168 | 1,314 | 18,769 | 7,453 | 11,025 | 46,148 |
| 2015 | 94 | 137 | 2,990 | 1,006 | 3,917 | 3,346 | 4,136 | 6,388 | 25,039 |
| 2016 | 252 | 1,423 | 2,568 | 1,051 | 2,820 | 765 | 10,244 | 11,388 | 12,937 |
| 2017 | 519 | 2,591 | 11,451 | 898 | 2,217 | 4,384 | 1,352 | 2,669 | 10,778 |

*Creel survey began in 2012.

Table 2. Length (FL mm) data sampled from the American shad commercial fishery throughout North Carolina, 2008-2017.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2008 | 436 | 145 | 526 | 899 |
| 2009 | 429 | 242 | 575 | 923 |
| 2010 | 434 | 305 | 520 | 1,148 |
| 2011 | 444 | 245 | 507 | 1,283 |
| 2012 | 444 | 235 | 552 | 1,549 |
| 2013 | 453 | 304 | 535 | 1,574 |
| 2014 | 455 | 295 | 508 | 1,026 |
| 2015 | 454 | 329 | 513 | 824 |
| 2016 | 449 | 350 | 513 | 446 |
| 2017 | 448 | 324 | 570 | 520 |

Table 3. Aging data collected from North Carolina American shad commercial fishery, 2008-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2008 | 6,7 | 3 | 9 | 447 |
| 2009 | 7 | 4 | 10 | 435 |
| 2010 | 6 | 3 | 9 | 453 |
| 2011 | 6 | 3 | 8 | 412 |
| 2012 | 5 | 3 | 8 | 525 |
| 2013 | 7 | 3 | 9 | 449 |
| 2014 | 7 | 3 | 9 | 418 |
| 2015 | 7 | 4 | 8 | 409 |
| 2016 | 7 | 4 | 8 | 280 |
| 2017 | 7 | 4 | 9 | 373 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – AMERICAN SHAD

Table 4. Aging data collected from North Carolina American shad independent sampling programs from 2008-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2008 | 5 | 3 | 8 | 188 |
| 2009 | 6 | 4 | 9 | 126 |
| 2010 | 6 | 3 | 8 | 197 |
| 2011 | 6 | 2 | 8 | 78 |
| 2012 | 5 | 3 | 8 | 151 |
| 2013 | 7 | 3 | 8 | 203 |
| 2014 | 6 | 3 | 8 | 118 |
| 2015 | 7 | 3 | 9 | 118 |
| 2016 | 5,6 | 3 | 7 | 114 |
| 2017 | 6 | 3 | 8 | 210 |

FIGURES

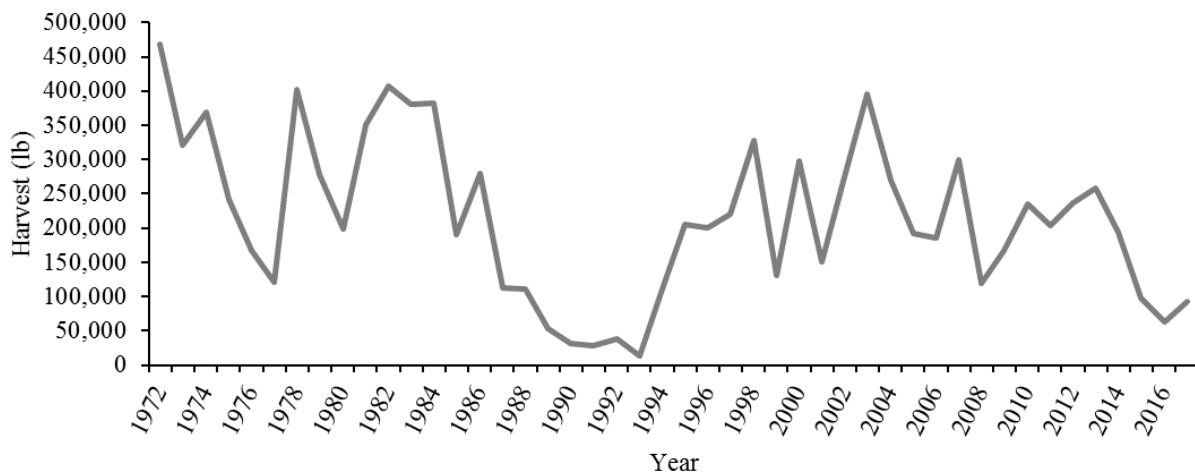


Figure 1. Landings of American shad (in North Carolina from 1972-2017, all waterbodies combined).

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – AMERICAN SHAD

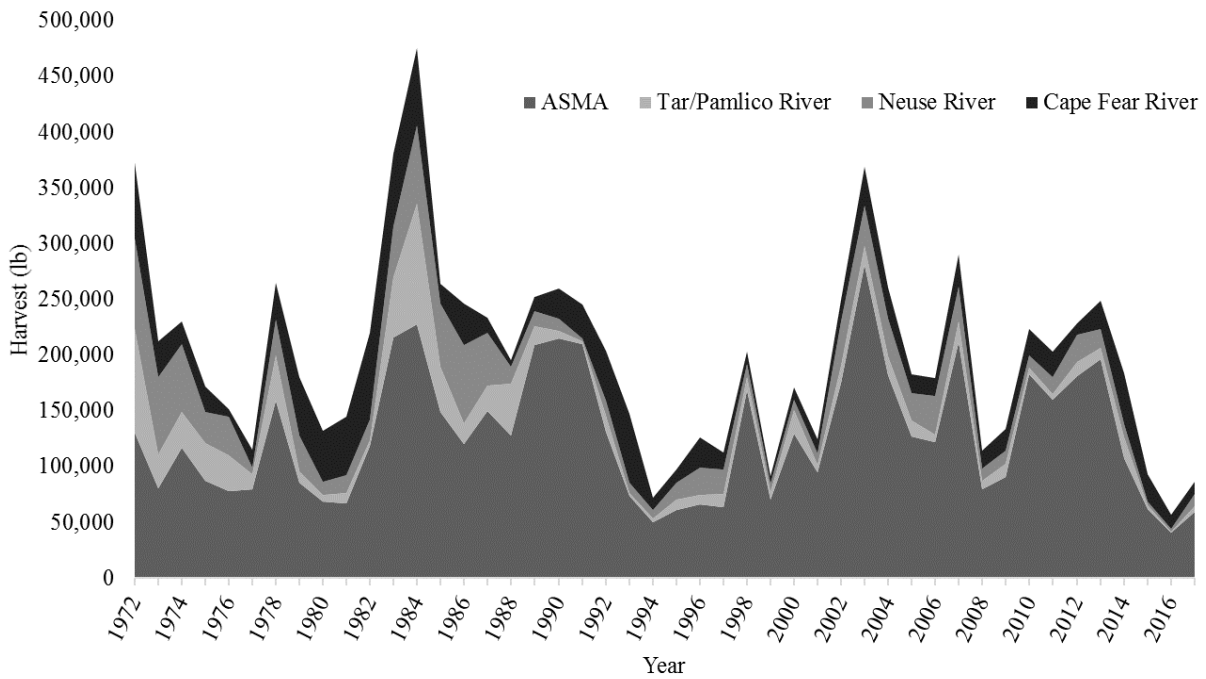


Figure 2. Landings of American shad in North Carolina by major waterbody from 1972-2017.

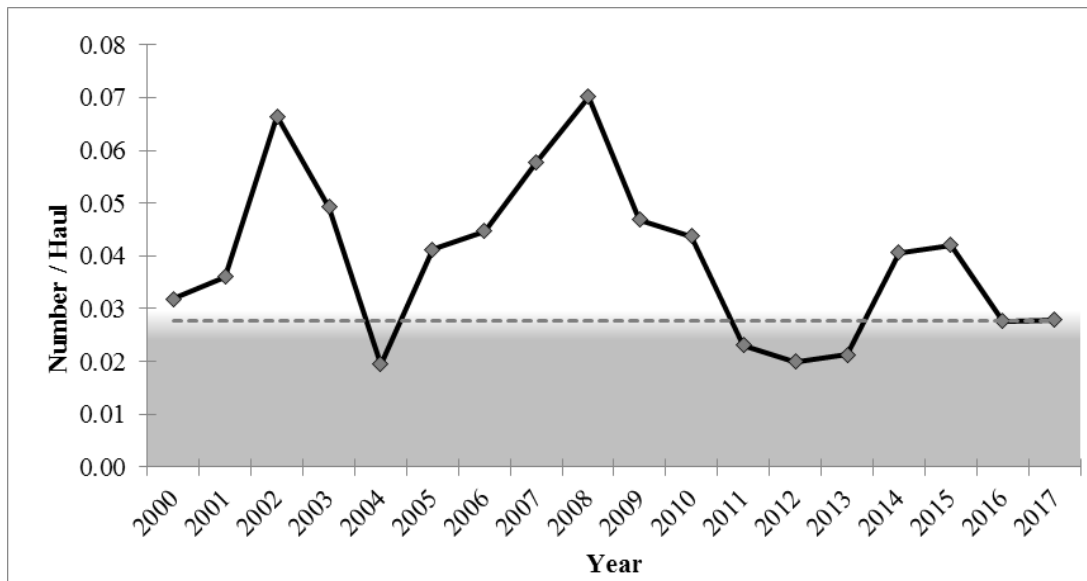


Figure 3. Albemarle Sound/Roanoke River sustainability parameter for female CPUE in the NCDMF IGNS, 2000-2017. Grey areas represent a parameter exceeding the threshold.

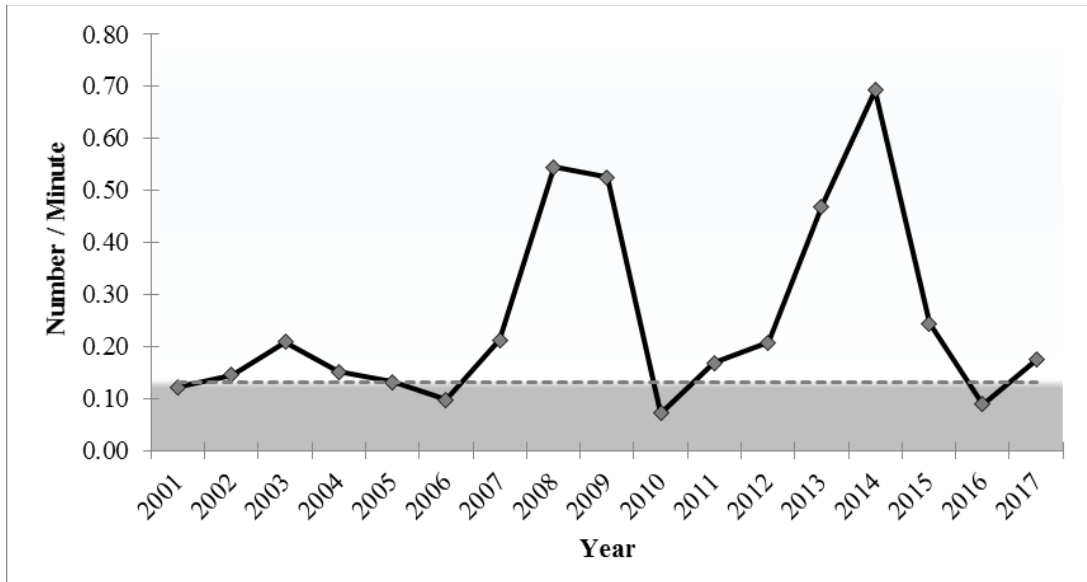


Figure 4. Albemarle Sound/Roanoke River sustainability parameter for female CPUE in NCWRC electrofishing survey, 2001-2017. Grey areas represent a parameter exceeding the threshold.

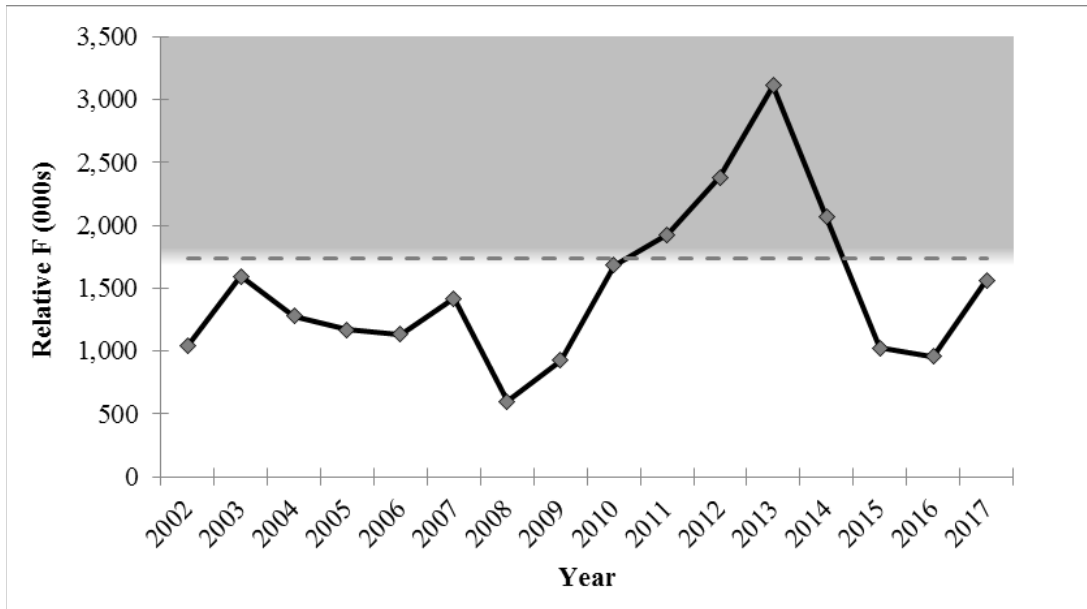


Figure 5. Albemarle Sound/Roanoke River sustainability parameter for female relative F in the NCDMF IGNS, 2002-2017. Grey areas represent a parameter exceeding the threshold.

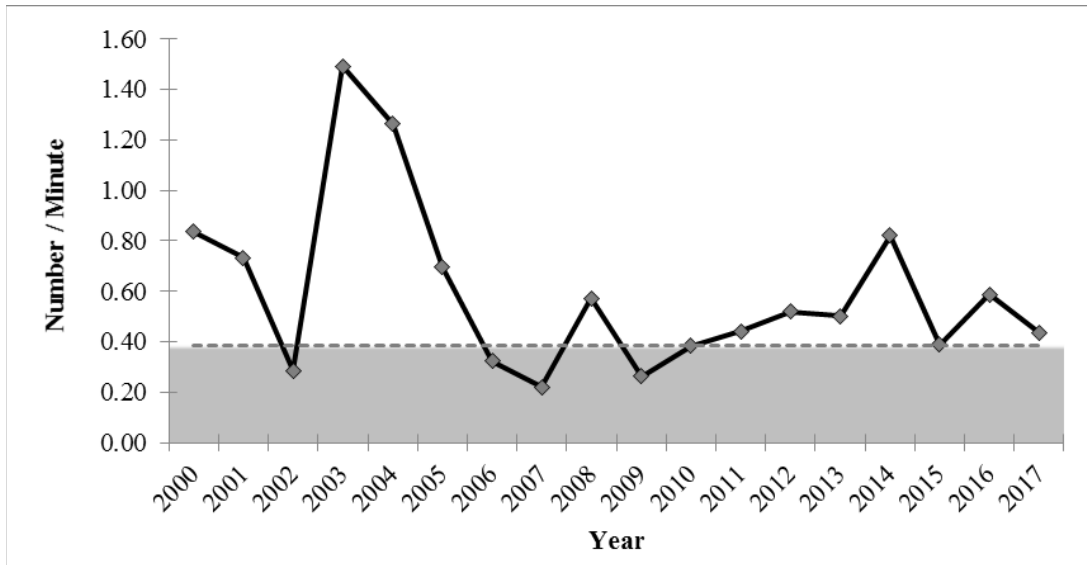


Figure 6. Tar/Pamlico River system sustainability parameter for female CPUE in NCWRC electrofishing survey, 2000-2017. Grey areas represent a parameter exceeding the threshold.

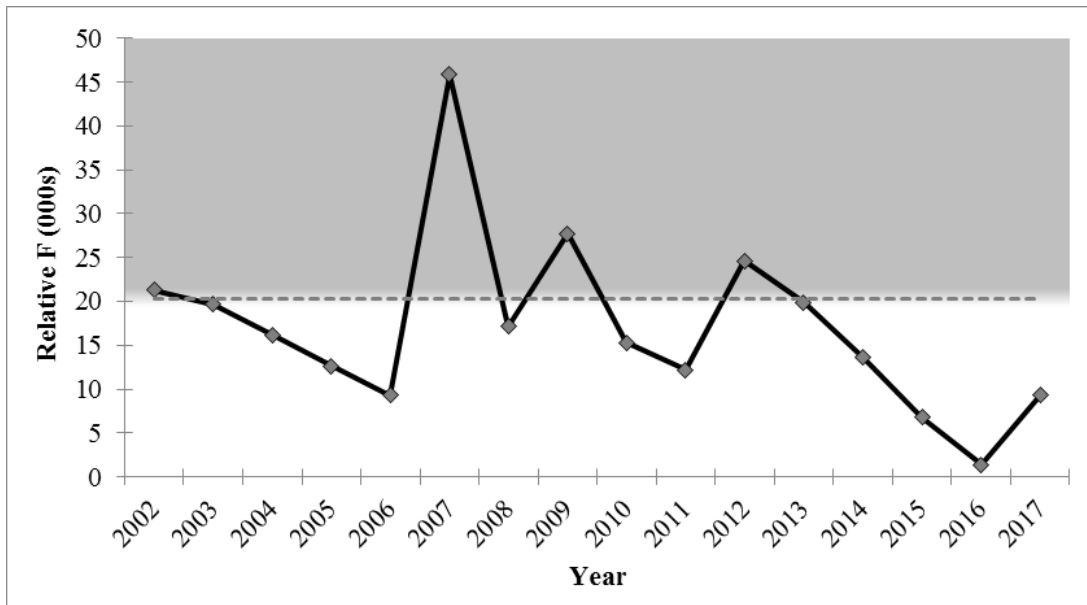


Figure 7. Tar/Pamlico River system sustainability parameter for female relative *F* in NCWRC electrofishing survey, 2002-2017. Grey areas represent a parameter exceeding the threshold.

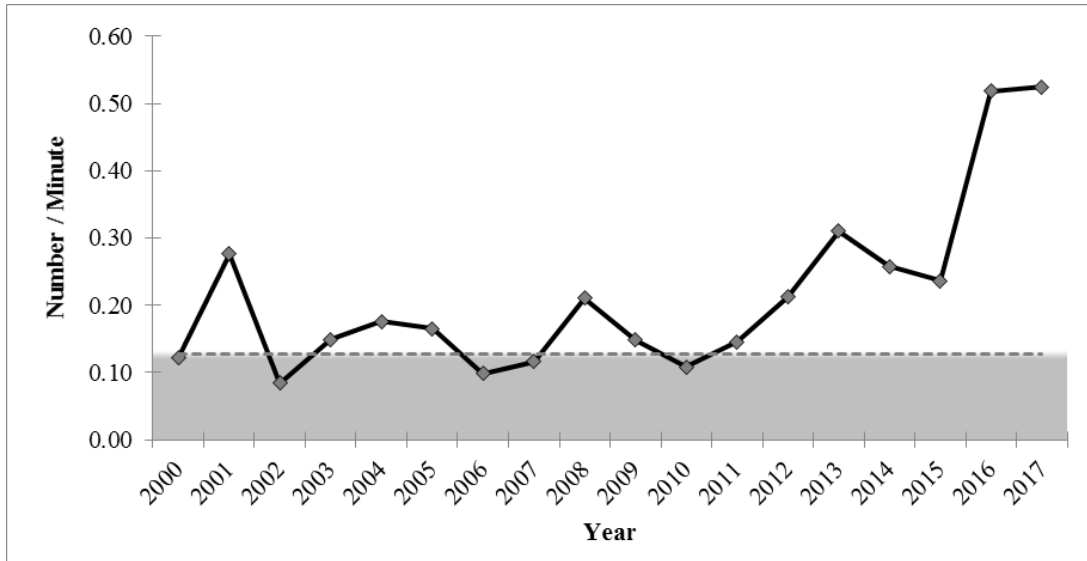


Figure 8. Neuse River system sustainability parameter for female CPUE in NCWRC electrofishing survey, 2000-2017. Grey areas represent a parameter exceeding the threshold.

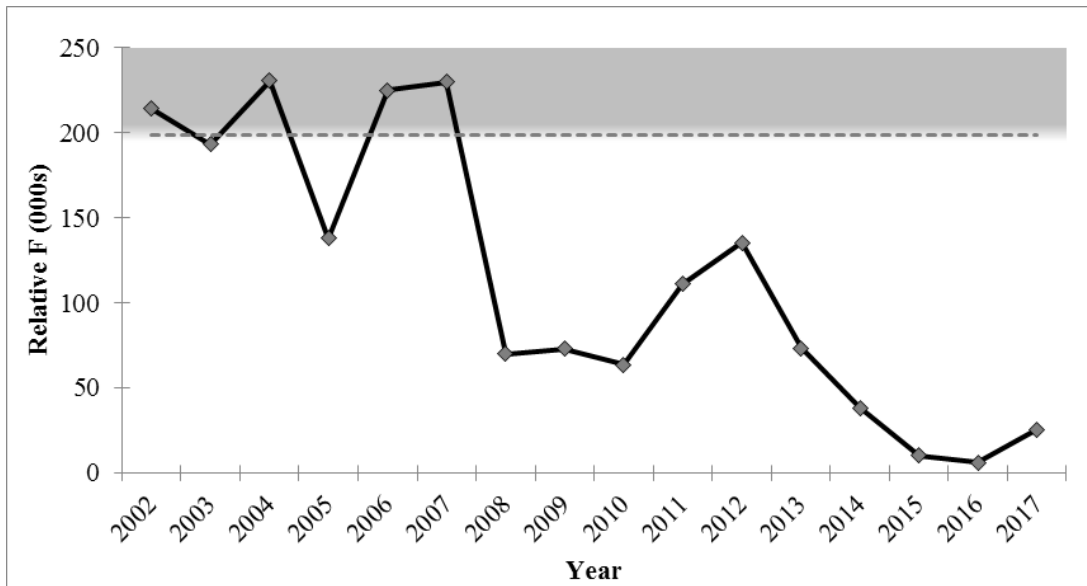


Figure 9. Neuse River system sustainability parameter for female relative *F* in NCWRC electrofishing survey, 2002-2017. Grey areas represent a parameter exceeding the threshold.

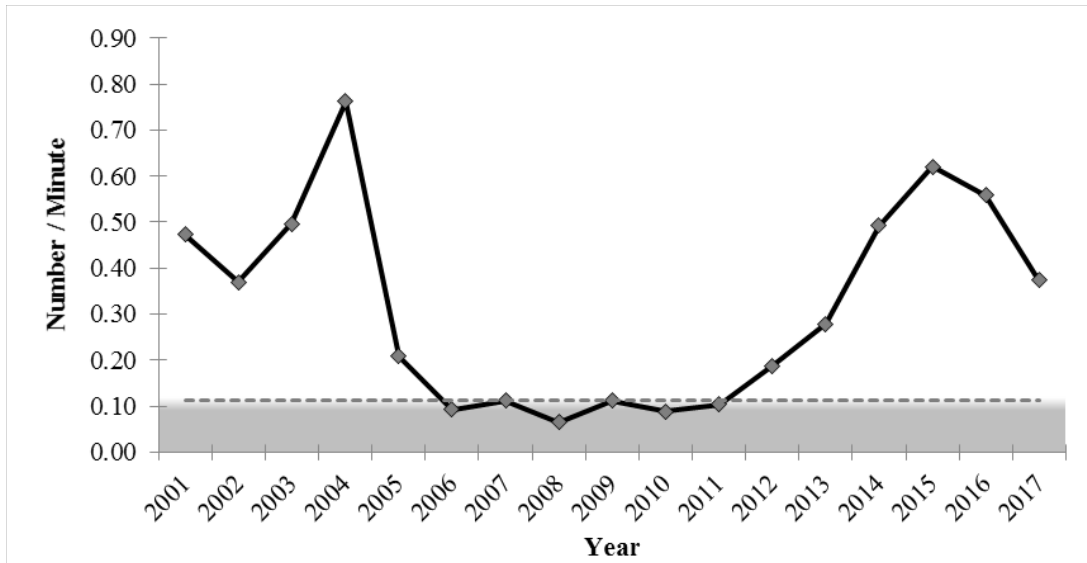


Figure 10. Cape Fear River system sustainability parameter for female CPUE in NCWRC electrofishing survey, 2001-2017. Grey areas represent a parameter exceeding the threshold.

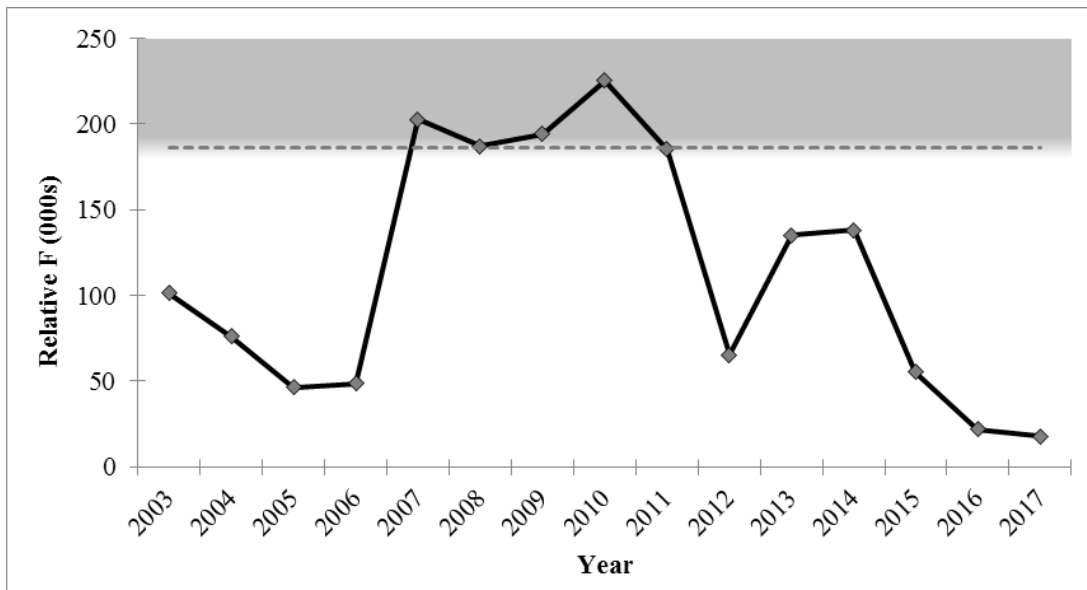


Figure 11. Cape Fear River system sustainability parameter for female relative *F* in NCWRC electrofishing survey, 2003-2017. Grey areas represent a parameter exceeding the threshold.

**FISHERY MANAGEMENT PLAN UPDATE
ATLANTIC CROAKER
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | October 1987 |
| Amendments: | Amendment 1 – November 2005 Addendum I – March 2011 Addendum II – August 2014 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | 2021 |

The Fishery Management Plan for Atlantic croaker was adopted in 1987 (ASMFC 1987) and included states from Maryland through Florida. Upon review, the South Atlantic State/Federal Fisheries Management Board (hereinafter referred to as Board) found its recommendations to be vague and recommended that an amendment be prepared to define management measures necessary to achieve the goals of the FMP. The Interstate Fisheries Management Program Policy Board also adopted the finding that the original FMP did not contain any management measures that states were required to implement (ASMFC 2014).

In 2002, the Board directed the Atlantic Croaker Technical Committee to conduct the first coast wide stock assessment of the species in preparation of developing an amendment. The stock assessment was developed in 2003 and approved by a Southeast Data Assessment Review panel for use in management in June 2004. Amendment 1 was approved in November 2005 and fully implemented by January 1, 2006 (ASMFC 2005).

Amendment 1 expanded the management area to include the states from New Jersey through Florida. The amendment defined two Atlantic coast management regions: the south-Atlantic region, including the states Florida through South Carolina; and the mid-Atlantic region, including the states from North Carolina through New Jersey (ASMFC 2005).

Amendment 1 established biological reference points to define overfished and overfishing stock status for the mid-Atlantic region only. Amendment 1 did not require any specific measures

restricting recreational or commercial harvest of Atlantic croaker, though states with more conservative measures were encouraged to maintain those regulations. Through adaptive management, the Board may revise Amendment 1, and regulatory and/or monitoring requirements could be included in the resulting addendum, along with procedures for determining *de minimis* status and implementing alternative management programs via conservation equivalency.

Amendment 1 specified triggers for initiation of a stock assessment in non-assessment years. If upon review of the data the technical committee felt there was sufficient evidence of changes in the stock, a stock assessment could be initiated in the absence of hitting the triggers. The triggers considered by the technical committee were:

1. Relative percent change in landings
 - a. A stock assessment will be triggered if the most recent year's commercial landings are less than 70 percent of the previous two year's landings.
 - b. A stock assessment will be triggered if the most recent year's recreational landings are less than 70 percent of the previous two year's average landings.
2. Biological Data Monitoring:
 - a. The technical committee will compare the most recent year's mean length data from the recreational fishery to the average of the last two years' mean lengths.
 - b. The technical committee will compare the most recent year's mean size (length and weight) data from the commercial fishery to the average of the last two years' mean size (length and weight) data.
 - c. The technical committee will monitor the overall age composition (proportion at age) and calculate the mean size at age for the age groups that are present in the state samples.
3. Effort vs. Landings (commercial)
 - a. Catch Per Unit Effort (CPUE) considerations for the near future: as effort data increases in quality, the trigger should change from a commercial landings basis to commercial CPUE by gear type. At this time, the technical committee will monitor effort (e.g. trips or days fished) vs. landings, on a gear type basis, to track parallel trends.
4. The technical committee will continue to derive a MRFSS CPUE, on a directed trip basis, to examine state-by-state catch rates on an annual basis.
5. State and regional surveys

Addendum I to Amendment 1 was initiated in August 2010. Addendum I consolidated the stock into one management unit and established a procedure by which the board may approve peer-reviewed biological reference points without a full administrative process, such as an amendment or addendum (ASMFC 2011).

Addendum II to Amendment 1 was initiated in February 2014 and was approved in August 2014. Addendum II establishes the use of the Traffic Light Approach (TLA) as a precautionary management framework in the management of Atlantic croaker. The management framework utilizing the Traffic Light Approach replaces the management triggers as stipulated in Addendum I (ASMFC 2014). The harvest component of the Atlantic croaker TLA is composed

of composite commercial and recreational harvest data. The population, or adult abundance, component of the Atlantic croaker TLA is composed of a composite of fishery-independent survey indices (National Marine Fisheries Service (NMFS) and Southeast Area Monitoring and Assessment Program (SEAMAP)). If thresholds for both population characteristics achieve or exceed thresholds for a three-year period management measures are enacted. Reaching the 30 percent threshold requires moderate management measures, and reaching the 60 percent threshold requires elevated management measures. Should a threshold be reached the appropriate percent reduction in harvest and state-by-state measures to achieve the reduction will be recommended by the technical committee and approved by the Board. The overall harvest reduction would be proportional to the magnitude of exceeding the trigger. Management options include size limits, bag/trip limits, seasonal closures, and gear restrictions. Management measures would remain in place for three years, and thresholds would not be applied to the harvest characteristics in assessing the fishery for three years, as this data may be influenced by management action. The TLA is reviewed in July each year.

A benchmark stock assessment for Atlantic croaker was completed in 2017 but was not accepted for management use by a peer review panel (ASMFC 2017a, 2017b). However, the review panel did not identify any major problems in the Atlantic croaker fishery that would require immediate management action. The TLA will continued to be used to guide management decisions between stock assessments. Recommendations for a revised TLA framework were presented to the Board in February 2018 and will be considered by the board for management use in August 2018.

To ensure compliance with interstate requirements, North Carolina also manages this species 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) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC) are similar to the goals of the N.C. Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

Management Unit

New Jersey through the east coast of Florida.

Goal and Objectives

The goal of Amendment 1 is to utilize interstate management to perpetuate the self-sustaining Atlantic croaker resource throughout its range and generate the greatest economic and social benefits from its commercial and recreational harvest and utilization over time. The four objectives of Amendment 1 are:

1. Manage the fishing mortality rate for Atlantic croaker to provide adequate spawning potential to sustain long-term abundance of the Atlantic croaker population.
2. Manage the Atlantic croaker stock to maintain the spawning stock biomass above the target biomass levels and restrict fishing mortality to rates below the threshold.
3. Develop a management program for restoring and maintaining essential Atlantic croaker habitat.
4. Develop research priorities that will further refine the Atlantic croaker management program to maximize the biological, social, and economic benefits derived from the Atlantic croaker population.

STATUS OF THE STOCK

Life History

Atlantic croaker (*Micropogonias undulatus*) inhabit marsh, submerged aquatic vegetation, mud and sand-bottom areas (Odell et al. 2017) from the Gulf of Maine to Argentina, but are most abundant from the Chesapeake Bay to northern Florida. Atlantic croaker feed chiefly on crustaceans (shrimp and crabs), worms, shellfish and small fishes (Powers et al. 2005; Nye et al. 2011). Atlantic croaker has a lengthy spawning season beginning in the early fall and extending through December with a peak during September and October (White and Chittenden 1977; Barbieri et al. 1994). Eggs and recently hatched larvae spawned in ocean waters drift toward land and the advanced larval stages and juveniles continue their migration inshore by actively swimming into estuarine nursery areas (Odell et al. 2017). Maximum recruitment (the number of fish entering the population) of juvenile fish is usually in the spring, with movement to offshore waters in the fall (Haven 1959; Norcross and Austin 1988). Atlantic croaker grow quickly, reaching sizes of over 20 inches (Ross 1988). Most Atlantic croaker are mature by the end of their first year (White and Chittenden 1977; Barbieri et al. 1994; ASMFC 2010). While it is uncommon to see Atlantic croaker over age 10 (NCDMF 1999; Bobko et al. 2003), the oldest observed specimen, caught in the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP), was 17.

Stock Status

A benchmark stock assessment was completed in 2017 but did not pass peer review and was not recommended for management use (ASMFC 2017a, 2017b). Because there is no currently approved stock assessment the stock status for Atlantic croaker with relation to overfished or overfishing is unknown. However, the peer review panel did not identify any major problems in the Atlantic croaker fishery that would require immediate management action, and recommended continued use of the TLA to monitor the stock (ASMFC 2017a, 2017b).

For reference, the most recent Atlantic croaker stock assessment that was accepted for management use following peer review was completed in 2010 (ASMFC 2010). Results of the 2010 stock assessment indicated Atlantic croaker was not experiencing overfishing and was

likely not overfished. Biomass had been increasing, the age-structure of the population had been expanding since the late 1980s and at that time it was unlikely the stock was in trouble.

Stock Assessment

A benchmark stock assessment, completed in 2017, did not pass peer review and will not be used for management. The assessment was not recommended for management because of concern over uncertainty in biomass estimates due to conflicting signals among abundance indices and catch time series as well as sensitivity of model results to assumption and model inputs (ASMFC 2017a). The review panel noted that the estimation of Atlantic croaker discards from the shrimp trawl fishery was an improvement from the last assessment and recommended shrimp trawl discard estimates be incorporated into annual monitoring using the Traffic Light Analysis.

To evaluate the status of the stock between stock assessments, the Traffic Light Analysis established under Addendum II is reviewed annually in years when an assessment is not already being conducted. The name comes from assigning a color (red, yellow, green) to categorize relative levels of indicators on the condition of the population (abundance metric) or fishery (harvest metric). For example, as harvest or abundance decrease, the amount of red in that year becomes more predominant. Management triggers were not tripped in 2016 since both population characteristics (harvest and abundance) were not above the 30 percent threshold for the 2014-2016 time period (ASMFC 2017a; Figures 1-3). However, the harvest index has generally indicated a declining trend while the adult abundance index has generally indicated an increasing trend. Recommendations for a revised TLA framework were presented to the Board in February 2018 and decisions regarding the use of the revised TLA for management use will be considered in August 2018.

STATUS OF THE FISHERY

Current Regulations

There are no commercial or recreational regulations on Atlantic croaker in North Carolina.

Commercial Landings

Four gear types (gill nets, fly nets, flounder trawl, and haul seines) are used in directed commercial trips and harvest of Atlantic croaker, and account for approximately 99% of the total landings. Commercial harvest of Atlantic croaker in North Carolina ranged from 1,007,963 to 14,429,197 pounds between 1994 and 2017, with the lowest landings occurring in 2017 (Figure 4). Commercial landings have averaged 7,398,397 pounds from 1994-2017 and have generally been declining since 2003. Atlantic croaker commercial landings are currently supported primarily by consistent landings in the ocean gill net fishery due to effort declines in the fly net and haul seine fisheries. Atlantic croaker are a component of the scrap or bait fishery in North Carolina but this component generally makes up a small percentage of landings.

Recreational Landings

Atlantic croaker are targeted recreationally by shore based anglers and those fishing from private vessels during the summer and fall. Recreational harvest of Atlantic croaker in North Carolina ranged from 85,473 to 241,993 pounds between 2005 to 2017 and has generally been decreasing since 2014 with the lowest harvest occurring in 2017 (Table 1). Despite declines in harvest, the number of releases has generally increased since 2007, but declined by 36 percent in 2017 compared to 2016.

Number of Atlantic croaker measured during the Marine Recreational Information Program (MRIP) sampling has generally remained stable from 2005 to 2017 (Table 2). Mean total length (TL) of Atlantic croaker in 2017 was 228 millimeters and has fluctuated little since 2005. Similarly, minimum and maximum TL has also fluctuated little since 2005. Though, a maximum TL of 319 in 2016 and 317 millimeters in 2017 were by far the lowest values since 2005.

Harvest data from the Recreational Commercial Gear License (RCGL) were collected from 2002 to 2008. The program was discontinued in 2009 due to lack of funding. From 2002-2008, an average of 14,534 pounds of Atlantic croaker were harvested per year (Table 3).

MONITORING PROGRAM DATA

Fishery Dependent Monitoring

The number of Atlantic croaker lengths obtained from fishery dependent sources from 2005 through 2017 ranged from 6,021 in 2017 to 21,719 in 2005 (Table 4). Mean TL varied little ranging from 257 mm to 304 mm. Minimum TL ranged from 113 mm to 187 mm. Maximum TL ranged from 385 mm to 500 mm.

From 2004 through 2017 the size range of Atlantic croaker captured in the commercial fishery (excluding scrap samples) ranged from 110 to 510 millimeters TL (Figure 5). Modal length was 340 millimeters TL in the 2004-2007 time block, there were bimodal peaks of 230 and 320 millimeters TL in the 2008-2011 time block, bimodal peaks of 250 and 320 millimeters TL in the 2012-2015 time block and bimodal peaks of 240 and 300 millimeters TL in the 2016-2017 time block. Bimodal peaks in three time blocks are likely the result of the diverse nature of the Atlantic croaker commercial fishery. Atlantic croaker are targeted with a variety of gears in both estuarine and ocean waters during multiple points in their life cycle. Modal age of Atlantic croaker in the commercial fishery was five in the 2004-2007 time block, four in the 2008-2011 time block, five in the 2012-2015 time block and one in the 2016-2017 time block (Figure 6).

Fishery Independent Monitoring

The number of Atlantic croaker aged in North Carolina from 2005 through 2017 has ranged from 237 in 2011 to 1,071 in 2014 (Table 5). Modal age has ranged from zero in 2008, 2016, and 2017 to five in 2007. Minimum age was zero in every year while maximum age ranged from six

to 15. From 2005-2010 the maximum age was between 13 and 15 and from 2011-2017 the maximum age was between six and nine.

The Pamlico Sound Survey (P195) samples 54 randomly selected stations (grids) in June and September. Stations are randomly selected from strata based upon depth and geographic location. Tow duration is 20 minutes, using double rigged demersal mongoose trawls (9.1 m headrope, 1.0 X 0.6 m doors, 2.2-cm bar mesh body, 1.9-cm bar mesh cod end and a 100-mesh tailbag extension). Data from this survey is used to produce juvenile abundance indices (JAI) for Atlantic croaker which is incorporated into ASMFC stock assessments and reported annually to ASMFC as part of compliance reports. The Atlantic croaker juvenile abundance index from the Pamlico Sound Survey (June only fish <140 mm) from 1987 through 2017 has been variable (Figure 7). The JAI has ranged from 67 individuals per tow in 1996 to 1,175 individuals per tow in 2010. The Atlantic croaker JAI had been declining since 2012 before increasing to 1,172 individuals per tow, the second highest value in the time series, in 2017. The mean JAI over the 31-years of the time series is 348 individuals per tow.

Modal length of Atlantic croaker from the June portion of the Pamlico Sound Survey was 120 mm TL and ranged from 40 millimeters to 210 millimeters TL (Figure 8). Modal length of Atlantic croaker from the September portion of the Pamlico Sound Survey was 130 millimeters TL and ranged from 90 to 230 millimeters TL. Atlantic croaker captured during P195 sampling are age zero and age one (Figure 9). Based on otolith ages, all Atlantic croaker under 150 millimeters TL caught in June 2017 were age zero, and most Atlantic croaker over 160 millimeters TL were age one. Most Atlantic croaker under 20 millimeters TL, captured during the September portion of P195 sampling, were age zero and most Atlantic croaker greater than 20 millimeters TL were age one.

MANAGEMENT STRATEGY

Per Addendum II to Amendment 1, the Traffic Light Approach is used as a precautionary management framework for Atlantic croaker. The Traffic Light Approach provides guidance in lieu of a current stock assessment for Atlantic croaker. Under this management program, if the amount of red in the Traffic Light for both population characteristics (adult abundance and harvest) meet or exceed the threshold for the specified three-year period, then management action is required. Management triggers were not tripped in 2016 since both population characteristics (harvest and abundance) were not above the 30 percent threshold for the 2014-2016 time period. Recommendations for a revised TLA framework were presented to the South Atlantic State/Federal Fisheries Management Board in February 2018 and decisions regarding the use of the revised TLA for management will be voted on in August 2018. A benchmark stock assessment was completed in 2017 but did not pass peer review and will not be used for management. See Table 6 for a summary of management strategies.

RESEARCH NEEDS

There are no research or monitoring programs required of the states except for the submission of an annual compliance report. However, several coastwide and state specific research recommendations have been identified and ranked through the ASMFC FMP and stock assessment process (ASMFC 2017a, 2017b).

- Increase observer coverage for commercial discards, particularly the shrimp trawl fishery. Develop a standardized, representative sampling protocol for observers to use to increase the collection of individual lengths and ages of discarded finfish – HIGH (Ongoing through NCDMF ongoing through NCDMF fishery dependent sampling)
- Describe the coastwide distribution, behavior, and movement of croaker by age, length and season, with emphasis on collecting larger, older fish – HIGH (Ongoing through NCDMF fishery dependent and independent sampling)
- Continue state and multi-state fisheries independent surveys throughout the species range and subsample for individual lengths and ages. Examine potential factors affecting catchability in long term fishery independent surveys – HIGH (Ongoing through NCDMF fishery independent sampling)
- Quantify effects of BRDs and TEDs implementation in the shrimp trawl fishery by examining their relative catch reduction rates on Atlantic croaker – HIGH (Ongoing through NCDMF fishery dependent sampling)
- Continue to develop estimates of length at maturity and year round reproductive dynamics throughout the species range. Assess whether temporal or density dependent shifts in reproductive dynamics have occurred – HIGH (Ongoing in North Carolina)
- Re-examine historical ichthyoplankton studies for an indication of the magnitude of estuarine and coastal spawning, as well as for potential inclusion as indices of spawning stock biomass in future assessments. Pursue specific estuarine data sets from the states (NJ, VA, NC, SC, DE, MD) and coastal data sets (MARMAP, EcoMon) - HIGH (Needed)
- Conduct studies of discard mortality for recreational and commercial fisheries by each gear type in regions where removals are highest – MEDIUM (Needed)
- In the recreational fishery, develop sampling protocol for collecting lengths of discarded finfish and collect otolith age samples from retained fish – MEDIUM (Needed)
- Encourage fishery dependent biological sampling, with proportional landings representative of the distribution of the fisheries. Develop and communicate clear protocols on truly representative sampling – MEDIUM (Ongoing through NCDMF fishery dependent sampling)
- Investigate environmental covariates in stock assessment models including climate cycles (e.g., Atlantic Multi-decadal Oscillation, AMO, and El Niño Southern Oscillation, El Niño) and recruitment and/or year class strength, spawning stock biomass, stock distribution, maturity schedules and habitat degradation – MEDIUM (Needed)
- Utilize NMFS Ecosystem Indicators bi-annual reports to consider folding indicators into the assessment; identify mechanisms for how environmental indicators affect the stock – MEDIUM (Needed)
- Encourage efforts to recover historical landings data, determine whether they are available at a finer scale for the earliest years than are currently reported – MEDIUM (Needed)

- Collect data to develop gear specific fishing effort estimates and investigate methods to develop historical estimates of effort – MEDIUM (Ongoing through NCDMF fishery dependent sampling)
- Develop gear selectivity studies for commercial fisheries with emphasis on age 1+ fish – MEDIUM (Needed)
- Conduct studies to measure female reproductive output at size and age (fecundity, egg and larval quality) and impact on assessment models and biomass reference points – MEDIUM (Needed)
- Develop and implement sampling programs for state specific commercial scrap and bait fisheries to monitor the relative importance of Atlantic croaker. Incorporate biological data collection into programs – MEDIUM (Ongoing through NCDMF fishery dependent sampling)
- Investigate the relationship between estuarine nursery areas and their proportional contribution to adult biomass, i.e., are select nursery areas along the Atlantic coast ultimately contributing more to SSB than other, reflecting better quality juvenile habitat? – MEDIUM (Needed)

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TABLES

Table 1. North Carolina recreational harvest of Atlantic croaker with landings in number of fish, pounds, and number released, 2005-2017. Percent Standard Error (PSE) is given for each.

| Year | Harvest Number | PSE | Weight | PSE | Number Released | PSE |
|---------|----------------|------|---------|------|-----------------|------|
| 2005 | 326,777 | 21.5 | 168,797 | 22.4 | 1,401,413 | 12.5 |
| 2006 | 556,024 | 19.3 | 222,286 | 21.1 | 2,578,819 | 10.3 |
| 2007 | 461,162 | 17.6 | 131,185 | 18.8 | 1,608,120 | 12.7 |
| 2008 | 317,940 | 15.7 | 132,731 | 17.1 | 1,419,019 | 12.1 |
| 2009 | 368,990 | 16.7 | 131,742 | 16.5 | 1,912,670 | 11.0 |
| 2010 | 478,156 | 12.4 | 241,993 | 12.4 | 1,598,139 | 8.9 |
| 2011 | 246,676 | 12.9 | 99,298 | 13.2 | 1,798,230 | 10.7 |
| 2012 | 288,813 | 11.5 | 105,530 | 11.9 | 1,255,216 | 8.7 |
| 2013 | 411,882 | 14.6 | 141,880 | 13.6 | 1,984,701 | 9.8 |
| 2014 | 541,657 | 13.3 | 227,949 | 14.6 | 2,713,787 | 11.7 |
| 2015 | 471,869 | 12.3 | 190,808 | 13.0 | 2,477,625 | 10.4 |
| 2016 | 368,203 | 19.7 | 141,571 | 21.7 | 2,147,160 | 14.6 |
| 2017 | 243,199 | 16.1 | 85,473 | 17.0 | 1,375,394 | 10.9 |
| Average | 390,873 | | 155,480 | | 1,866,946 | |

Table 2. Total number measured, mean, minimum, and maximum length (mm) of Atlantic croaker measured by MRIP sampling in North Carolina, 2005-2017.

| Year | Number Measured | Mean Length | Minimum Length | Maximum Length |
|------|-----------------|-------------|----------------|----------------|
| 2005 | 140 | 247 | 171 | 438 |
| 2006 | 198 | 236 | 122 | 378 |
| 2007 | 113 | 201 | 103 | 348 |
| 2008 | 188 | 244 | 141 | 392 |
| 2009 | 210 | 224 | 145 | 402 |
| 2010 | 330 | 248 | 157 | 427 |
| 2011 | 255 | 239 | 148 | 363 |
| 2012 | 230 | 233 | 124 | 358 |
| 2013 | 267 | 229 | 151 | 392 |
| 2014 | 215 | 236 | 105 | 357 |
| 2015 | 142 | 237 | 147 | 352 |
| 2016 | 219 | 235 | 135 | 319 |
| 2017 | 169 | 228 | 153 | 317 |

Table 3. North Carolina RCGL harvest of Atlantic croaker 2002-2008. Estimates of trips and landings are from a RCGL survey conducted from 2002-2008; funding was discontinued in 2009.

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – ATLANTIC CROAKER

| Year | Number Harvested | Pounds Harvested | Number Released | Total Catch |
|------|------------------|------------------|-----------------|-------------|
| 2002 | 50,132 | 36,392 | 33,253 | 83,386 |
| 2003 | 19,584 | 12,136 | 21,764 | 41,348 |
| 2004 | 22,858 | 13,956 | 24,134 | 46,992 |
| 2005 | 15,692 | 9,544 | 14,453 | 30,146 |
| 2006 | 11,975 | 7,328 | 37,970 | 49,946 |
| 2007 | 14,800 | 8,899 | 9,486 | 24,285 |
| 2008 | 18,080 | 13,480 | 10,480 | 28,560 |

Table 4. Mean length, minimum length, maximum length (mm), and total number of Atlantic croaker measured from North Carolina commercial fish house samples, 2005-2017.

| Year | Mean Length | Minimum Length | Maximum Length | Number Measured |
|------|-------------|----------------|----------------|-----------------|
| 2005 | 304 | 125 | 500 | 21,719 |
| 2006 | 290 | 120 | 487 | 20,533 |
| 2007 | 290 | 118 | 494 | 15,011 |
| 2008 | 283 | 116 | 495 | 15,032 |
| 2009 | 285 | 123 | 486 | 20,448 |
| 2010 | 284 | 128 | 452 | 21,511 |
| 2011 | 292 | 118 | 422 | 15,947 |
| 2012 | 284 | 144 | 454 | 10,923 |
| 2013 | 281 | 143 | 437 | 9,059 |
| 2014 | 265 | 113 | 423 | 11,523 |
| 2015 | 274 | 137 | 394 | 9,593 |
| 2016 | 272 | 187 | 385 | 6,959 |
| 2017 | 257 | 168 | 385 | 6,021 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – ATLANTIC CROAKER

Table 5. Total number aged, modal, minimum, and maximum age of Atlantic croaker in North Carolina from fishery dependent and fishery independent sampling, 2005-2017. Age data from 2017 is preliminary.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2005 | 3 | 0 | 14 | 597 |
| 2006 | 1 | 0 | 13 | 658 |
| 2007 | 5 | 0 | 15 | 321 |
| 2008 | 0 | 0 | 15 | 739 |
| 2009 | 1 | 0 | 14 | 709 |
| 2010 | 4 | 0 | 13 | 703 |
| 2011 | 1 | 0 | 8 | 237 |
| 2012 | 2 | 0 | 7 | 349 |
| 2013 | 1 | 0 | 8 | 577 |
| 2014 | 2 | 0 | 8 | 1,070 |
| 2015 | 1 | 0 | 9 | 993 |
| 2016 | 0 | 0 | 6 | 474 |
| 2017 | 0 | 0 | 7 | 452 |

Table 6. Summary of management strategies and needs.

| Management Strategy | Implementation Status |
|---|--|
| Establish Traffic Light method for monitoring the stock in non-assessment years | Addendum 2 to Amendment 1, approved August 2014. Replaced triggers established by Amendment 1 |
| Change management unit to single coast wide stock (New Jersey to east coast of Florida) and set new biological reference points | Addendum 1 to Amendment 1, approved March 2011 |
| Establish triggers to be used in monitoring stock in non-assessment years | Amendment 1 to the Interstate Fisheries Management Plan for Atlantic croaker, approved November 2005 |
| ASMFC annual state compliance reports submitted in July each year | Amendment 1 to the Interstate Fisheries Management Plan for Atlantic croaker, approved November 2005 |
| Encourage the use of circle hooks to minimize recreational discard mortality | Needed |
| Consider approval of <i>de minimis</i> requests from Delaware, South Carolina, Georgia, and Florida | Ongoing |
| Consider basic research and monitoring information needed for informed management in light of budgetary constraints | Ongoing |

FIGURES

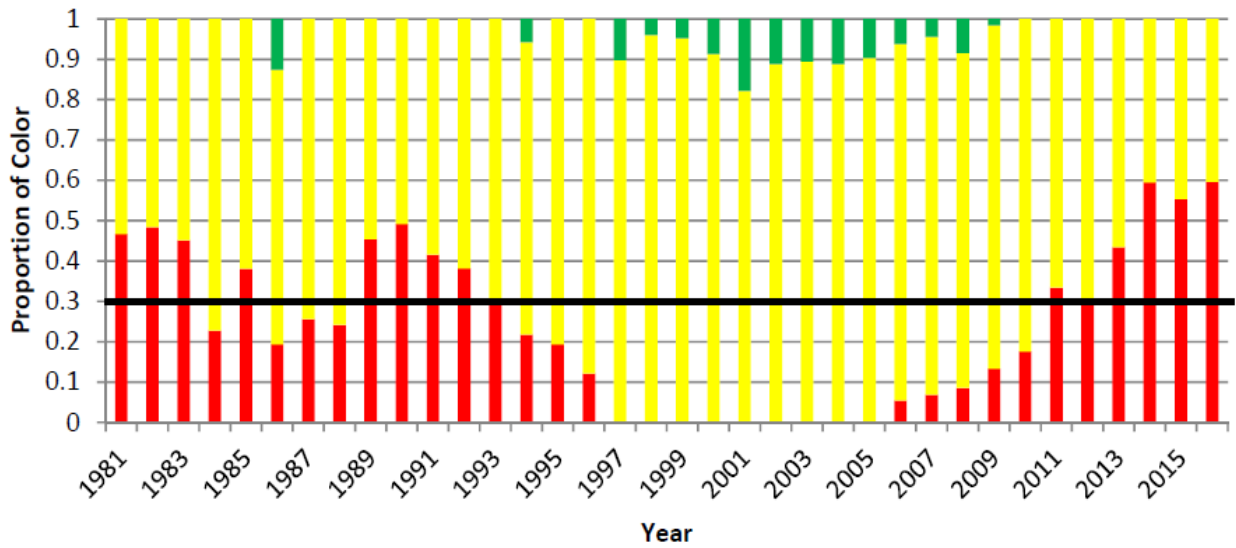


Figure 1. Annual color proportions for the harvest composite Traffic Light Analysis of Atlantic croaker recreational and commercial landings, 1981-2016 (ASMFC 2017a). Black line is the 30 percent threshold for management action. The reference period is 1996-2008.

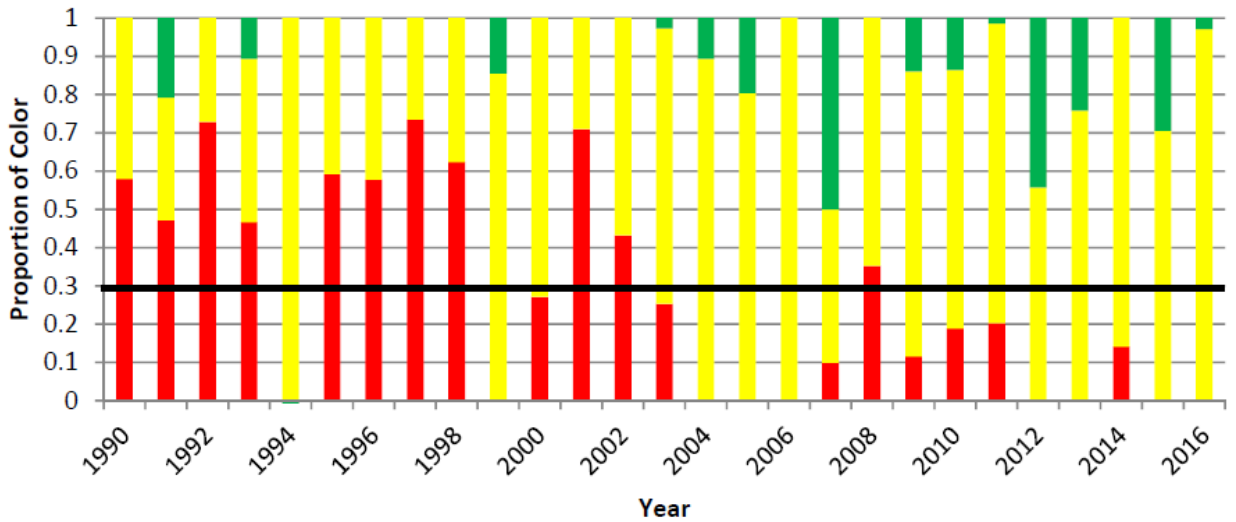


Figure 2. Adult croaker Traffic Light Analysis composite characteristic index (NMFS and SEAMAP surveys), 1990-2016 (ASMFC 2017a). Black line is the 30 percent threshold for management action. The reference period is 1996-2008.

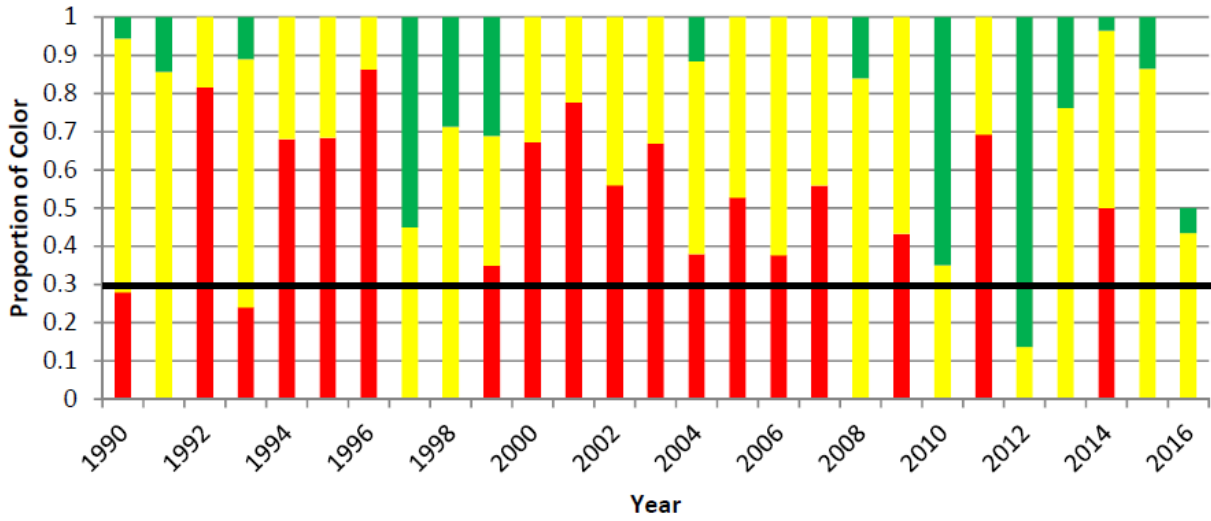


Figure 3. Juvenile croaker Traffic Light Analysis composite characteristic index (Pamlico Sound Survey and Virginia Institute of Marine Science Survey), 1990-2016 (ASMFC 2017a). Black line is the 30 percent threshold for management action. The reference period is 1996-2008.

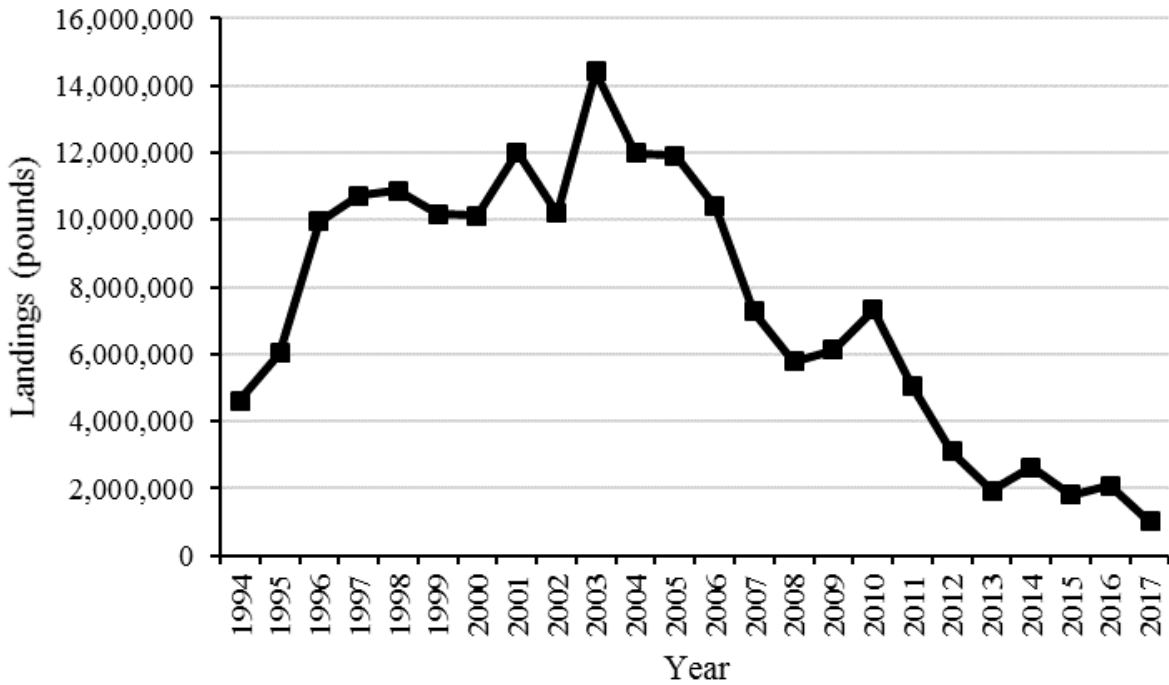


Figure 4. North Carolina commercial landings of Atlantic croaker, 1994-2017.

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – ATLANTIC CROAKER

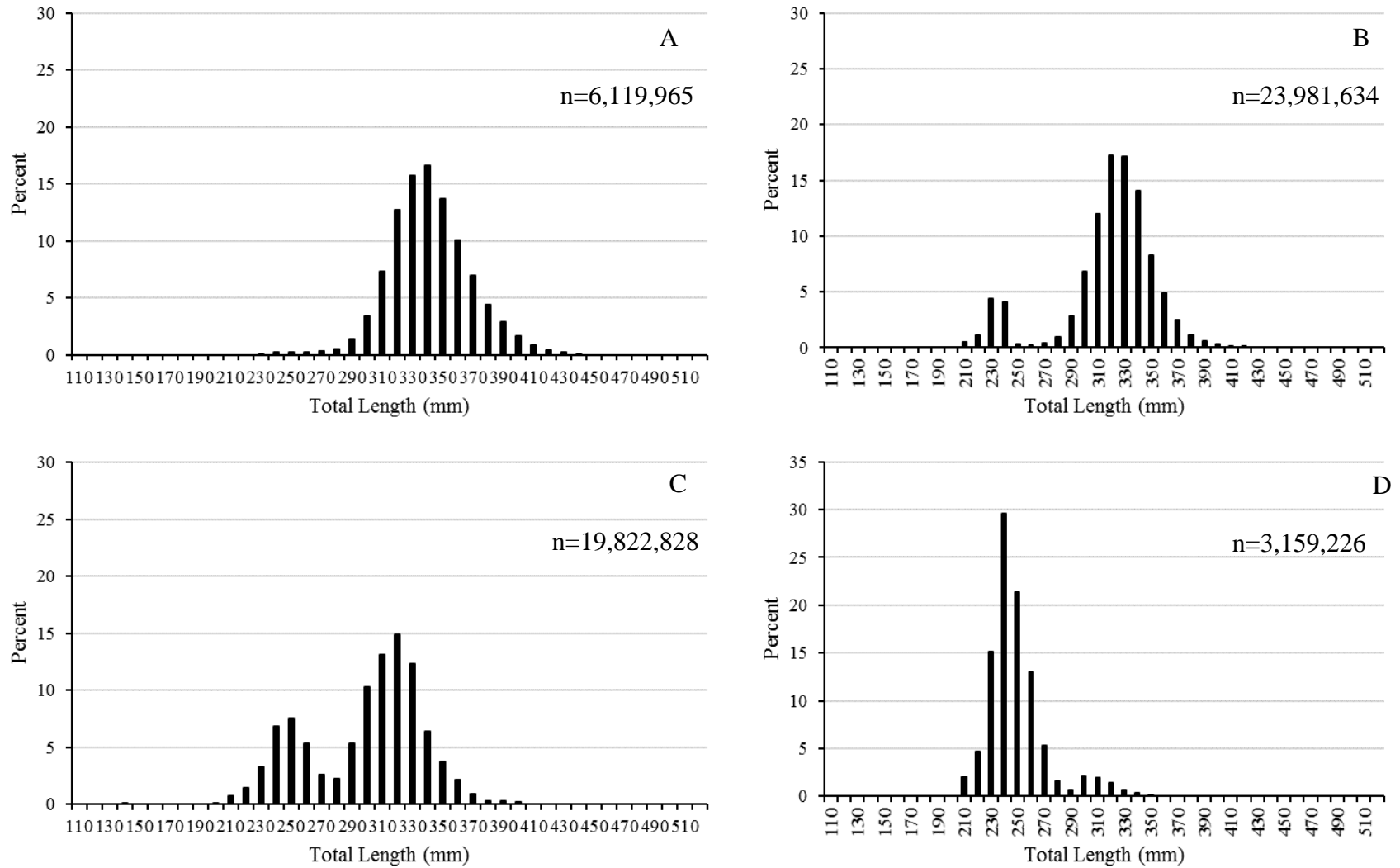


Figure 5. Expanded length-frequency of Atlantic croaker from the commercial fishery (excluding scrap samples) based on NCDMF fish house sampling, 2004-2017. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – ATLANTIC CROAKER

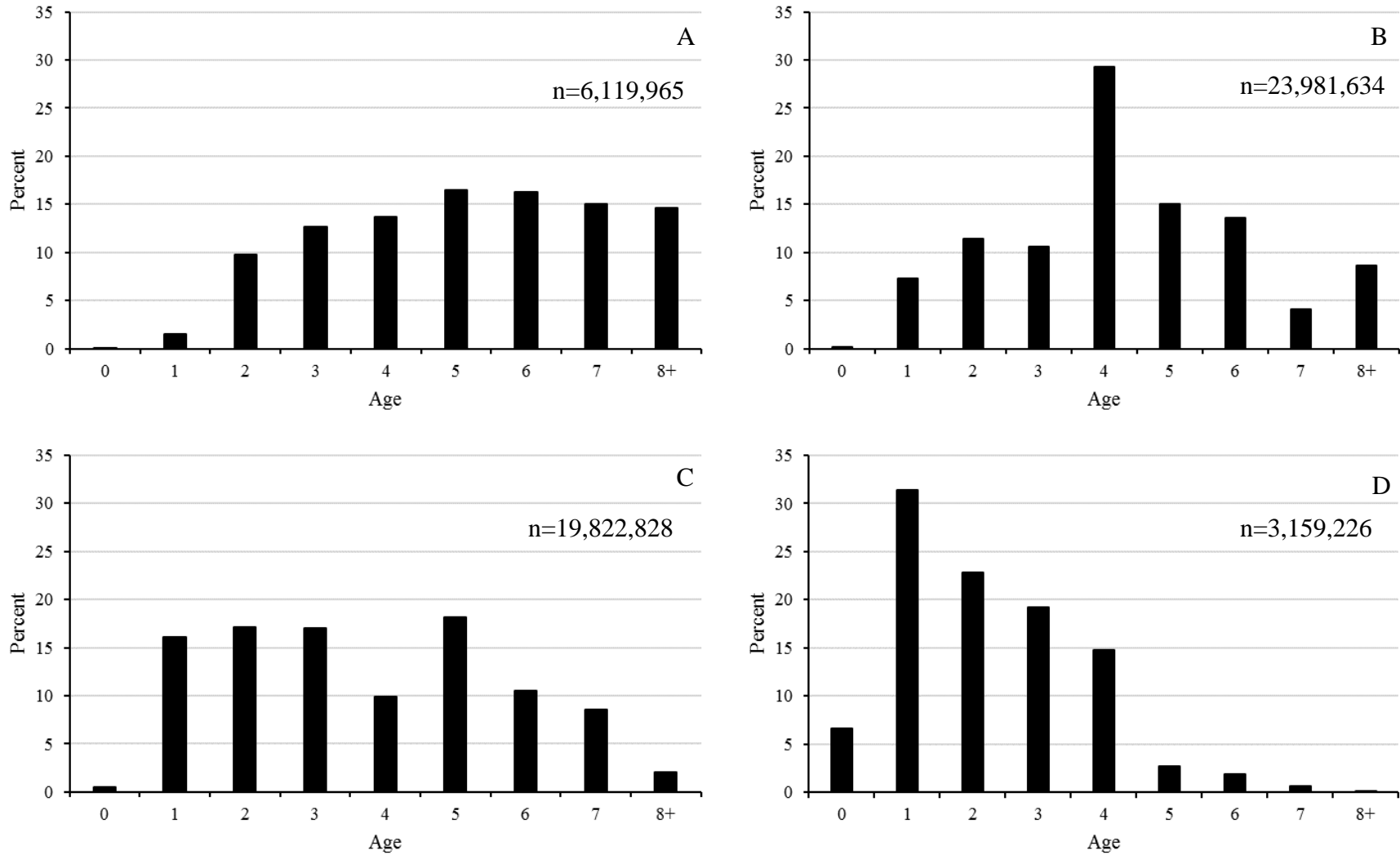


Figure 6. Expanded age-frequency of Atlantic croaker from the commercial fishery (excluding scrap samples) based on otolith ages, 2004-2017. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017. Age data from 2017 is preliminary.

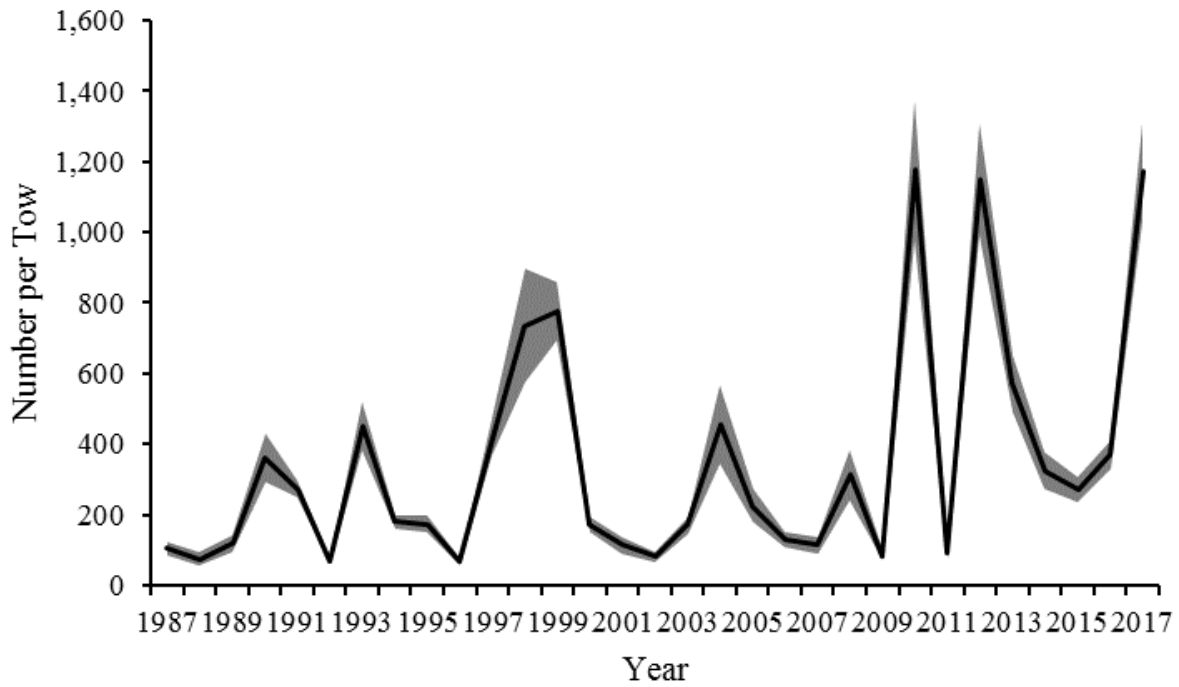


Figure 7. Atlantic croaker juvenile (<140 mm TL) abundance index (CPUE; number per tow) for June from the Pamlico Sound Survey, 1987-2017. Shaded area represents standard error.

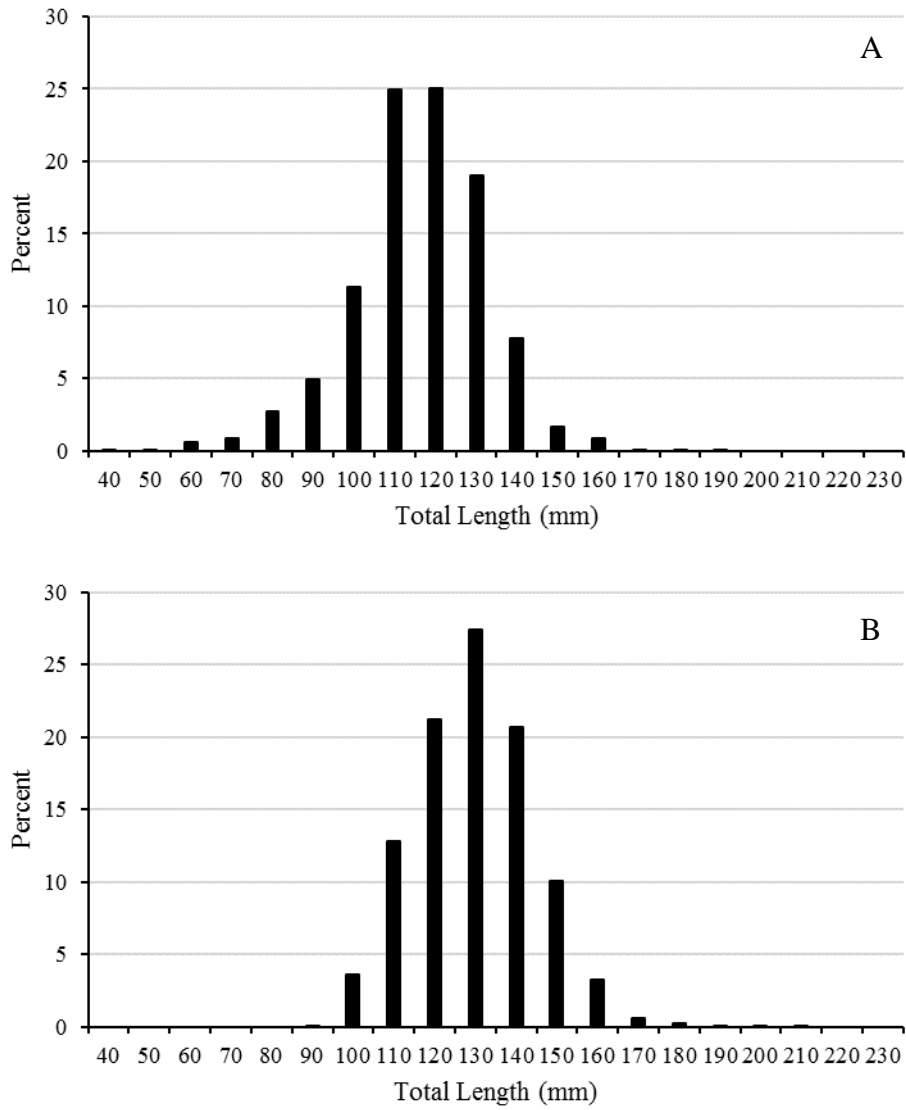


Figure 8. Expanded length frequency of Atlantic croaker captured in P195 sampling during June (A) and September (B), 2017.

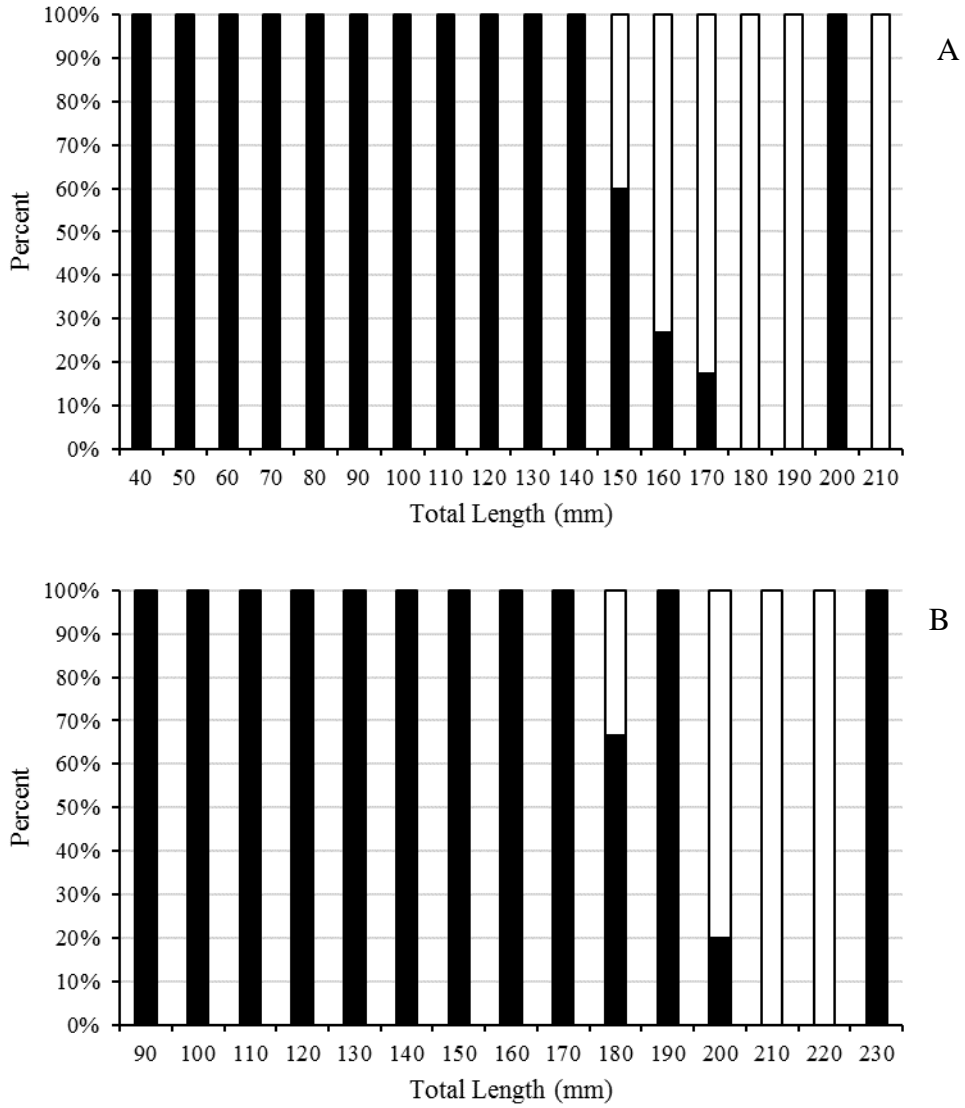


Figure 9. Percentage of age 0 (black) and age 1 (white) Atlantic croaker captured during P195 sampling in June (A) and September (B) based on otolith ages, 2017. Age data from 2017 is preliminary.

**FISHERY MANAGEMENT PLAN UPDATE
ATLANTIC MENHADEN
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | August 1981 |
| Amendments: | Amendment 1 – July 2001 Addendum I – August 2004 Addendum II – October 2005 Technical Addendum I – February 2006 Addendum III – November 2006 Addendum IV – November 2009 Addendum V – November 2011 Amendment 2 – December 2012 Technical Addendum I – May 2013 Addendum I – August 2016 Amendment 3 – November 2017 |
| Revisions: | Revision – October 1992 |
| Supplements: | Supplement – October 1986 |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | 2020 |

The first Atlantic States Marine Fisheries Commission (ASMFC) Atlantic Menhaden Fishery Management Plan (FMP) was approved in August 1981. The objective of the original plan was to achieve a coastwide age composition of landings in the purse seine fishery by spawners and achieve the greatest continuing yield for each area by determining age at harvest and eliminating other restrictions not contributing to management goals. Revision to the FMP was approved in 1992. The revised FMP was the result of an updated stock assessment. In 2001, Amendment 1 to the FMP was approved. This Amendment adopted a new stock assessment and new overfishing definition, as well as required mandatory reporting for all menhaden purse seine fisheries. Addendum I to Amendment 1 was approved in August 2004 to modify the biological reference points, stock assessment schedule and revise the habitat section. The 2003 stock assessment used a new model with a fecundity-based biological reference point to determine stock status. Addendum II was approved by the ASMFC Atlantic Menhaden Management Board in 2005 and established a five-year annual cap on reduction fishery landings in Chesapeake Bay and was

implemented in 2006. Addendum II also established a research program to determine the menhaden population abundance in the Chesapeake Bay and to address localized depletion. Passed in November of 2006, Addendum III mirrored the intent and provisions of Addendum II, but incorporated 2005 landings data and allowed for the transfer of under-harvest to the following year's harvest. The ASMFC Atlantic Menhaden Management Board then approved Addendum IV in November of 2009 which extended the Chesapeake Bay reduction fishery harvest cap, established through Addendum III, for an additional three years (2011 to 2013). In 2010, the ASMFC Atlantic Menhaden Management Board tasked the Atlantic Menhaden Technical Committee (TC) to develop alternative reference points. In addition, the Policy Board directed the Multispecies TC to work with the Menhaden TC to explore reference points that account for predation. Addendum V was approved in November 2011 and established a new interim fishing mortality threshold and target (based on maximum spawning potential or MSP) with the goal of increasing abundance, spawning stock biomass, and menhaden availability as a forage species. The new threshold and target equated to a MSP of 15% and 30%, respectively.

The development of Amendment 2 established a 170,800 MT (376,549,543 pounds) total allowable catch (TAC) beginning in 2013 that continued until completion of and Board action on the 2015 benchmark stock assessment. The TAC was based on a 20% reduction from the 2009 to 2011 three-year average of total coastwide catch. Additionally, a bycatch allowance of 6,000 pounds per vessel per day was established when states met their TAC. The Board adopted new biological reference points for biomass based on MSP, with the goal of increasing abundance, spawning stock biomass, and menhaden availability as a forage species. In 2013, Technical Addendum I to Amendment 2 established a set aside program for episodic events. The 2015 Atlantic menhaden stock assessment update indicated menhaden are not overfished and overfishing is not occurring, which resulted in Board action to increase the TAC for both 2015 and 2016 to 187,880 MT (414,204,497 pounds), a 10% increase. Addendum I, approved in August 2016, modified the bycatch allowance to authorize two individuals fishing stationary gear from the same vessel to land 12,000 pounds per day. This Addendum supported a history, especially in the pound net industry, of cooperative fishing which enables fishermen to pool resources. In October 2016, the Atlantic Menhaden Board increased the TAC by 6.45% setting the 2017 TAC at 200,000 MT (440,924,523 pounds).

Amendment 3 maintained the single-species biological reference points management program until the review and adoption of ecological reference points (ERPs). The intent of menhaden-specific ERPs is to provide a method to assess the status of menhaden not only in regard to their own sustainability, but also in regard to their interactions with predators and the status of other prey species. This approach allows fishery managers to consider the harvest of menhaden within a broad ecosystem context, which includes other fish, birds, mammals, and humans who utilize and depend on marine resources. The TAC for 2018 and 2019 fishing seasons at 216,000 MT (476,198,485 pounds). Subsequent years TAC will be guided by menhaden-specific ecological reference points. Amendment 3 allocated a baseline quota of 0.5 percent to each jurisdiction, and then additional TAC was allocated based on historic 2009 to 2011 landings. Additionally, the quota transfer program was maintained, quota rollover was prohibited, the 6,000 pound trip limit for non-directed and small-scale gears following the closure of the directed fishery was maintained, and 1 percent of the TAC was set aside for episodic events from New York through

Maine. Finally, the Chesapeake Bay reduction fishery cap was reduced from 87,216 MT (192,278,366 pounds) to 51,000 MT (112,435,753 pounds).

To ensure compliance with interstate requirements, North Carolina also manages this species 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).

Management Unit

The management unit is defined as the Atlantic menhaden resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the estuaries eastward to the offshore boundary of the Exclusive Economic Zone (EEZ). The Atlantic states from Maine through Florida including Pennsylvania are included in the management unit.

Goal and Objectives

The goal of Amendment 3 is to manage the Atlantic menhaden fishery in a manner which equitably allocates the resource’s ecological and economic benefits between all user groups. The primary user groups include those who extract and utilize menhaden as a source of prey, and those whose livelihood depends on the health of the marine ecosystem (ASMFC 2017).

STATUS OF THE STOCK

Life History

Atlantic menhaden (*Brevoortia tyrannus*) are an estuarine-dependent species with a single stock along the Atlantic coast that range from northern Florida to Nova Scotia. Menhaden form large nearshore schools from early spring through early winter. By summer, schools divide by size and age, with older and larger menhaden distributing farther north. During fall and early winter, menhaden migrate south to North Carolina to spawn 20-30 miles offshore. Sexual maturity is reached between ages 1 and 3. Floating egg masses hatch within two to three days of spawning and ocean currents carry larvae into estuarine nursery areas where they develop into juveniles and remain during their first year. Research indicates that the number of new fish that enter the fishery annually (year-class strength) is likely determined by environmental factors (currents, temperature, predation, etc.) acting on larvae as they approach and enter inlets and nursery areas. Atlantic menhaden can live up to 10 years. Atlantic menhaden strain microscopic organisms drifting or floating in the water column while swimming in schools near the surface. Atlantic

menhaden are important prey to many species including striped bass, bluefish, osprey, dolphins, and whales.

Stock Status

The ASMFC stock status of Atlantic menhaden in 2017 is not overfished and overfishing is not occurring. Based on the current adopted benchmarks, the Atlantic menhaden stock status is not overfished and overfishing is not occurring (SEDAR 2015). The biological reference point used to determine the fecundity target is defined as the mature egg production one would expect when the population is being fished at the threshold fishing mortality rate. Fishing mortality rates have remained below the revised overfishing threshold ($F_{26\%MSP} = 1.26$) since the 1960s and below the target ($F_{57\%MSP} = 0.38$) since 2003. Fishing mortality is now 42% below the target. Population fecundity, a measure of reproductive capacity, was estimated to be well above both the threshold (86 trillion eggs) and the target (189 trillion eggs) in recent years. In 2013, fecundity is estimated to have been 71% higher than the threshold value. This means that the spawning stock in 2013 appears to be more than adequate to produce the target number of eggs, and thus the population is not overfished.

Stock Assessment

The 2015 benchmark stock assessment for Atlantic menhaden was initiated in late 2012 (SEDAR 2015). The TC initiated the benchmark stock assessment to identify and evaluate all available data sources and explore alternative model configurations as recommended by the 2009 peer review panel. In this benchmark assessment, significant changes were made to growth, maturity, natural mortality, indices of relative abundance, and the selectivity of fisheries. Additionally, this benchmark assessment incorporates a “fleets-as-areas” base model configuration, such that the reduction and bait fisheries were divided into northern and southern regions, creating four separate fleets.

STATUS OF THE FISHERY

Current Regulations

No regulatory changes were made in 2017 that affected menhaden.

Effective January 1, 2013, a law was passed making it unlawful to harvest menhaden with a purse seine net deployed by a mother ship and one or more runner boats within North Carolina’s three-mile jurisdiction.

Commercial Landings

North Carolina’s Atlantic menhaden landings have been on a decline, especially since the last menhaden processing factory in North Carolina closed in 2005. Landings have remained relatively constant since 2012 (Table 1). The average landings over the last 10 years were 1,155,917 pounds. Since 2013, landings have been regulated under the TAC initiated in Amendment 2. North Carolina has landed on average 33% of the state allocated portion of the

TAC, the majority of which is used for bait in the blue crab and recreational fisheries. The decline in commercial landings is likely due to the removal of the purse seine fishery and loss of processing facilities. Gill nets are now the most common gear used to harvest menhaden throughout the state.

Recreational Landings

In October 2011, the North Carolina Division of Marine Fisheries implemented a recreational cast net and seine mail survey to develop catch and effort estimates for various species, including menhaden. Menhaden are used as live bait by recreational anglers, and from 2011 to 2017 recreational annual harvest averaged 71,701 fish harvested and 87,832 fish released (Table 2).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fishing activity is monitored in a variety of North Carolina Division of Marine Fisheries (NCDMF) fishery-dependent sampling programs (P400s series) for compliance with ASMFC requirements. Monitoring includes the sink net fishery, winter trawl fishery, estuarine gill net fishery, and sciaenid pound net fishery. Commercial landings of Atlantic menhaden are monitored through the NCDMF Trip Ticket Program. Table 3 describes the mean, minimum, and maximum lengths of Atlantic menhaden sampled from North Carolina fishery-dependent monitoring. Mean lengths in the menhaden commercial fishery have remained fairly consistent from 2009 to 2017.

Fishery-Independent Monitoring

Atlantic menhaden are sampled in a variety of NCDMF independent surveys for compliance with ASMFC requirements. However, NCDMF surveys were not used in the most recent benchmark stock assessment. Atlantic menhaden are sampled in the North Carolina Estuarine Trawl Survey, Pamlico Sound Survey, the Juvenile Anadromous Survey, and the Striped Bass Independent Gillnet Study.

MANAGEMENT STRATEGY

In May 2015, the ASMFC Atlantic Menhaden Management Board approved a TAC for the 2015 and 2016 fishing seasons at 187,880 MT (414,204,497 pounds) per year, a 10% increase from the 2014 TAC. The increase was in response to the positive findings of the 2015 Atlantic menhaden benchmark assessment which indicated the resource is not overfished and overfishing is not occurring. In October 2016, the Atlantic Menhaden Board increased the TAC by 6.45% setting the 2017 TAC at 200,000 MT (440,924,523 pounds). In Amendment 3, November 2017, management continued with single species reference points until ecological based reference points that reflect Atlantic menhaden's role as a forage species are available. The amendment additionally established a new state allocation system, reduced the Chesapeake Bay reduction cap, and set the 2018 and 2019 TAC at 216,000 MT (476,198,485 pounds).

RESEARCH NEEDS

- Continue current level of sampling from bait fisheries, particularly in the Mid-Atlantic and New England. Analyze sampling adequacy of the reduction fishery and effectively sample areas outside of that fishery.
- Conduct aging validation study to confirm scale to otolith comparisons. Use archived scales to do ratio isotope analysis.
- Develop a menhaden specific coastwide fishery independent index of adult abundance at age.
- Conduct studies on spatial and temporal dynamics of spawning.
- Conduct Management Strategy Evaluation (MSE) on the various reference point options for menhaden.
- Continue to develop an integrated length and age based model.
- Develop a seasonal spatially-explicit model, once sufficient age-specific data on movement rates of menhaden are available.
- Continue exploring the development of multispecies models that can take predator-prey interactions into account. This should inform and be linked to the development of assessment models that allow natural mortality to vary over time.
- Continue to improve methods for incorporation of natural mortality (e.g., multi-species statistical catch-at-age model).
- Study specific habitat requirements for all life history stages.
- Develop habitat maps for all life history stages.
- Develop a mechanism for estimating or obtaining data for economic analysis on the reduction fishery, due to the confidential nature of the data.
- Conduct studies to fully recognize the linkages between the menhaden fishery and the numerous other fisheries which it supports and sustains.

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TABLES

Table 1. North Carolina Atlantic menhaden annual commercial landings based on North Carolina Trip Ticket Program, 2008-2017. Total Allowable Catch established 2013.

| Year | Landings (lb) | Total Allowable Catch (lb) | Value (\$) |
|------|---------------|----------------------------|-------------|
| 1994 | 73,853,901 | | \$3,178,602 |
| 1995 | 58,374,081 | | \$3,560,953 |
| 1996 | 53,850,943 | | \$4,858,471 |
| 1997 | 97,727,057 | | \$8,794,202 |
| 1998 | 57,976,455 | | \$4,121,667 |
| 1999 | 42,799,080 | | \$2,680,633 |
| 2000 | 56,280,112 | | \$3,495,744 |
| 2001 | 56,012,396 | | \$4,551,445 |
| 2002 | 69,190,596 | | \$5,045,407 |
| 2003 | 48,936,502 | | \$3,943,814 |
| 2004 | 50,577,938 | | \$4,532,534 |
| 2005 | 13,386,245 | | \$1,223,078 |
| 2006 | 962,648 | | \$147,779 |
| 2007 | 1,113,167 | | \$139,178 |
| 2008 | 645,231 | | \$70,339 |
| 2009 | 2,124,733 | | \$229,648 |
| 2010 | 1,299,130 | | \$111,552 |
| 2011 | 3,529,967 | | \$336,528 |
| 2012 | 538,783 | | \$82,974 |
| 2013 | 454,172 | 1,818,580 | \$73,490 |
| 2014 | 794,658 | 1,818,580 | \$128,194 |
| 2015 | 896,891 | 2,020,645 | \$152,241 |
| 2016 | 397,725 | 2,020,645 | \$75,167 |
| 2017 | 755,136 | 2,190,513 | |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – ATLANTIC MENHADEN

Table 2. North Carolina Atlantic menhaden annual recreational landings based on North Carolina recreational cast net and seine mail survey, 2012-2017.

| Year | Harvest (fish) | Released (fish) |
|------|----------------|-----------------|
| 2012 | 96,001 | 48,352 |
| 2013 | 104,913 | 98,256 |
| 2014 | 26,278 | 66,989 |
| 2015 | 71,575 | 118,953 |
| 2016 | 61,705 | 106,575 |
| 2017 | 72,327 | 87,864 |

Table 3. Atlantic menhaden fork length (FL)(mm) data from NCDMF sampled from the North Carolina commercial fishery-dependent sampling program (P400s), 2008-2017.

| Year | Mean Fork Length FL (mm) | Minimum Fork Length FL (mm) | Maximum Fork Length FL (mm) | Total Number Measured (number) |
|------|--------------------------|-----------------------------|-----------------------------|--------------------------------|
| 2008 | 205 | 100 | 325 | 1,602 |
| 2009 | 230 | 100 | 309 | 1,240 |
| 2010 | 226 | 147 | 319 | 613 |
| 2011 | 236 | 95 | 323 | 1,920 |
| 2012 | 220 | 70 | 362 | 2,355 |
| 2013 | 237 | 124 | 385 | 3,187 |
| 2014 | 225 | 130 | 324 | 4,249 |
| 2015 | 232 | 141 | 470 | 3,095 |
| 2016 | 248 | 112 | 333 | 1,595 |
| 2017 | 236 | 128 | 470 | 1,556 |

**FISHERY MANAGEMENT PLAN UPDATE
ATLANTIC STURGEON
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | November 1990 |
| Amendments: | Amendment 1 July 1998 Technical Addendum #1 October 2000 Addendum I January 2001 Addendum II May 2005 Addendum III November 2006 Addendum IV September 2012 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | To Be Determined |

Amendment 1 to the Interstate Fishery Management Plan (FMP) for Atlantic Sturgeon was developed by the Atlantic States Marine Fisheries Commission (ASMFC) with a goal to restore Atlantic sturgeon spawning stocks to population levels which will provide for sustainable fisheries, and ensure viable spawning populations. Addendum I was completed to allow importation of non-indigenous Atlantic sturgeon and permit the development of private aquaculture facilities. Addendum II required the compliance with ASMFC Terms, Limitations, Enforcement and Reporting Requirements for each exemption to the harvest and possession moratoria as outlined in Section 4 of the FMP. It also allowed for Lapaz Inc. to import Atlantic sturgeon fingerlings, produce fish, and sell the meat. Further exemption was provided to Acadian Sturgeon and Caviar to import fish to North Carolina. Addendum III compliments Addendum II and provides authority for LaPaz Inc. to import Atlantic sturgeon from Supreme Sturgeon and Caviar for commercial aquaculture. Addendum IV is the Atlantic Sturgeon Habitat Addendum.

To ensure compliance with interstate requirements, North Carolina also manages this species 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).

Management Unit

Migratory stocks of Atlantic sturgeon from Maine through Florida.

Goal and Objectives

The goal is to restore Atlantic sturgeon spawning stocks to population levels which will provide for sustainable fisheries, and ensure viable spawning populations (ASMFC 1998). Amendment 1 to the Atlantic Sturgeon FMP was approved in July 1998. In order to achieve this goal, the plan sets forth the following objectives:

1. Establish 20 protected year classes of females in each spawning stock;
2. Close the fishery for a sufficient time period to reestablish spawning stocks and increase numbers in current spawning stocks;
3. Reduce or eliminate bycatch mortality of Atlantic sturgeon;
4. Determine the spawning sites and provide protection of spawning habitats for each spawning stock;
5. Where feasible, reestablish access to historical spawning habitats for Atlantic sturgeon; and
6. Conduct appropriate research as needed.

STATUS OF THE STOCK

Life History

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are an anadromous species, which means they reside primarily in oceans as adults but migrating up rivers to spawn. The species is found from Labrador, Canada, south to the St. Johns River, Florida. Atlantic sturgeon spend their first few years of life in their natal estuary before becoming highly migratory and travelling throughout the coastal Atlantic waters and various estuaries to feed.

Once mature, Atlantic sturgeon exhibit natal homing, returning to the specific river where they were spawned to reproduce. Migratory patterns are seasonal, with northern migrations in spring as water temperatures rise and southern movements in fall as water temperatures decrease. Some adult sturgeon will return to spawning grounds in consecutive years but others may only spawn once every two or three years. Adult fish that reproduce in the Roanoke River enter the

Albemarle Sound basin during the spring of the year. They spend the summer in the western Albemarle Sound and lower Roanoke River. Once temperatures begin to fall around September the fish ascend the Roanoke River to the rapids near Weldon to spawn. When spawning is complete and as water temperatures fall they leave the river and proceed to the ocean through the Albemarle Sound.

Atlantic sturgeon are thought to have historically spawned within the Roanoke, Tar/Pamlico, Neuse, and Cape Fear rivers. Currently the Roanoke River is the only North Carolina river with a known spawning population. Evidence from the collection of young of year fish exists for the other North Carolina rivers but collections of eggs has not been documented. Additionally, telemetry tagged sturgeon (tracked with radio signals) have been documented within the Cape Fear and Northeast Cape Fear rivers potentially making a spawning run.

Atlantic sturgeon at various life stages are found within most estuarine waters of North Carolina throughout the entire year. Due to their highly migratory behavior, Atlantic sturgeon spawned in other regions often enter North Carolina waters. Sturgeon from the Hudson, Chesapeake, Carolina, and South Atlantic Distinct Population Segments have been identified in North Carolina waters.

Atlantic sturgeon are opportunistic bottom feeders that prey on various types of worms, shrimps, crabs, snails and small fishes.

Atlantic sturgeon may live to a maximum age of 70 years; however, in more southern locations the maximum age is from 30 to 40 years. Age at which Atlantic sturgeon reach sexual maturity is unknown for specimens in North Carolina, but other fish within the Carolina and South Atlantic Distinct Population Segment mature as early as 5 to 13 years for males and 7 to 19 years for females. In contrast, sturgeon in more northern latitudes (Hudson River) mature at 11 to 20 years for males and 20 to 30 years for females. Research conducted in South Carolina show spawning intervals of one to five years for males and three to five years for females.

Stock Status

Reported coastwide landings peaked in 1890 at 3.4 million kg (7,495,717 pounds) and declined precipitously thereafter. The 1998 Atlantic Sturgeon Stock Assessment Report indicated populations of Atlantic sturgeon throughout their range were either extirpated or at historically low abundance. Recruitment was variable at low levels in all regions. The stock was considered overfished but overfishing was not occurring. The target fishing mortality (F) rate was defined as that level of F that generated an eggs-per-recruit (EPR) equal to 50% of the EPR at $F = 0.0$ (i.e., virgin stock). This rate (F_{50}) equals 0.03 (annual harvest rate of 3%) for a restored population. This target is far below estimates of F prior to enactment of fishing moratoria, which ranged from 0.01-0.12 for females and 0.15-0.24 for males in the Hudson River. These numbers may not apply to southern stocks, where more signs toward recovery are being seen.

Stock Assessment

The Atlantic States Marine Fisheries Commission completed a benchmark assessment on Atlantic sturgeon in July 2017. Due to the limited availability of data, this assessment employed a number of approaches including Mann-Kendall test, Autoregressive Integrated Moving Average (ARIMA) model, and power, cluster, dynamic factor, and population viability analyses for the coastwide stock and by Distinct Population Segment (DPS). Several of these analyses indicated no significant trends in various time series with the exception that both the Mann-Kendall and population viability analysis detected a significant increasing trend of young of year and juvenile abundance in North Carolina's Albemarle Sound Independent Gill Net Survey. Results also indicated that analyses based on indices indicated a coast-wide structure rather than a DPS-structured stock. The Arima analysis indicated the time series had no significant trend or an increasing trend when using all available years of data for all indices and the terminal year index values were all credibly above the 25th percentile for their unique time series. Coast-wide abundance values are not available however stock reduction analysis indicated that the population declined to a low but stable level in the early 1900's but began to increase from the late 1990's onwards. In addition, estimates of coast-wide total mortality were below the Z50%EPR threshold, suggesting current levels of total mortality are sustainable. However, Z estimates for the New York Bight, Chesapeake, and South Atlantic DPS had less than 50% chance that Z was above the threshold while the Maine and Carolina had greater than 70% chance that Z was above the threshold, indicating that mortality is too high within these DPS's.

STATUS OF THE FISHERY

Current Regulations

Coastwide commercial and recreational moratorium.

Commercial Landings

No landings recorded since 1991.

Recreational Landings

No recreational fishery.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

The North Carolina Division of Marine Fisheries (NCDMF) provides at sea observer coverage for the estuarine gill net fisheries throughout North Carolina.

North Carolina developed a Section 10 Incidental Take Permit for the estuarine waters of North Carolina relative to gill net fishing. Through this process North Carolina developed a zero inflated poisson general linear model that estimated bycatch in the gill net fisheries. This model

divided the state estuarine waters into management units and estimated takes (live and dead) within each of these units, by season, and mesh size. Results from this model are available in the Application for an Incidental Take Permit submitted to the National Oceanic and Atmospheric Administration (NOAA) Fisheries in December 2012 by the NCDMF.

A total of 349 Atlantic sturgeon have been encountered in the North Carolina on-board observer program from 2003 through 2017. These sturgeon have ranged from 270 to 1,580 mm Total Length (TL) and averaged 651 mm TL (Table 1). Two-hundred ninety-one of the 349 sturgeon have been encountered in the Albemarle Sound Management Unit. An additional 73 Atlantic sturgeon were observed through the alternate platform observer program during 2013, 2014, 2015, 2016, and 2017. These trips are conducted from division-owned vessels where the observers do not ride with the fisherman but observe from a distance. These fish ranged in size from 390 to 1,219 mm TL and averaged 687 mm TL. Sixty-three of the 73 sturgeon encountered were observed in the Albemarle Sound Management Unit.

Fishery-Independent Monitoring

The NCDMF currently has three independent gill net surveys that encounter and tag Atlantic sturgeon. The Albemarle Sound Independent Gill Net Survey (IGNS) is a stratified random gill net survey that employs gill nets with mesh sizes that range from 2.5 inch stretch mesh (ISM) through 7 ISM (0.5 ISM increments) and 8 ISM and 10 ISM of floating and sinking nets. Gill nets are fished in 40 yard shots totaling 960 yards per set. Each set is fished for approximately 24-hours before retrieval. Nets were fished from January through May, November, and December each year from 1991 through 2017. Lengths of sturgeon collected have ranged from 153 to 1,498 mm FL, and averaged 522 mm FL (Table 2). Six fish were collected with a fork length greater than 1,000 mm, and only three of 1,943 fish collected were adults. Catch per unit effort (CPUE) shows an increasing trend over the entire time series but annual CPUE are variable (Figure 1).

The Fishery Independent Assessment Survey (FIAS) is conducted in Pamlico Sound, Pungo, Pamlico, and Neuse rivers, and consists of gill net sets, ranging in mesh size from 3.0 ISM through 6.5 ISM (0.5 ISM increments) and are fished for approximately 12 hours before retrieval. The Pamlico Sound portion has been conducted since 2001 and the rivers portion since 2003. A total of 54 sturgeon have been collected in Pamlico Sound and an additional 85 have been collected in the Pamlico, Pungo, and Neuse rivers. Average lengths are larger than those seen in the Albemarle, indicating capture of more sub-adult fish than young-of-year fish (Tables 3, 4). Three adults have been collected in the Pamlico Sound Survey and three adults have been collected in the Rivers Survey.

The Southern Independent Gill Net Survey is modeled after the (FIAS) but with periods of reduced soak times. The areas fished include the New and Cape Fear rivers. Two-hundred forty yards were fished per sample and 120 samples were completed per year. The areas fished include the coastal ocean waters off the New and Cape Fear rivers. Two-hundred and seventy yards were fished per sample. Effort has been ongoing since 2008. Sampling was discontinued in the Ocean on July 1, 2015. Fourteen fish have been collected in the Cape Fear River IGNS and they ranged from 569 to 949 mm FL. No adult Atlantic sturgeon have been collected in this survey.

During 2010, the NCDMF joined a multi-state grant entitled “Research and Management of Endangered and Threatened Species in the Southeast: Riverine Movements of Shortnose and Atlantic Sturgeon” cooperating with South Carolina Department of Natural Resources, The University of Georgia, and North Carolina State University. Funding was provided through NOAA Fisheries, Section 6. Ninety-four Atlantic sturgeon were tagged with acoustic transmitters from 2011 through 2013 in the Cape Fear River and Albemarle Sound. These fish ranged from 772 to 1,753 mm FL and averaged 928 mm FL (Table 5).

MANAGEMENT STRATEGY

Atlantic coastal states implemented a moratorium on harvest and possession of Atlantic sturgeon in coastal waters (0-3 miles) in 1998, while NOAA Fisheries banned harvest in the exclusive economic zone. The best available data indicate that river-specific populations are appropriate management units. It is recommended that the moratorium remain in place for each population until it can be documented that the spawning population includes at least 20 year classes of mature females (half the number of year classes that probably existed in unfished populations). Given that female Atlantic sturgeon do not mature until about 20 years of age, the moratorium can be expected to remain in place for several decades from when harvest of a given population ended. As populations increase during restoration, bycatch of sturgeon will increase; hence, managers should ensure that mechanisms are in place to monitor the level of bycatch and make reductions where necessary.

In 2012, NOAA Fisheries listed the Carolina DPS of Atlantic sturgeon as an endangered species under the 1973 Endangered Species Act (ESA). This listing determination drastically influenced the management strategy in North Carolina. The largest influence was the requirement of the NCDMF to obtain a Section 10 Incidental Take Permit to allow the estuarine gill net fisheries to continue. Without the Section 10 Permit, interactions in the fishery would have been illegal. In 2016, NOAA Fisheries published a proposed rule to designate Atlantic sturgeon critical habitat (specific areas that are considered essential to the conservation of the species) in each of the DPSs. The final rule to designate critical habitat was published in September 2017. This rule designated approximately 1,939 km (1,205 miles) of aquatic habitat for the Carolina DPS, including the following rivers in North Carolina: Roanoke, Tar/Pamlico, Neuse, Cape Fear, Northeast Cape Fear, and Pee Dee. Any future fishery for Atlantic sturgeon will only be possible if NOAA Fisheries removes Atlantic sturgeon from the ESA. However, additional protections provided through the ESA listing should increase the potential recovery.

RESEARCH NEEDS

Biological/Captive Propagation

- Standardize and obtain baseline data on population status for important sturgeon rivers. Data should include assessment of stock status in various rivers, size and composition of the spawning population, reproductive success and juvenile production;
- Develop long-term marking/tagging procedures to provide information on individual tagged Atlantic sturgeon for up to 20 years;

- Establish success criteria in order to evaluate the effectiveness of stocking programs;
- Determine size at maturity for North, Mid- and South Atlantic sturgeon;
- Monitor catch/effort and size/age composition of landings of any future authorized directed fisheries;
- Determine length at age by sex for North, Mid- and South Atlantic stocks;
- Determine maturity at age by sex for North, Mid- and South Atlantic stocks;
- Determine fecundity at age, length, and weight for North, Mid-, and South Atlantic stocks;
- Characterize size and condition of Atlantic sturgeon by gear and season taken as bycatch in various fisheries;
- Establish environmental tolerance levels (dissolved oxygen, pH, temperature, etc.) for different life stages;
- Establish coastal tagging projects to delineate migratory patterns (this measure is being implemented by the USFWS and member states.);
- Expand tagging of juveniles in major spawning rivers to allow estimates of rates of loss to bycatch;
- Establish a tag recovery clearinghouse and database for consolidation and evaluation of tagging and tag return information including associated biological, geographic, and hydrographic data (this measure is being implemented by the USFWS through the Maryland Fisheries Resources Office located in Annapolis, Maryland.);
- Encourage shortnose sturgeon researchers to include Atlantic sturgeon research in their projects;
- Establish methods for the recovery of tags and associated information (this measure is being implemented through ASMFC/USFWS cooperative efforts.);
- Evaluate existing groundfish survey data to determine what can be learned about at-sea migratory behavior;
- Conduct basic culture experiments to provide information on: a) efficacy of alternative spawning techniques, b) egg incubation and fry production techniques, c) holding and rearing densities, d) prophylactic treatments, e) nutritional requirements and feeding techniques, and f) optimal environmental rearing conditions and systems;
- Determine the extent to which Atlantic sturgeon are genetically differentiable among rivers;
- Conduct research to identify suitable fish sizes, and time of year for stocking cultured fish;
- Conduct and monitor pilot-scale stocking programs before conducting large-scale efforts over broad geographic areas;
- Determine effects of contaminants on early life stages;
- Develop methods to determine sex and maturity of captured sturgeon;
- Develop sperm cryopreservation techniques and refine to assure availability of male gametes;
- Refine induced spawning procedures;
- Develop the capability to capture wild broodstock and develop adequate holding and transport techniques for large broodstock;
- Conduct studies to identify tissue(s) suitable for genetic analyses and the techniques for their collection and storage. In those states which permit future harvest of Atlantic sturgeon, material for genetic analysis should be collected from up to 50% of the fish landed in the commercial fisheries. In states with no future directed fisheries, federal and state programs which encounter sturgeon should be encouraged to collect specified tissues for genetic analysis;

- Standardize collection procedures to obtain biological tissues, and identify a suitable repository to archive all materials;
- Conduct research to determine the susceptibility of Atlantic sturgeon to sturgeon adenovirus and white sturgeon iridovirus. Methods should be developed to isolate the sturgeon adenovirus and an Atlantic sturgeon cell line should be established for infection trials;
- Conduct research to identify the major pathogens of Atlantic sturgeon and a cell line for this species should be developed.

Social

- To evaluate the social impacts the needed data might include the following for consumptive and non-consumptive users: demographic information (e.g. age, gender, ethnicity/race, etc.), social structure information (e.g. historical participation, affiliation with NGOs, perceived conflicts, etc.), other cultural information (e.g. occupational motivation, cultural traditions related to resource's use), and community information.
- A cost and benefit analysis of possible stocking protocols is needed.

Assessment

- Identify spawning units along the Atlantic coast at river or tributary and coastwide level.
- **Expand and improve the genetic stock definitions of Atlantic sturgeon, including developing and updated genetic baseline sample collection at the coastwide, DPS, and river-specific level for Atlantic sturgeon, with the consideration of spawning season-specific data collection.
- Determine habitat use by life history stage including adult staging, spawning, and early juvenile residency.
- Expand the understanding of migratory ingress of spawning adults and egress of adults and juveniles along the coast.
- Identify Atlantic sturgeon spawning habitat through the collection of eggs or larvae.
- Investigate the influence of warming water temperatures on Atlantic sturgeon, including the effects on movement, spawning, and survival.
- Evaluate the effects of predation on Atlantic sturgeon by invasive species (e.g., blue and flathead catfish).
- **Establish regional (river or DPS-specific) fishery-independent surveys to monitor Atlantic sturgeon abundance or expand existing regional surveys to include annual Atlantic sturgeon monitoring. Estimates of abundance should be for both spawning adults and early juveniles at age.
- **Establish coastwide fishery-independent surveys to monitor mixed stock abundance or expand existing surveys to include annual Atlantic sturgeon monitoring.
- **Continue to collect biological data, PIT tag information, and genetic samples from Atlantic sturgeon encountered in surveys that require it (e.g., NEAPMAP). Consider including this level of data collection from surveys that do not require it.
- **Encourage data sharing of acoustic tagged fish, particularly in underrepresented DPSs, and support program that provide a data sharing platform such as The Atlantic Cooperative

Telemetry Network. Data sharing should be accelerated if it was required or encouraged by funding agencies.

- **Maintain and support current networks of acoustic receivers and acoustic tagging programs to improve the estimates of total mortality.
- **Collect DPS-specific age, growth, fecundity, and maturity information.
- **Collect more information on regional vessel strike occurrences, including mortality estimates. Identify hot spots for vessel strikes and develop strategies to minimize impacts on Atlantic sturgeon.
- **Monitor bycatch and bycatch mortality at the coastwide level, including international fisheries where appropriate (i.e., the Canadian weir fishery). Include data on size, health condition at capture, and number of fish captured.
- **Establish recovery goals for Atlantic sturgeon to measure progress of and improvement in the population since the moratorium and ESA listing.
- **Expand the acoustic tagging model to obtain abundance estimates and incorporate movement.
- Evaluate methods of imputation to extend timeseries with missing values.

Monitoring population trends through juvenile abundance indices, characterizing the incidence of bycatch and mortalities in various fisheries and conducting tag/recapture studies for estimates of bycatch loss are being addressed through current sampling. It should be noted that any sampling or research that encounters Atlantic sturgeon whether incidental or targeted now require Section 10 permits through NOAA Fisheries or a Section 7 consultation if funded through a federal grant program. These permit requirements directly influence the data collection abilities of the NCDMF, potentially impacting the completion of research recommendations.

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TABLES

Table 1. Atlantic Sturgeon total length data (millimeters) collected from the North Carolina Division of Marine Fisheries Onboard Observer Program, 2008-2017.

| Year | Mean Total Length | Minimum Total Length | Maximum Total Length | Collection Number |
|------|-------------------|----------------------|----------------------|-------------------|
| 2008 | 639 | 480 | 845 | 18 |
| 2009 | | | | 0 |
| 2010 | | | | 0 |
| 2011 | 763 | 464 | 1,386 | 4 |
| 2012 | 651 | 464 | 900 | 10 |
| 2013 | 643 | 492 | 920 | 29 |
| 2014 | 684 | 405 | 1,524 | 42 |
| 2015 | 685 | 270 | 995 | 54 |
| 2016 | 682 | 420 | 1,580 | 54 |
| 2017 | 646 | 441 | 1,050 | 45 |

Table 2. Atlantic Sturgeon length data (millimeters) collected from the Albemarle Sound Independent Gill Net Survey, 2008-2017.

| Year | Mean Fork Length | Minimum Fork Length | Maximum Fork Length | Collection Number |
|------|------------------|---------------------|---------------------|-------------------|
| 2008 | 543 | 257 | 840 | 124 |
| 2009 | 629 | 391 | 800 | 55 |
| 2010 | 579 | 395 | 812 | 32 |
| 2011 | 604 | 393 | 1,498 | 47 |
| 2012 | 574 | 296 | 1,060 | 64 |
| 2013 | 556 | 275 | 1,395 | 139 |
| 2014 | 609 | 355 | 1,180 | 69 |
| 2015 | 587 | 355 | 980 | 86 |
| 2016 | 537 | 251 | 935 | 123 |
| 2017 | 570 | 348 | 1,014 | 174 |

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Table 3. Atlantic Sturgeon length data (millimeters) collected from the Pamlico Sound Independent Gill Net Survey, 2008-2017.

| Year | Mean Fork Length | Minimum Fork Length | Maximum Fork Length | Collection Number |
|------|------------------|---------------------|---------------------|-------------------|
| 2008 | 663 | 643 | 947 | 2 |
| 2009 | 967 | 967 | 967 | 1 |
| 2010 | 606 | 200 | 698 | 4 |
| 2011 | | | | 0 |
| 2012 | 1,415 | 1,415 | 1,415 | 1 |
| 2013 | | | | 0 |
| 2014 | | | | 0 |
| 2015 | N/A | N/A | N/A | 1 |
| 2016 | 756 | 747 | 765 | 2 |
| 2017 | 1,560 | 1,560 | 1,560 | 1 |

Table 4. Atlantic Sturgeon length data (millimeters) collected from the Pamlico, Pungo, and Neuse Rivers Independent Gill Net Survey, 2008-2017.

| Year | Mean Fork Length | Minimum Fork Length | Maximum Fork Length | Collection Number |
|------|------------------|---------------------|---------------------|-------------------|
| 2008 | 532 | 532 | 532 | 1 |
| 2009 | 706 | 716 | 716 | 1 |
| 2010 | | | | 0 |
| 2011 | 2,300 | 2,300 | 2,300 | 1 |
| 2012 | 625 | 625 | 625 | 1 |
| 2013 | | | | 0 |
| 2014 | * | * | * | 1 |
| 2015 | 612 | 365 | 1,435 | 23 |
| 2016 | 723 | 464 | 975 | 8 |
| 2017 | 1,140 | 1,140 | 1,140 | 1 |

- Length not recorded

Table 5. Atlantic Sturgeon length data (millimeters) collected through section 6 funding in the Cape Fear River and Albemarle Sound, North Carolina, 2011-2013.

| Year | Mean Fork Length | Minimum Fork Length | Maximum Fork Length | Number |
|-------|------------------|---------------------|---------------------|--------|
| 2011 | 960 | 630 | 1,620 | 45 |
| 2012 | 948 | 772 | 1,753 | 21 |
| 2013 | 862 | 605 | 1,162 | 28 |
| Total | 928 | 772 | 1,753 | 94 |

FIGURES

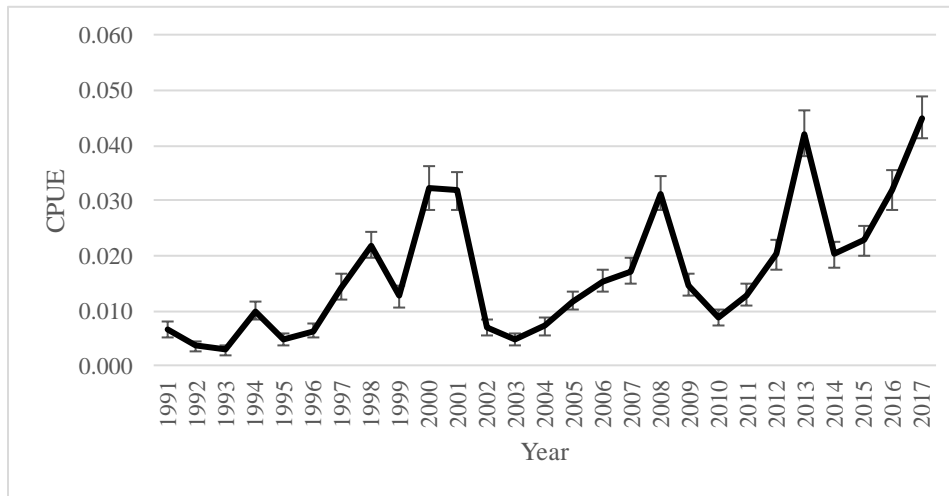


Figure 1. Catch per unit effort of Atlantic sturgeon collected from the Albemarle Sound Independent Gill Net Survey from 1991-2017.

**FISHERY MANAGEMENT PLAN UPDATE
BLACK DRUM
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---------------|
| Original FMP Adoption: | June 2013 |
| Amendments: | None |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | February 2016 |
| Schedule Changes: | None |
| Next Benchmark Review: | February 2020 |

In June 2013, the Atlantic States Marine Fisheries Commission (ASMFC) adopted the Interstate Fishery Management Plan (FMP) for Black Drum and required all states to maintain their current regulations and implement a maximum possession limit and minimum size limit (of no less than 12 inches) by January 1, 2014. States were also required to further increase the minimum size limit (to no less than 14 inches) by January 1, 2016. In response to the ASMFC requirement, the North Carolina Marine Fisheries Commission implemented a 14- to 25-inch total length slot size limit (with one fish over 25 inches), 10-fish recreational bag limit and a 500-pound commercial trip limit effective January 1, 2014. The FMP also includes a management framework to adaptively respond to future concerns or changes in the fishery or population. Concern about the increase in harvest by both recreational and commercial were alleviated by the findings of the 2015 stock assessment. The ASMFC Interstate Fisheries Management Program Policy Board chose to not make any additional changes to the FMP at the time given the findings of the assessment.

In May 2018, ASMFC approved Addendum I to the Black Drum FMP to allow Maryland to reopen its black drum commercial fishery in the Chesapeake Bay with a daily vessel limit of up to 10 fish and a 28-inch minimum size. The Black Drum Technical Committee noted that reopening the fishery would not likely lead to overfishing due to the relatively small size of the fishery and recommended that biological monitoring be conducted to monitor the commercial fishery.

To ensure compliance with interstate requirements, North Carolina also manages this species under the North Carolina Fishery Management Plan for Interjurisdictional Fisheries (IJ FMP).

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – BLACK DRUM

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).

Management Unit

The ASMFC FMP includes all states from Florida to New Jersey. The management unit is defined as the black drum (*Pogonias cromis*) resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the estuaries eastward to the offshore boundaries of the U.S. Exclusive Economic Zone (EEZ) (ASMFC 2013).

Goal and Objectives

The goal of the Black Drum FMP is to provide an efficient management structure to implement coastwide management measures. The objectives of the FMP include:

1. Provide a flexible management system to address future changes in resource abundance, scientific information, and fishing patterns among user groups or area.
2. Promote cooperative collection of biological, economic, and sociological data required to effectively monitor and assess the status of the black drum resource and evaluate the management efforts.
3. Manage the black drum fishery to protect both young individuals and established breeding stock.
4. Develop research priorities that will further refine the black drum management program to maximize the biological, social, and economic benefits derived from the black drum population.

STATUS OF THE STOCK

Life History

Black Drum is the largest member of the drum family (Sciaenidae), reaching sizes of over 46 inches and 120 pounds. The range of black drum extends along the nearshore western Atlantic coast from the Gulf of Maine to Florida, into the Gulf of Mexico, and as far south as Argentina. Along the Atlantic Coast, black drum are thought to migrate northward and inshore each spring and southward and offshore by late fall. Juvenile black drum can be found throughout the estuarine waters of North Carolina, while adults tend to congregate around structure including

bridge and dock pilings. They are primarily bottom feeders; juvenile diets consist mainly of small fish and invertebrates, while the adult diet consists primarily of mollusks and crustaceans. Spawning is thought to occur in the offshore waters of the Mid-Atlantic during the winter and early spring. The number of juvenile fish entering the population annually (recruitment) is thought to be highly variable and dependent on natural environmental conditions. Females are sexually mature between the ages of 4 and 6 (25 to 28 inches) and spawn yearly through adulthood. An average-sized female may spawn 32 million eggs each year. At ages 4 and 5 (22 to 25 inches) males are mature. The species is long-lived, reaching up to 60 years of age. Black drum are approximately 11 to 14 inches at age 1, 15 to 17 inches at age 2, and 19 to 21 inches at age 3.

Stock Status

The 2015 ASMFC Black Drum Stock Assessment determined that the stock is not overfished and not experiencing overfishing and considered sustainable in 2016.

Stock Assessment

Variable catch history in state surveys and fisheries, coupled with complex migratory patterns, made the use of traditional statistical catch-at-age models difficult. A data-poor modeling approach was used for the first coastwide benchmark stock assessment (ASMFC 2015). Data-poor models estimate reference points based on historical catch data and life history information. A Depletion-Based Stock Reduction Analysis (DB-SRA) model was used to estimate biomass and maximum sustainable yield (MSY). Median MSY was estimated to be 2.12 million pounds and the median overfishing limit (OFL) is estimated to be 4.12 million pounds (see Management Strategy section below). While the median biomass has declined steadily from the 1900s, the median biomass in 2012 was well above the level needed to produce maximum sustainable yield (B_{MSY} ; 47.26 million pounds; Figure 2). The DB-SRA results determined that black drum is not overfished and not experiencing overfishing based on the black drum life history, indices of abundance, and history of exploitation (ASMFC 2016).

STATUS OF THE FISHERY

Current Regulations

Minimum Size Limit

- It is unlawful to possess black drum less than 14-inches total length or greater than 25-inches total length, except that one (1) black drum over 25-inches total length may be retained.

Harvest Limits

- It is unlawful to possess more than ten (10) black drum per person per day by hook and line or for recreational purposes.
- It is unlawful for any commercial fishing operation, regardless of the number of persons, license holders or vessels involved, to possess more than 500 pounds of black drum per trip.

Commercial Landings

Black drum is primarily caught as bycatch in several North Carolina commercial fisheries; however, they are predominately landed in the estuarine gill net and pound net fisheries. The commercial harvest of black drum has been highly variable over the last 10 years (Table 1; Figure 1). On average 117,300 pounds of black drum were landed annually from 2008 to 2017. Commercial landings have ranged from a low of 51,103 pounds in 2015 to a high of 301,998 pounds in 2008. Commercial landings more than doubled from 2016 to 2017.

Recreational Landings

Recreational fishing activity is monitored through the Marine Recreational Information Program. The recreational landings have been highly variable over the last 10 years, ranging from a low of 60,406 pounds in 2014 to a high of 713,047 pounds in 2013 (Table 2; Figure 1). In 2017, 164,295 pounds of black drum were harvested, below the 10-year average of 263,743 pounds. The harvest (pounds of fish) decreased 31% from 2016 to 2017. Recreational releases (number of fish) decreased 58% from 2016 to 2017.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial black drum landings are monitored through the North Carolina trip ticket program. Under this program, licensed fishermen can only sell commercial catch from coastal fishing waters to licensed NCDMF fish dealers. The dealer is required to complete a trip ticket every time a licensed fisherman lands fish. Trip tickets capture data on gears used to harvest fish; area fished, species harvested, and total weights of each species/market grade category. Trip tickets are submitted to NCDMF on the 10th of the month following the month in which the landings occurred. Landings are available approximately 30 to 45 days after they are submitted from the dealers.

Commercial fishing activity is monitored through fishery dependent sampling conducted under Title III of the Interjurisdictional Fisheries Act and has been ongoing since 1982. Biological samples (lengths, aggregate weights) are obtained from several NCDMF commercial fisheries dependent sampling programs. Black drum lengths and aging structures are collected at local fish houses. After sampling a portion of the catch, the total weight of the catch by species and market grade are obtained for each trip, either by using the trip ticket weights or some other reliable estimate.

Since the implementation of the 14- to 25-inches slot limit in 2014, the mean total length (TL) of commercially harvest black drum has increased. The mean TL has ranged from 13- inches to 19- inches (Table 3). In 2017, the minimum TL was 10-inches and the maximum TL was 30-inches. Undersized black drum have continued to be harvested since the implementation of the 14- minimum size limit established in 2014, this is likely due to fishermen being unaware of changes in regulations, and/or fishermen confusing the minimum size limits of black drum and sheephead.

The minimum size limit of sheepshead is 10-inches fork length (FL) and was implemented in 2015.

The Marine Recreational Intercept Program (MRIP) is the primary survey used to collect data on angler harvest and effort. MRIP provides estimates of catch and effort at a regional level from the recreational fishing community and consists of two components, the Access-Point Angler Intercept Survey (APAIS) and the Coastal Household Telephone Survey (CHTS). The CHTS uses a random digit dialing telephone survey approach to collect marine recreational fishing effort information from residential households located in coastal counties. Individual catch and discard data for calculation of catch rate at the species level are collected through APAIS, an onsite intercept survey conducted at fishing access-sites (e.g., boat ramps, beaches, piers, marinas, etc.). Creel clerks collect intercept data year-round (in two-month waves) by interviewing anglers completing fishing trips in one of four fishing modes (man-made structures, beaches, private boats, and for-hire vessels). Individual lengths (inches-TL) and weights (pounds) are recorded for each individual specimen sampled. Results from both component surveys are combined at the state, area, fishing mode and wave level to provide estimates of the total number of fish caught, released, and harvested; the weight of the harvest; the total number of trips; and total participation in marine recreational fishing.

The mean TL of recreational harvested black drum ranged from a low of 10-inches in 2011 to a maximum of 17-inches in 2015 and 2016 (Table 4). In 2017, the minimum TL was 9-inches and the maximum TL was 27-inches. Similar to the commercial fishery, undersized black drum have continued to be harvested since the implementation of the 14-inch minimum size limit established in 2014.

Fishery-Independent Monitoring

A fishery independent gill net survey was initiated by the NCDMF in May of 2001. The survey utilizes a stratified random sampling scheme designed to characterize the size and age distribution for key estuarine species in Pamlico Sound. By continuing a long-term database of age composition and developing index of abundance for black drum this survey will help managers assess the black drum stocks without relying solely on commercial and recreational fishery dependent data. Additionally, data collected is used to help improve bycatch estimates, evaluate the success of management measures, and look at habitat usage.

The annual weighted black drum CPUE from the independent gill net survey has ranged from a high of 3.52 in 2002 to a low of 0.38 in 2012 (Table 5; Figure 3). In 2017, the CPUE was 1.17, slightly above the time-series average (1.01 black drum per set). Proportional Standard Error (PSE) has ranged from 12 to 39. This survey was used in the ASMFC benchmark stock assessment for black drum as annual index of relative abundance for sub-adult and adult black drum.

Black drum age structures are collected from various fishery independent (scientific surveys) and dependent (fisheries) sources throughout the year. In 2017, 734 black drum were aged; the majority (75%) of the age structures were collected from independent sources and may not be

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representative of fish caught in North Carolina’s recreational and commercial fisheries (Table 6). Ages ranged in from 0 to 43 years.

MANAGEMENT STRATEGY

Data poor models such as the one used for 2015 ASMFC Black Drum Stock Assessment are designed to estimate reference points based on historical catch data and the life history of a particular species. Due to the uncertainty of the inputs and the nature of data poor methods the ASMFC stock assessment subcommittee (SASC) recommended that a precautionary maximum sustainable yield (MSY) estimate of 2.12 million pounds with an interquartile range of 1.60 to 3.05 million pounds as the recommended target reference point (Figure 2). The threshold MSY or overfishing limit (OFL) was set at 4.12 million pounds. The SASC also recommended that future assessments include a “rumble-strip” (traffic light) approach that has been implemented by the Mid-Atlantic Fisheries Management Council for other data poor species. This method allows managers to examine a set of indicators that detect major changes in harvest and F that could trigger a reassessment of the reference points.

Each year the ASMFC Plan Review Team (PRT) Black Drum monitors each states’ compliance with FMP during its annual review. States must demonstrate that the compliance criteria of the FMP are satisfied and submit an annual report concerning its fisheries and management programs. Following the review of the 2016 fishing year, the PRT determined that all states were compliant with the FMP. The ASMFC Interstate Fisheries Management Program Policy Board also determined that given the findings of the 2015 assessment, no additional changes to the management of black drum were needed.

See Table 7 for current management strategies and implementation status of the ASMFC Black Drum FMP.

RESEARCH NEEDS

The FMP outlines research needs for black drum. The ASMFC black drum PRT will annually review and prioritize the research needs as part of the ASMFC FMP review process. The research recommendations outlined in the 2017 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Black Drum include:

- Age otoliths that have been collected and archived – HIGH (ongoing)
- Collect information to characterize the size composition of fish discarded in recreational fisheries – HIGH (ongoing).
- Collect information on the magnitude and sizes of commercial discards. Obtain better estimates of black drum bycatch in other fisheries, especially juvenile fish in south Atlantic states – HIGH (ongoing)
- Increase biological sampling in commercial fisheries to better characterize the size and age composition of commercial fisheries by state and gear – HIGH (ongoing).
- Increase biological sampling in recreational fisheries to better characterize the size and age composition by state and wave – HIGH (ongoing)

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- Obtain estimates of selectivity-at-age for commercial fisheries by gear, recreational harvest, and recreational discards – HIGH (ongoing).
- Continue all current fishery-independent surveys and collect biological samples for black drum on all surveys – HIGH (ongoing)
- Develop fishery-independent adult surveys. Consider long line and purse seine surveys – HIGH (ongoing).
- Collect age samples, especially in states where maximum size regulations preclude the collection of adequate adult ages – HIGH (ongoing).
- Conduct reproductive studies, including: age and size-specific fecundity, spawning frequency, spawning behaviors by region, and movement and site fidelity of spawning adults – MEDIUM (needed).
- Conduct a high reward tagging program to obtain improved return rate estimates. Continue and expand current tagging programs to obtain mortality and growth information and movement at size data – HIGH (needed).
- Conduct tagging studies using implanted radio tracking tags that are compatible with coastal tracking arrays along the Atlantic coast in order to track movement and migration of adults – HIGH (needed).
- Improve sampling of night time fisheries – MEDIUM (needed).
- Conduct studies to estimate catch and release mortality rates in recreational fisheries – HIGH (needed).
- Collect genetic material (i.e., create “genetic tags”) over a long time span to obtain information on movement and population structure, and potentially estimate population size – MEDIUM (needed).
- Obtain better estimates of harvest from the black drum recreational fishery, especially in states with short seasons – MEDIUM (ongoing).

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ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – BLACK DRUM

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TABLES

Table 1. North Carolina commercial black drum landings (pounds), number of dealers and ex-vessel value, 2008-2017 (NCTTP).

| Year | Dealers | Ex-Vessel Value | Pounds |
|------|---------|-----------------|---------|
| 2008 | 156 | \$104,937 | 301,998 |
| 2009 | 151 | \$64,875 | 148,994 |
| 2010 | 128 | \$32,805 | 69,194 |
| 2011 | 132 | \$26,432 | 56,083 |
| 2012 | 157 | \$54,133 | 94,352 |
| 2013 | 151 | \$79,480 | 127,170 |
| 2014 | 120 | \$32,298 | 51,217 |
| 2015 | 117 | \$43,158 | 51,103 |
| 2016 | 127 | \$82,200 | 90,012 |
| 2017 | 135 | \$185,198 | 182,876 |

Table 2. North Carolina recreational black drum harvest pounds, harvest number and number released and PSE=Proportional Standard Error, 2008-2017 (MRIP).

| Year | Harvest Weight | | Harvest Number | | Released Alive | |
|------|----------------|-----|----------------|-----|----------------|-----|
| | Pounds | PSE | Number | PSE | Number | PSE |
| 2008 | 524,138 | 27 | 359,702 | 21 | 188,680 | 25 |
| 2009 | 121,038 | 20 | 92,058 | 23 | 69,484 | 29 |
| 2010 | 305,517 | 35 | 122,709 | 21 | 102,348 | 21 |
| 2011 | 151,407 | 18 | 211,396 | 18 | 104,286 | 21 |
| 2012 | 243,965 | 18 | 139,363 | 16 | 91,895 | 20 |
| 2013 | 713,047 | 27 | 363,466 | 21 | 121,306 | 28 |
| 2014 | 60,406 | 26 | 24,058 | 28 | 361,514 | 26 |
| 2015 | 115,609 | 30 | 35,529 | 29 | 559,251 | 30 |
| 2016 | 238,012 | 28 | 71,708 | 24 | 566,785 | 36 |
| 2017 | 164,295 | 27 | 65,455 | 28 | 240,378 | 19 |

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Table 3. Commercial black drum total length (TL) data from NCDMF fishery-dependent sampling programs (P400s), 2008-2017.

| Year | Mean TL (inches) | Minimum TL (inches) | Maximum TL (inches) | Total Measured (number) |
|------|---------------------|------------------------|------------------------|----------------------------|
| 2008 | 15 | 7 | 50 | 2,695 |
| 2009 | 16 | 7 | 48 | 1,060 |
| 2010 | 17 | 8 | 49 | 658 |
| 2011 | 13 | 7 | 33 | 1,204 |
| 2012 | 15 | 6 | 37 | 1,123 |
| 2013 | 16 | 5 | 36 | 866 |
| 2014 | 17 | 10 | 47 | 381 |
| 2015 | 19 | 10 | 44 | 310 |
| 2016 | 17 | 10 | 47 | 810 |
| 2017 | 18 | 10 | 30 | 549 |

Table 4. Recreational black drum total length (TL) data from Marine Recreational Intercept Program (MRIP), 2008-2017. MRIP data was provided as centerline length.

| Year | Mean TL (inches) | Minimum TL (inches) | Maximum TL (inches) | Total Measured (number) |
|------|---------------------|------------------------|------------------------|----------------------------|
| 2008 | 13 | 7 | 48 | 363 |
| 2009 | 12 | 8 | 25 | 191 |
| 2010 | 14 | 7 | 29 | 258 |
| 2011 | 10 | 7 | 24 | 567 |
| 2012 | 13 | 7 | 26 | 237 |
| 2013 | 13 | 7 | 26 | 154 |
| 2014 | 16 | 13 | 23 | 33 |
| 2015 | 17 | 11 | 25 | 75 |
| 2016 | 17 | 10 | 28 | 114 |
| 2017 | 16 | 9 | 27 | 161 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – BLACK DRUM

Table 5. Annual weighted black drum CPUE (all ages combined) from the North Carolina Pamlico Sound Independent Gill Net Survey. N=number of samples; CPUE=Catch per unit effort (black drum per gill net set); SE=Standard Error; PSE=Proportional Standard Error.

| Year | N | CPUE | SE | PSE |
|------|-----|------|------|-----|
| 2001 | 237 | 1.91 | 0.41 | 21 |
| 2002 | 320 | 3.52 | 0.46 | 13 |
| 2003 | 320 | 1.16 | 0.3 | 26 |
| 2004 | 320 | 0.46 | 0.09 | 20 |
| 2005 | 304 | 0.49 | 0.13 | 27 |
| 2006 | 320 | 0.78 | 0.09 | 12 |
| 2007 | 320 | 0.76 | 0.16 | 21 |
| 2008 | 320 | 0.87 | 0.16 | 18 |
| 2009 | 320 | 0.79 | 0.16 | 20 |
| 2010 | 320 | 0.54 | 0.18 | 33 |
| 2011 | 298 | 0.84 | 0.15 | 18 |
| 2012 | 308 | 0.38 | 0.07 | 18 |
| 2013 | 308 | 0.42 | 0.07 | 17 |
| 2014 | 308 | 0.76 | 0.17 | 22 |
| 2015 | 306 | 1.04 | 0.41 | 39 |
| 2016 | 308 | 1.33 | 0.21 | 16 |
| 2017 | 308 | 1.17 | 0.26 | 22 |

Table 6. Summary of black drum age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) sources from 2012-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|-------|-----------|-------------|-------------|-------------------|
| 2011 | 0 | 0 | 60 | 140 |
| 2012 | 1 | 0 | 3 | 327 |
| 2013 | 2 | 0 | 4 | 187 |
| 2014 | 1 | 0 | 31 | 409 |
| 2015 | 0 | 0 | 4 | 400 |
| 2016 | 1 | 0 | 12 | 662 |
| 2017* | 1 | 0 | 43 | 734 |

*Preliminary ages, pending second read.

Table 7. Summary of ASMFC management strategies and their implementation status for Black Drum Fishery Management Plan.

| Management Strategy | Implementation Status |
|--|-----------------------------|
| <i>HARVEST MANAGEMENT</i> | |
| Implement a maximum possession limit and size limit (of no less than 12 inches) by January 1, 2014 | Accomplished (other states) |
| Implement a maximum possession limit and size limit (of no less than 14 inches) by January 1, 2016 | Proclamation FF-73-2013 |

FIGURES

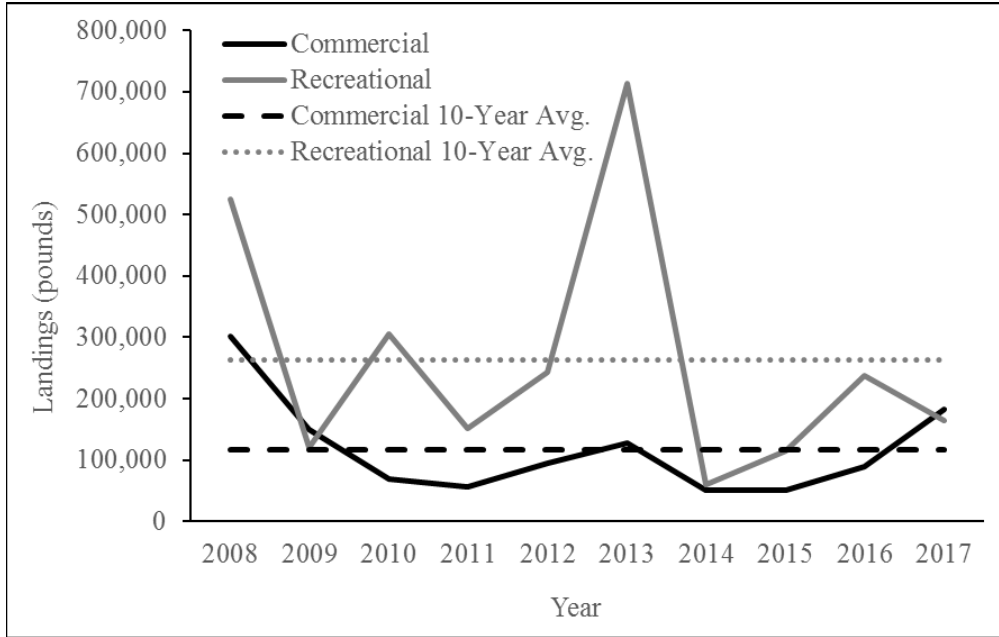


Figure 1. North Carolina commercial from the NCTTP and MRIP black drum landings (pounds), 2008-2017.

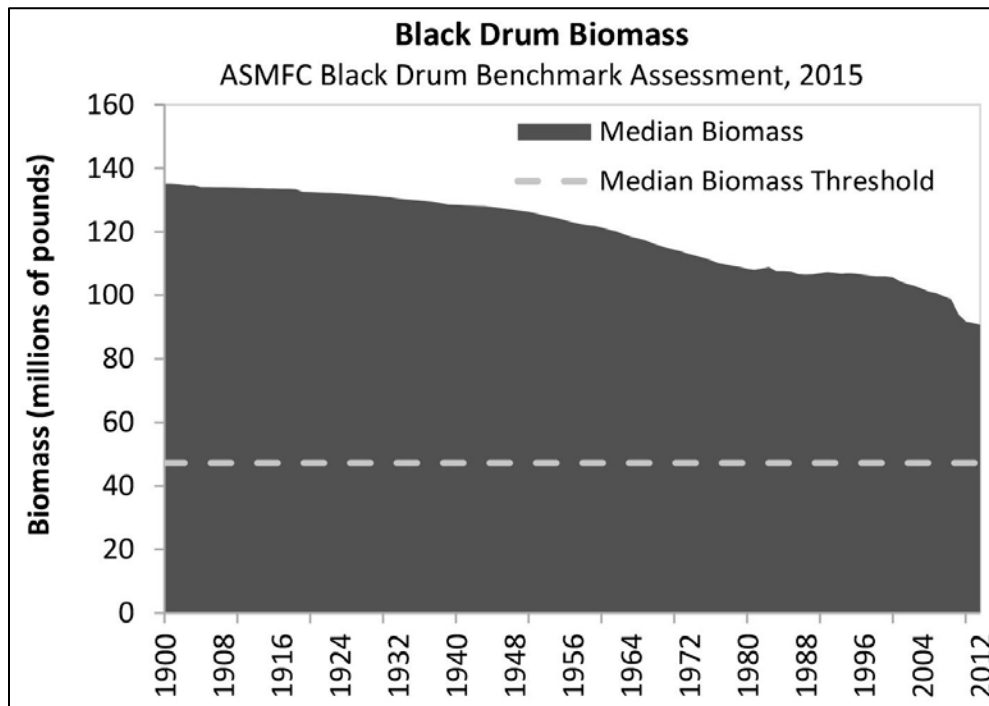


Figure 2. Depletion-Based Stock Reduction Analysis (DB-SRA) median biomass and threshold, 1900-2012 (ASMFC 2015).

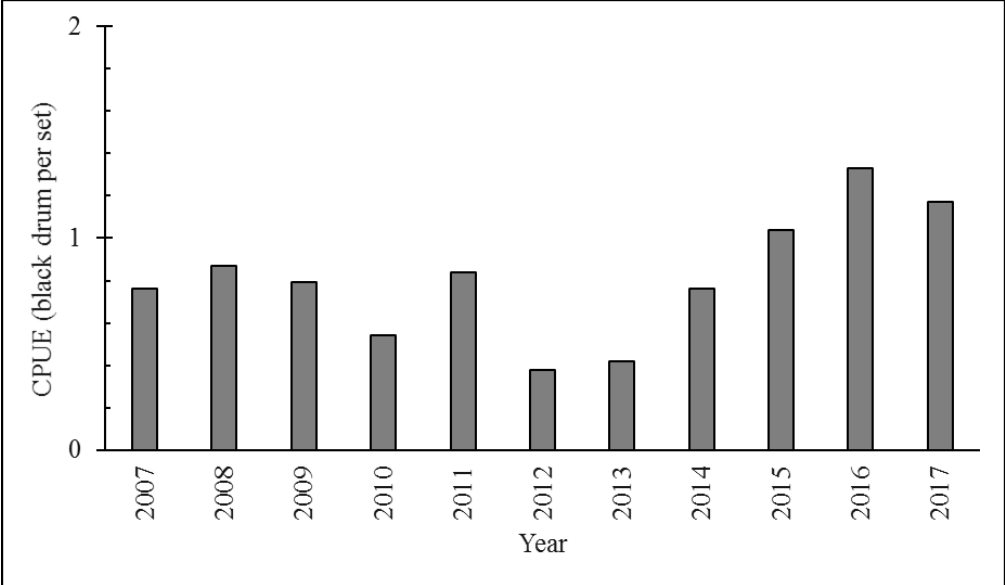


Figure 3. Annual weighted black drum CPUE (number captured for ages combined) from the North Carolina Pamlico Sound Independent Gill Net Survey, 2007-2017.

**FISHERY MANAGEMENT PLAN UPDATE
BLACK SEA BASS NORTH OF CAPE HATTERAS
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | Incorporated into the Summer Flounder FMP through Amendment 9 in 1996 |
| Amendments: | Amendment 9 in 1996 Amendment 10 in 1997 Amendment 11 in 1998 Amendment 12 in 1999 Framework 1 in 2001 Addendum IV in 2001 Addendum VI in 2002 Amendment 13 in 2003 Framework 5 in 2004 Addendum XII in 2004 Addendum XIII in 2004 Addendum XVI in 2005 Amendment 16 in 2007 Framework 7 in 2007 Addendum XIX in 2007 Addendum XX in 2009 Amendment 15 in 2011 Addendum XXI in 2011 Addendum XXII in 2012 Amendment 19 (Recreational Accountability Amendment) in 2013 Addendum XXIII in 2013 Addendum XXV in 2014 Amendment 17 in 2015 Framework 8 in 2015 Amendment 18 in 2015 Addendum XXVII in 2016 Amendment 20 in 2017 Framework 10 in 2017 Addendum XXX in 2018 Framework 11 in 2018 |
| Revisions: | None |

| | |
|------------------------|---|
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | A benchmark stock assessment was completed in 2016 and a stock assessment update is scheduled for early 2019. |

Because of their presence in, and movement between, state waters (0-3 miles) and federal waters (3-200 miles), the Mid-Atlantic Fisheries Management Council (MAFMC) manages black sea bass (*Centropristis striata*) north of Cape Hatteras cooperatively with the Atlantic States Marine Fisheries Commission (ASMFC). The two management entities work in conjunction with the National Marine Fisheries Service (NMFS) as the federal implementation and enforcement entity. The Summer Flounder, Scup and Black Sea Bass Fishery Management Plan (FMP) and amendments use output controls (catch and landings limits) as the primary management tool, with landings divided between the commercial (49 percent) and recreational (51 percent) fisheries. The FMP also includes minimum fish sizes, bag limits, seasons, gear restrictions, permit requirements, and other provisions to prevent overfishing and ensure sustainability of the fisheries. Recreational bag and size limits and seasons are determined on an ad-hoc state and regional basis in state waters and coastwide measures in federal waters. The commercial quota is divided into state-by-state quotas.

Specific details for each Amendment include:

Amendment 9 - incorporated black sea bass into the Summer Flounder FMP; established black sea bass management measures including commercial quotas, recreational harvest limits, size limits, gear restrictions, permits, and reporting requirements.

Amendment 10 – modified commercial minimum mesh requirements; continued commercial vessel moratorium; prohibited transfer of summer flounder at sea; established a special permit for the summer flounder party/charter sector.

Amendment 11 - modified certain provisions related to vessel replacement and upgrading, permit history transfer, splitting, and permit renewal regulations.

Amendment 12 - revised the Summer Flounder, Scup, and Black Sea Bass FMP to comply with the Sustainable Fisheries Act and established a framework adjustment process; established quota set-aside for research for summer flounder, scup and black sea bass; established state-specific conservation equivalency measures; allowed the rollover of the winter scup quota; revised the start date for the scup summer quota period; established a system to transfer scup at sea.

Framework 1 – established quota set-aside for research for summer flounder, scup and black sea bass.

Addendum IV – provided that upon the recommendation of the relevant monitoring committee and joint consideration with the Mid-Atlantic Fishery Management Council, the Mid-Atlantic

Fishery Management Board will decide the state regulations rather than forward a recommendation to the National Marine Fisheries Science center; made states responsible for implementing the Mid-Atlantic Fishery Management Boards decisions on regulations. Addendum VI – provided a mechanism for initial possession limits, triggers, and adjusted possession limits to be set during the annual specification setting process without the need for further Emergency Rules.

Amendment 13 - revised black sea bass commercial quota system; addressed other black sea bass management measures; established multi-year specification setting of quota for summer flounder, scup and black sea bass; established region-specific conservation equivalency measures for summer flounder; built flexibility into process to define and update status determination criteria for each plan species. Amendment 13 also removed the necessity for fishermen who have both a Northeast Region (NER) black sea bass permit and a Southeast Region (SER) snapper/grouper permit to relinquish their permits for a six-month period prior to fishing south of Cape Hatteras during the northern closure.

Framework 5 – established multi-year specification setting of quota for summer flounder, scup, and black sea bass.

Addendum XII - continued the use of a state-by-state allocation system, managed by the ASMFC on an annual coastwide commercial quota.

Addendum XIII – modified the Summer Flounder, Scup, and Black Sea Bass FMP so that Total Allowable Landings for summer flounder, scup, and/or black sea bass can be specified for up to three years.

Addendum XVI – established guidelines for delayed implementation of management strategies.

Amendment 16 - standardized bycatch reporting methodology.

Framework 7 – built flexibility into process to define and update status determination criteria for each plan species.

Addendum XIX – continued the state-by-state black sea bass commercial management measures, without a sunset clause; broadened the descriptions of stock status determination criteria contained within the Summer Flounder, Scup, and Black Sea Bass FMP to allow greater flexibility in those definitions, while maintaining objective and measurable status determination criteria for identifying when stocks or stock complexes covered by the fishery management plan are overfished.

Addendum XX – set policies to reconcile commercial quota overages to address minor inadvertent quota overages; streamlined the quota transfers process and established clear policies and administrative protocols to guide the allocation of transfers from states with underages to states with overages; allowed for commercial quota transfers to reconcile quota overages after a years end.

Amendment 15 - established annual catch limits and accountability measures.

Addendum XXI – allowed more flexibility in setting recreational measures for the 2011 fishing year and proposed state-by-state or regional management measures for the 2011 black sea bass fishery.

Addendum XXII – divided the recreational black sea bass coastwide allocations into state-by-state management for 2012 only.

Amendment 19 (Recreational Accountability Amendment) – modified the accountability measures for the MAFMC recreational fisheries.

Addendum XXIII – established regional management for the 2013 recreational black sea bass fishery.

Addendum XXV – established regional management for the 2014 recreational black sea bass and summer flounder fishery.

Amendment 17 – implemented standardized bycatch reporting methodology.

Framework 8 – allowed the black sea bass recreational fishery to begin on May 15 of each year, instead of May 19, to provide additional fishing opportunities.

Amendment 18 – eliminated the requirement for vessel owners to submit “did not fish” reports for the months or weeks when their vessel was not fishing; removed some of the restrictions for upgrading vessels listed on federal fishing permits.

Addendum XXVII - continued regional management of the recreational summer flounder fishery, extended ad hoc regional management of the black sea bass recreational fishery for the 2016 and 2017 fishing year and addressed the discrepancies in recreational summer flounder management measures within Delaware Bay.

Amendment 20 - implemented management measures to prevent the development of new, and the expansion of existing, commercial fisheries on certain forage species in the Mid-Atlantic.

Framework 10 - implemented a requirement for vessels that hold party/charter permits for Council-managed species to submit vessel trip reports electronically (eVTRs) while on a trip carrying passengers for hire.

Addendum XXX – established 2018 recreational black sea bass management with options for regional allocations that require uniform regulations and other alternatives to the current North/South regional delineation (MA-NJ/DE-NC)

Framework 11 - established a process for setting constant multi-year Acceptable Biological Catch (ABC) limits for Council-managed fisheries, clarified that the Atlantic Bluefish, Tilefish, and Atlantic Mackerel, Squid, and Butterfish FMPs will now automatically incorporate the best available scientific information in calculating ABCs (as all other Mid-Atlantic management

plans do) rather than requiring a separate management action to adopt them, clarified the process for setting ABCs for each of the four types of ABC control rules.

Specific details for each amendment under development include: None

To ensure compliance with interstate requirements, North Carolina also manages this species 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 MAFMC, 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).

Management Unit

U.S. waters in the western Atlantic Ocean from Cape Hatteras northward to the U.S.-Canadian border.

Goal and Objectives

The objectives of the Summer Flounder, Scup and Black Sea Bass FMP are to:

1. Reduce fishing mortality in the summer flounder, scup and black sea bass fisheries to assure that overfishing does not occur;
2. Reduce fishing mortality on immature summer flounder, scup and black sea bass to increase spawning stock biomass;
3. Improve the yield from these fisheries;
4. Promote compatible management regulations between state and federal jurisdictions;
5. Promote uniform and effective enforcement of regulations;
6. Minimize regulations to achieve the management objectives stated above.

The 2011 Omnibus Amendment contains Amendment 15 to the Summer Flounder, Scup and Black Sea Bass FMP. The amendment is intended to formalize the process of addressing scientific and management uncertainty when setting catch limits for the upcoming fishing year(s) and to establish a comprehensive system of accountability for catch (including both landings and discards) relative to those limits, for each of the managed resources subject to this requirement. Specifically: (1) Establish allowable biological catch control rules, (2) Establish a MAFMC risk policy, which is one variable needed for the allowable biological catch control rules, (3)

Establish annual catch limits, (4) Establish a system of comprehensive accountability, which addresses all components of the catch, (5) Describe the process by which the performance of the annual catch limit and comprehensive accountability system will be reviewed, (6) Describe the process to modify the measures above in 1-5 in the future.

STATUS OF THE STOCK

Life History

Black sea bass are split into two stocks but together are found along the Atlantic coast from the Gulf of Maine to the Florida Keys. The northern stock is located from the Gulf of Maine to Cape Hatteras, North Carolina while the southern stock is located from Cape Hatteras, North Carolina to the Florida Keys. Black sea bass have a unique life history in that they are protogynous hermaphrodites which means they begin life as female and then change to male once they reach age 2 to 5 or when they reach 9 to 13 inches in total length. During the spawning season, dominant males develop a large nuchal (nape of the neck) hump, whereas subordinate males do not and are typically smaller in size. Spawning for the northern stock typically occurs offshore on the inner continental shelf during the months from May to July. Juveniles and adults move nearshore during the summer. Seasonal migration is common for black sea bass (north of Cape Hatteras). Black sea bass have a maximum age of 12 years. They are likely to stay near rock pilings, wrecks and jetties and prey on fish, crabs, mussels and razor clams (Steimle 1999).

Stock Status

The 2016 black sea bass benchmark stock assessment included data through 2015 and indicated that the stock was not overfished and overfishing was not occurring in 2015. A black sea bass stock assessment update is scheduled for early 2019.

Stock Assessment

The 2016 black sea bass benchmark stock assessment estimated fishing mortality and stock sizes using a spatially explicit age-based statistical catch at age model calculated by using the Age Structured Assessment Program. This indicated that the fishing mortality rate was below the threshold reference point and the spawning stock biomass was above the target reference point so the stock was not overfished and overfishing was not occurring.

STATUS OF THE FISHERY

Current Regulations

Commercial: 11-inch total length minimum size limit in Atlantic Ocean and internal coastal waters north of Cape Hatteras. Landings windows are set by proclamation with variable harvest limits by gear and time-period to prevent landings from exceeding North Carolina's commercial quota (see most recent North Carolina Division of Marine Fisheries (NCDMF) proclamation).

Recreational: 12 ½-inch total length minimum size limit and 15-fish creel limit in Atlantic Ocean and internal coastal waters north of Cape Hatteras. Season for the recreational fishery is May 15 to December 31.

Commercial Landings

All black sea bass landings are reported through the North Carolina Trip Ticket Program. Most black sea bass landings from north of Cape Hatteras were from trawls, although fish pots and rod and reel gears caught small numbers. Landings generally declined from 2008 to 2012 but have increased notably each year since 2013 (Figure 1). The low landings in 2012-2013 were partly due to the closure of Oregon Inlet to large vessels (such as trawlers) and the consequent transfer of most of North Carolina's quota allocation to Virginia and other states. In 2014 and 2015, more winter trawl vessels returned to North Carolina to land catches rather than transferring quota to Virginia and other states. Trends in commercial trips have generally followed landings trends (Figure 1). Trips include the number of trip ticket records with landings of black sea bass reported. Trips may represent more than one day of fishing, especially for trawling.

Recreational Landings

All black sea bass harvest is reported through the NCDMF Marine Recreational Information Program. Recreational harvest of black sea bass from north of Cape Hatteras is variable from year to year. While landings from 2014 to 2016 were low, 2017 reported increased landings (Table 1).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Three NCDMF sampling programs collect biological data on commercial and recreational fisheries that catch black sea bass north of Cape Hatteras. Program 433 (Winter Trawl Fishery) and Program 438 (Offshore Live Bottom Fishery) are the primary programs that collect harvest length data. Other commercial sampling programs focusing on fisheries that do not target black sea bass rarely collect biological data. NCDMF sampling of the recreational fishery occurs through the Marine Recreational Information Program which collects harvest and length data.

There were no clear trends in commercial length data from 2008 to 2017 (Table 2). Annual mean lengths were fairly consistent for the time-series. The number of fish measured in 2017 was the fourth highest in the time-series. Otoliths have been collected since 2013 but age data are not yet available.

There were some potential trends in length data in the recreational fishery but sample size was low throughout 2008-2017 (Table 3). Mean lengths were fairly consistent, although higher earliest in the time-series. The number of measurements declined in 2017. Age data were not collected for black sea bass north of Cape Hatteras from recreational fisheries.

Fishery-Independent Monitoring

NCDMF independent sampling programs rarely encounter black sea bass north of Cape Hatteras (Table 4). Most of the sample numbers came from Program 120 (Estuarine Trawl Survey) and from Program 195 (Pamlico Sound Survey), which typically collect samples of black sea bass juveniles from inshore waters each year. However, it is not clear that samples collected inshore north of Cape Hatteras are from the northern stock of black sea bass; this combined with the small sample numbers means that these data cannot be used in an abundance index. NCDMF currently does not have independent sampling programs in Atlantic Ocean waters north of Cape Hatteras.

MANAGEMENT STRATEGY

Management of black sea bass (north of Cape Hatteras) has been based on results from NMFS Northeast Fisheries Science Center (NEFSC) stock assessments. Results from the 2016 benchmark stock assessment are being used to guide management. Projections based on stock assessments are used to set the coastwide quota level each year. Amendments to the FMP are undertaken as issues arise that require action.

RESEARCH NEEDS

The following research needs were reviewed (existing needs) or developed (new) during the 2017 Stock Assessment Workshop by the Southern Demersal Working Group and the MAFMC Scientific and Statistical Committee. Text in parentheses indicates known progress made to address needs.

- The panel recommends multiple age-structured models be evaluated for use in a future model such as a simple separable model with smoothing on F among years (some progress has been made, evaluation of catch curves is a routine diagnostic), a more complex, spatially structured model with 6 month time step within independent stock areas in spring and mixing in winter with natal homing, if data area adequate to support such a model (some progress has been made using area exchange and SS3 models), and consideration should be given to including tag return data in an age-structured (and possibly spatially-structured) assessment model (tag results were considered for use in area exchange models but explored more in SS3 models).
- The panel recommends evaluation of a species specific survey, such as a pot survey to provide increased information on abundances and biological characteristics (some research has been done but was terminated by MAFMC due to program design).
- Continue and expand the tagging program to provide increased age information and increased resolution on mixing rates among putative populations (no additional designed tagging projects were conducted).
- Continue and expand genetic studies to evaluate the potential of population structure north of Cape Hatteras (some genetic work evaluated for the Gulf of Maine by Northeastern University).
- Continue research on rate, timing and occurrence of sex-change in this species. Recent research findings discussed at the stock assessment review committee lead to the hypothesis that

protogyny is not obligate in this species – some individuals may never have been female before maturing as a male (NEFSC and Rutgers University continue research).

- The validity of the age data used in the assessment requires further evaluation, in particular the reliability of scale-based ageing needs to be determined. A scale-otolith intercalibration exercise might be of utility (the working paper within the latest assessment explores this issue).
- Expand on previous genetic studies with smaller spatial increments in sampling (progress unknown).
- Consider the impact of climate change on black sea bass, particularly in the Gulf of Maine (progress unknown).
- Evaluate population sex change and sex ratio, particularly comparing dynamics among communities (progress unknown).
- Study black sea bass catchability in a variety of survey gear types (progress unknown).
- Investigate and document social and spawning dynamics of black sea bass (progress unknown).
- Increased work to understand habitat use in sea bass and seasonal changes (progress unknown).
- Evaluate use of samples collected by industry study fleets (progress unknown).

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National Marine Fisheries Science Center Northeast Fisheries Science Center. 2017. Benchmark Stock Assessment of Black Sea Bass. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center.

North Carolina Division of Marine Fisheries. 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.

North Carolina Division of Marine Fisheries. 2017. <http://portal.ncdenr.org/web/mf/home>.

Steimle, Frank, Christine Zetlin, Peter Berrien, and Sukwoo Chang. 1999. Black Sea Bass, *Centropristis striata*, Life History and Habitat Characteristics. National Oceanic and Atmospheric Administration. 50 pp.

TABLES

Table 1. Recreational hook and line harvest of black sea bass north of Cape Hatteras in numbers of fish from Marine Recreational Information Program data 2008-2017.

| Year | Harvest (numbers) |
|------|-------------------|
| 2008 | 9,353 |
| 2009 | 3,307 |
| 2010 | 10,850 |
| 2011 | 30,975 |
| 2012 | 3,664 |
| 2013 | 8,002 |
| 2014 | 696 |
| 2015 | 1,966 |
| 2016 | 864 |
| 2017 | 13,062 |

Table 2. Summary of length (total length, mm) data for black sea bass north of Cape Hatteras from NCDMF commercial fishery sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 375 | 234 | 656 | 6,379 |
| 2009 | 381 | 233 | 662 | 3,991 |
| 2010 | 378 | 226 | 635 | 5,254 |
| 2011 | 377 | 228 | 631 | 2,946 |
| 2012 | 372 | 260 | 586 | 1,094 |
| 2013 | 378 | 229 | 611 | 1,696 |
| 2014 | 383 | 214 | 622 | 3,782 |
| 2015 | 392 | 219 | 618 | 7,261 |
| 2016 | 401 | 236 | 719 | 6,624 |
| 2017 | 396 | 255 | 617 | 5,402 |

Table 3. Summary of length (total length, mm) data for black sea bass north of Cape Hatteras from NCDMF Marine Recreational Information Program.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 361 | 273 | 501 | 48 |
| 2009 | 391 | 293 | 611 | 48 |
| 2010 | 357 | 311 | 529 | 29 |
| 2011 | 365 | 273 | 568 | 36 |
| 2012 | 404 | 329 | 511 | 14 |
| 2013 | 372 | 238 | 518 | 15 |
| 2014 | 407 | 338 | 523 | 8 |
| 2015 | 415 | 327 | 511 | 10 |
| 2016 | 354 | 309 | 542 | 21 |
| 2017 | 358 | 315 | 444 | 14 |

Table 4. Summary of length (total length, mm) data for black sea bass north of Cape Hatteras from NCDMF fishery independent sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 131 | 110 | 157 | 8 |
| 2009 | 86 | 25 | 130 | 15 |
| 2010 | 67 | 62 | 71 | 2 |
| 2011 | 87 | 69 | 117 | 5 |
| 2012 | 175 | 127 | 222 | 2 |
| 2013 | 101 | 35 | 134 | 5 |
| 2014 | 127 | 117 | 137 | 2 |
| 2015 | 110 | 103 | 117 | 2 |
| 2016 | 165 | 165 | 165 | 1 |
| 2017 | 115 | 62 | 143 | 3 |

FIGURES

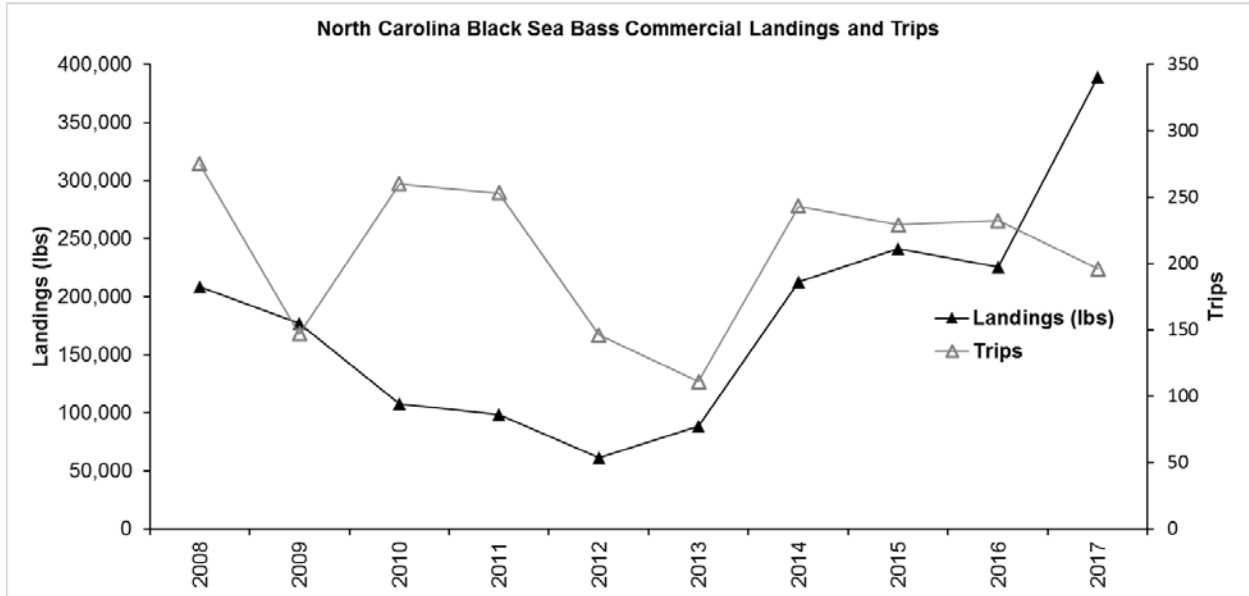


Figure 1. North Carolina commercial landings (total pounds, lb) and trips for black sea bass north of Cape Hatteras 2008-2017.

**FISHERY MANAGEMENT PLAN UPDATE
BLUEFISH
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | October 1990 |
| Amendments: | Amendment 1 2000 Framework 1 2001 Amendment 2 2007 Amendment 3 2011 Amendment 4 2013 Amendment 5 2015 Amendment 6 2017 Framework 2 2017 Framework 3 2018 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | None |

The bluefish Fishery Management Plan (FMP) was developed through a novel (at the time) joint management effort between the interstate Atlantic States Marine Fisheries Commission (ASMFC) and the federal Mid-Atlantic Fishery Management Council (MAFMC). Amendment 1 initiated a 10-year rebuilding schedule to eliminate overfishing and allow for stock rebuilding which was achieved in 2009. Amendment 1 also established commercial and recreational quota allocations, state-specific commercial allocations, and allowed for transfer of unused recreational quota to the commercial fishery. Framework one established annual harvest allocations specifically for biological monitoring programs. Amendment 2 and 5 was implemented to establish a strategy for monitoring bluefish bycatch. Amendment 3 was added formalizing processes to incorporate scientific and management uncertainty when establishing catch limits. Amendment 4 removed the stipulation that recreational catches that exceeded catch limits the previous year must take a reduction the following year for stock species that are not overfished nor is overfishing occurring. Amendment 6 addressed considerations for examining potential influence of the removal of forage fish species by increasing directed fishing and advocated for future ecosystem based management approaches. Framework 2 required for-

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – BLUEFISH

hire vessels with federal permits for species managed by MAFMC to submit electronic vessel trip reports to the National Oceanic and Atmospheric Administration. Framework 3 established a process to specify constant multi-year acceptable biological catches.

The FMP allows a state-by-state commercial quota system and a coastwide recreational harvest limit to reduce fishing mortality. Reporting and permit requirements, outlined in Amendment I, are implemented for both commercial and recreational fishing sectors as well as fish dealers. The bluefish monitoring committee annually reviews contemporaneous fisheries data and recommends appropriate management measures as needed to achieve management goals.

To ensure compliance with interstate requirements, North Carolina (N.C.) also manages bluefish 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 MAFMC, 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).

Management Unit

The FMP defines the management unit of bluefish as a single stock occurring in U.S. waters of the western Atlantic Ocean. All member Atlantic states participate in the bluefish FMP process with the exception of Pennsylvania and the District of Columbia.

Multiple committees advise Atlantic bluefish fisheries managers. The ASMFC Stock Assessment Subcommittee and Technical committee provide scientific insight to the ASMFC bluefish Management Board and the MAFMC Demersal committee. Board members task science committees with logistical assistance, provide framework adjustment recommendations, and vote on management strategies for implementation.

Goal and Objectives

On July 26, 2000, the National Oceanic and Atmospheric Administration (NOAA) Fisheries published the final rule to implement the measures contained in Amendment 1 of the ASMFC/MAFMC bluefish FMP. The goal of Amendment 1 is to conserve the bluefish resource along the Atlantic Coast, specifically to: 1) increase understanding of the stock and fishery; 2) provide highest availability of bluefish to U.S. fishermen; while maintaining, within limits, traditional uses of bluefish; 3) provide for cooperation among the coastal states, the various regional marine fishery management councils, and federal agencies involved along the coast to enhance the management of bluefish throughout its range; 4) prevent recruitment overfishing; and 5) reduce the waste in both the commercial and recreational fisheries.

STATUS OF THE STOCK

Life History

Bluefish (*Pomatomus saltatrix*) are migratory open water (pelagic) species found throughout the Atlantic Ocean. Bluefish migrate seasonally, moving north as water temperatures rise during spring and summer and south during the fall and winter to areas along the South Atlantic Bight (Shepherd et al. 2006). During the summer, bluefish mostly concentrate in waters from Maine to Cape Hatteras (Klein-MacPhee 2002). During the winter, they are found in offshore waters between North Carolina and Florida (Goodbred and Graves 1996). Therefore, bluefish are found off North Carolina year-round (Morley et al. 2007). Within North Carolina's estuarine waters bluefish are most common from March through October. Bluefish generally school with similarly sized fish (Austin et al. 1999).

Bluefish are fast growers (Wilk 1977) and opportunistic predators who feed indiscriminately. Over 70 different marine species have been documented in bluefish stomach contents including Atlantic menhaden, butterfish, silversides, spotted seatrout, Atlantic croaker, spot, shrimp, lobster, squid, crabs, worms, and clams (Buckel et al. 1999; Scharf et al. 2004).

The maximum documented age for bluefish is 14 years (Robillard et al. 2009). The annual maximum ages for bluefish collected in North Carolina usually range between 10 and 11 years old. The largest bluefish can exceed 39 inches and 31 pounds (<http://portal.ncdenr.org/web/mf/north-carolina-state-saltwater-records>).

Bluefish usually reach sexual maturity by age 2 around a length of 13 inches (Robillard et al. 2008). They spawn offshore from Massachusetts through Florida. Some research suggests that two discrete cohorts of bluefish spawn at different times during the year with one group spawning during the spring and a second spawning during the summer (Lassiter 1962). More recent research suggests that bluefish continue to spawn as they migrate northward during the spring and summer (Robillard et al. 2008).

Stock Status

A 2015 benchmark stock assessment indicated that the Atlantic bluefish stock is not experiencing overfishing and is not considered overfished (NFCS 2015). A review of the 2015 benchmark stock assessment will be conducted in 2018 updating the analysis with three additional years of data (2015-2017).

Stock Assessment

Estimates from the 2015 stock assessment model informed by state and federal indices show a general decreasing trend in fishing mortality and increasing trend in population biomass since 1988 (Figure 1).

STATUS OF THE FISHERY

Current Regulations

In North Carolina, there is a recreational bag limit of 15 bluefish per day and only five of the 15 harvested bluefish can be greater than 24-inches total length.

Commercial Landings

Bluefish commercial landings have fluctuated annually since 1972 (Figure 2); however, landings have been relatively less variable since 1994. Ocean gill nets represent the largest commercial landings of bluefish averaging 1,549,890 pounds during the time series followed by estuarine gill nets with an average of 330,889 pounds.

Recreational Landings

Recreational landings for bluefish have been relatively stable since the 1990s (Figure 3). Preliminary Marine Recreational Information Program (MRIP) data collected by the NOAA Fisheries indicates that approximately 700,724 pounds of bluefish were recreationally harvested in 2017.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Bluefish are sampled from a variety of North Carolina commercial fishery gears including estuarine long haul, ocean trawl, pound net, ocean gill net, estuarine gill net, and ocean beach seine fisheries. Information on the location(s) of the catch should be obtained in as much detail as possible (e.g. water body, nearest landmark, marker number, etc.). Additionally, information on fishing gear type, specifications, soak time, and water depth should be recorded. Subsampling of commercial catch to collect biological information on bluefish includes fork length (mm) and aggregate weight (kg) by market grade when possible. Trip ticket information (total weight of catch) is also recorded and reported to DMF by licensed dealers.

A total of 56,983 bluefish were measured from commercial landings between 2008 and 2017 (Table 1). Mean fork length (mm) ranged from 348 mm to 461 mm with a minimum of 131 mm and maximum of 900 mm during the ten year period.

Fishery-Independent Monitoring

Bluefish are found in several of NCDMF sampling programs, including the juvenile trawl (P120), the Pamlico Sound trawl (P195), and the Pamlico Sound independent gillnet (P915), and Long-line (P365) surveys. The Division's Pamlico Sound Independent Gill Net Survey was initiated in May of 2001 and has sampled continuously since. This survey catches more bluefish than any other independent survey. This survey provides fishery independent indices of relative abundance along with associated length and age data. These estimates will provide essential data

for input into future stock assessments. The Catch per Unit of Effort (CPUE) or number of bluefish per set has ranged from 2.7 in 2015 to 7.8 in 2007 during the last 17 years (Figure 4).

The majority of bluefish age samples are obtained from the Pamlico Sound independent gillnet survey. Bluefish ages range from 0 to 10 years old, with a modal age of 2 years old (Table 2).

MANAGEMENT STRATEGY

Amendment 1 of the bluefish FMP allocates 83 percent of the resource to recreational fisheries and 17 percent to commercial fisheries. However, the commercial quota can be increased up to 10.5 million pounds if the recreational fishery is projected to not land its entire allocation for the upcoming year. The commercial fishery is controlled through state-by-state quotas based on historic landings from 1981-1989. Recently, the ASMFC and MAFMC have decided to investigate implementing a new quota allocation amendment to the FMP based on more updated fisheries data as recent catch trends have led to several instances of quota transfers between sectors and states. Public comment on proposed quota allocation changes will occur in the summer of 2018 with final rulemaking action occurring in late 2020.

As North Carolina is a state subject to compliance of the biological monitoring program (Addendum I), NCDMF extracted otoliths from 662 bluefish with 188 samples collected in the spring and 474 samples collected in the fall for 2017.

The ASMFC/MAFMC FMP allocates 32 percent of the Atlantic Coast total bluefish quota to North Carolina. The FMP for bluefish welcomes individual states to implement management measures in addition to those required by the FMP or FMP amendments. The scope of North Carolina's bluefish proclamation authority is limited to actions which comply with the management requirements incorporated in Federal Fishery Management or Atlantic States Marine Fisheries Commission plans (15A NCAC 03M .0512). North Carolina continues to maintain a 15-fish recreational bag limit on bluefish that has been in place since June 19, 2001. An additional restriction that only five of the 15 fish can be greater than 24-inches total length, did not fall within the proclamation authority of the NCDMF Director, and required a North Carolina rule change. This management measure had full support of recreational anglers and advisory committees and was passed unanimously by the N.C. Marine Fisheries Commission (4/23/2002). The rule (15A NCAC 03M .0511) went into effect 4/01/2003.

RESEARCH NEEDS

- Continue research on species interactions and predator-prey relationships. Investigate the feasibility of alternative survey methods that target bluefish across all age classes to create a more representative fishery-independent index of abundance
- Initiate sampling of offshore populations in winter months
- Initiate coastal surf zone seine study to provide more complete indices of juvenile abundance
- Develop additional adult bluefish indices of abundance (e.g., broad spatial scale longline survey or gillnet survey)
- Expand age structure of Southeast Area Monitoring and Assessment Program index

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- Investigate species associations with recreational angler trips targeting bluefish (on a regional and seasonal basis) to potentially modify the MRIP index used in the assessment model
- Explore age- and time-varying natural mortality from, for example, predator prey relationships; quantify effects of age- and time-varying natural mortality in the assessment model
- Continue to evaluate the spatial, temporal, and sector-specific trends in bluefish growth and quantify their effects in the assessment model
- Continue to examine alternative models that take advantage of length-based assessment frameworks. Evaluate the source of bimodal length frequency in the catch (e.g., migration, differential growth rates)
- Modify thermal niche model to incorporate water temperature data more appropriate for bluefish in a timelier manner [e.g., sea surface temperature data & temperature data that cover the full range of bluefish habitat (South Atlantic Bight and estuaries)]
- Quantify recreational discard mortality of bluefish has discards are a large component of the recreational fishery
- Investigate potential spatial distribution shifts of the Atlantic stock

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TABLES

Table 1. Summary of length data (mm) sampled from the bluefish commercial fishery from 2008-2017.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2008 | 416 | 131 | 826 | 6,359 |
| 2009 | 461 | 145 | 860 | 5,784 |
| 2010 | 422 | 146 | 886 | 5,388 |
| 2011 | 406 | 155 | 843 | 4,653 |
| 2012 | 348 | 134 | 862 | 5,731 |
| 2013 | 359 | 158 | 830 | 5,819 |
| 2014 | 371 | 192 | 858 | 5,485 |
| 2015 | 352 | 180 | 778 | 5,333 |
| 2016 | 353 | 195 | 840 | 6,851 |
| 2017 | 394 | 176 | 900 | 5,580 |

Table 2. Bluefish age data collected from all sources combined, 2008-2017.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|------|-----------|-------------|-------------|-------------------|
| 2008 | 1 | 0 | 10 | 656 |
| 2009 | 3 | 0 | 10 | 489 |
| 2010 | 3 | 0 | 8 | 527 |
| 2011 | 3 | 0 | 9 | 552 |
| 2012 | 1 | 0 | 9 | 811 |
| 2013 | 0 | 0 | 9 | 741 |
| 2014 | 1 | 0 | 9 | 792 |
| 2015 | 1 | 0 | 9 | 530 |
| 2016 | 1 | 0 | 11 | 598 |
| 2017 | 2 | 0 | 11 | 652 |

FIGURES

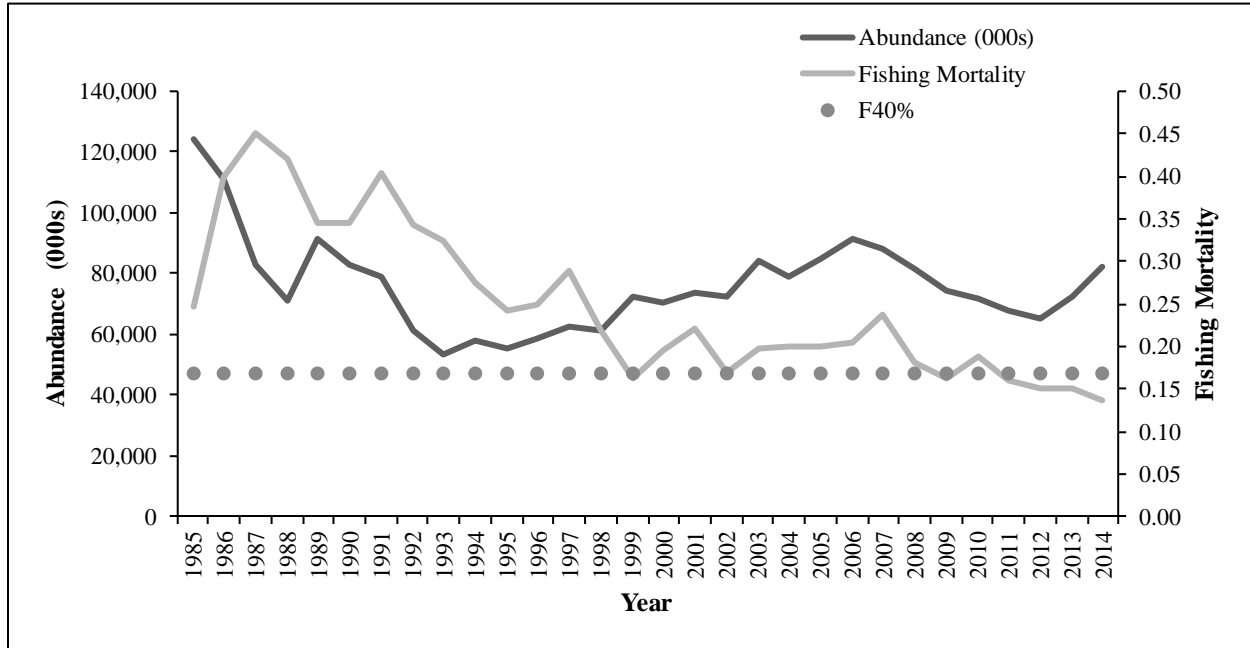


Figure 1. Total bluefish abundance and fishing mortality as estimated in the benchmark model updated through 2014. F_{40%} (fishing mortality that would result in a 40% spawning potential ratio) indicated by dotted horizontal line (cited from NEFSC (2015)).

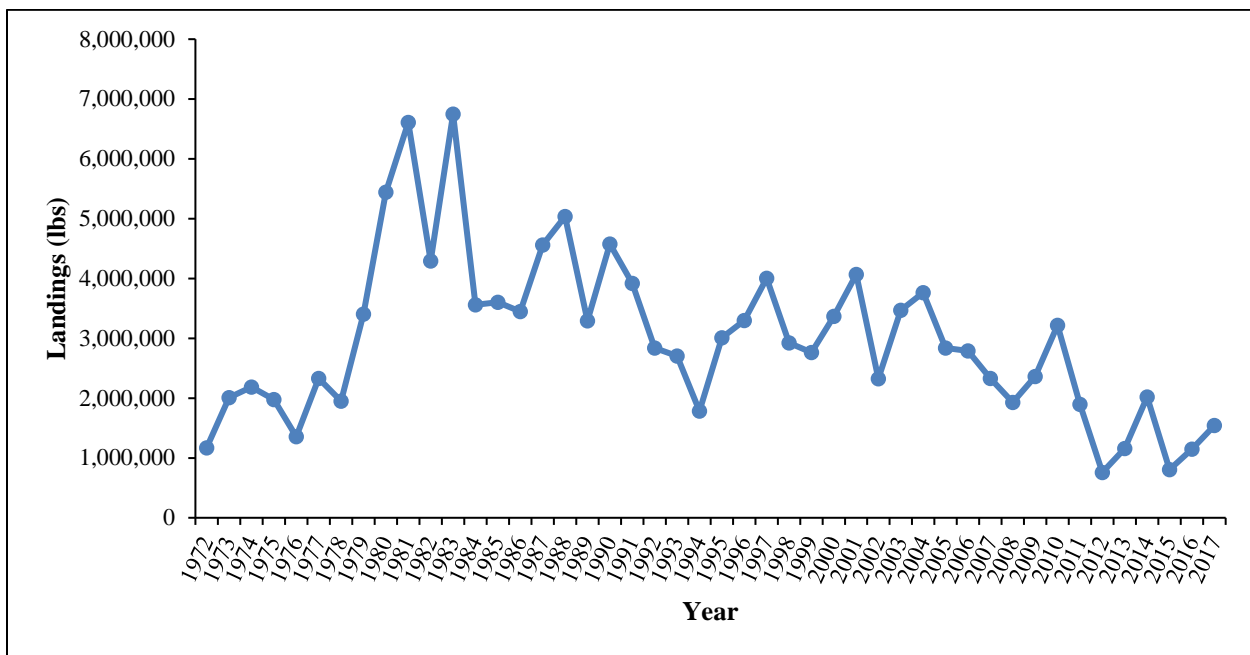


Figure 2. North Carolina commercial landings of bluefish from 1972 to 2017.

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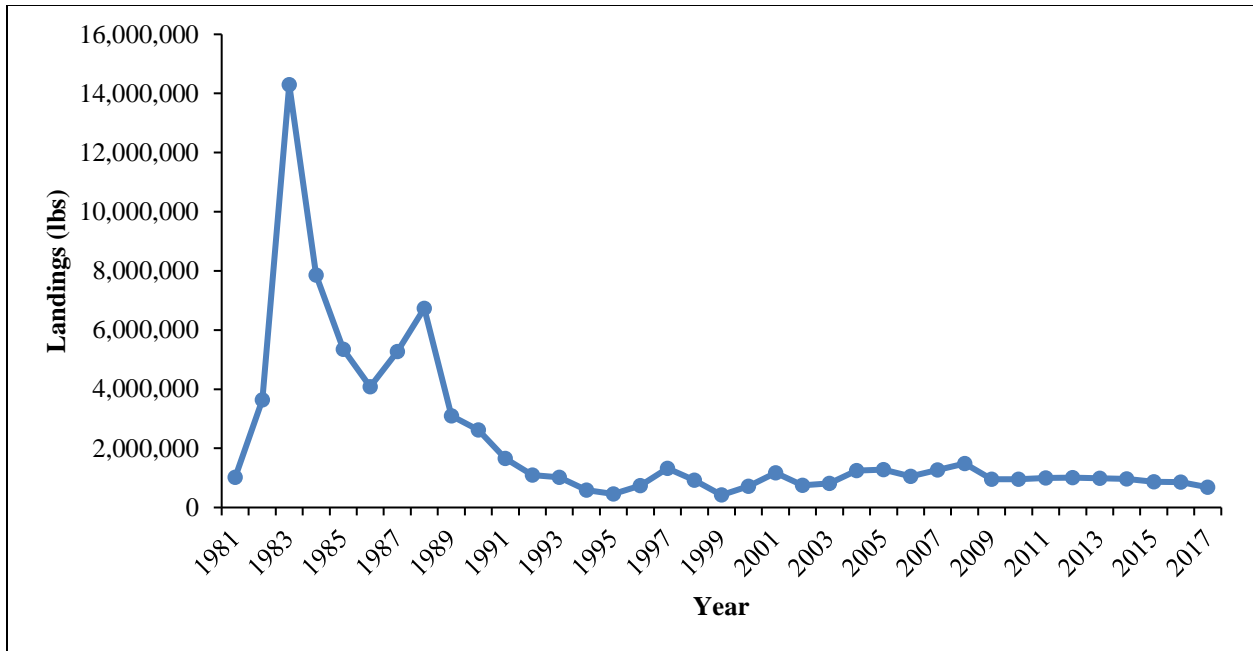


Figure 3. North Carolina recreational landings of bluefish from 1981 to 2017.

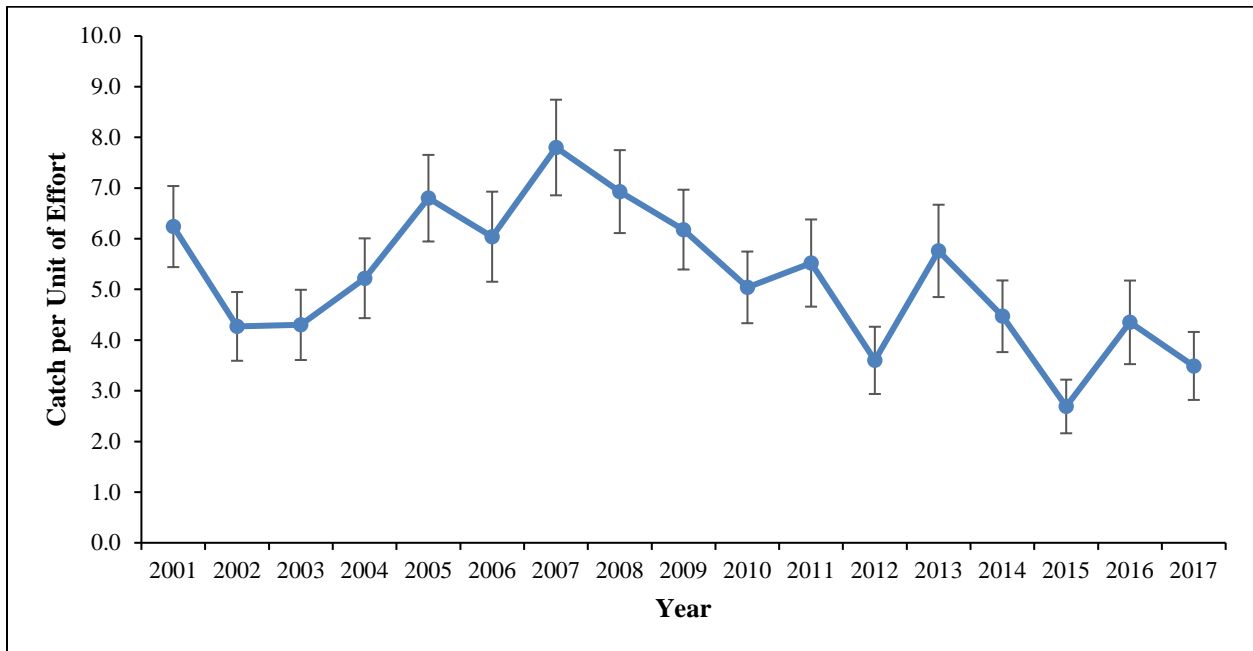


Figure 4. Catch per Unit of Effort (CPUE) of bluefish, from the Pamlico Sound Independent Gillnet Survey from 2001 to 2017. Error bars represent the standard error about the annual CPUE estimates.

**FISHERY MANAGEMENT PLAN UPDATE
SPOT
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | October 1987 |
| Amendments: | Omnibus Amendment – August 2012 Addendum I – August 2014 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | 2021 |

The original interstate Fishery Management Plan (FMP) for spot was adopted in 1987 with recommendations to improve data collection to produce a stock assessment and improve information for management (ASMFC 1987). The original FMP for spot was adopted prior to passage of the Atlantic Coastal Fisheries Cooperative Management Act (1993) and the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Program (ISFMP) Charter (1995). After passage of the Act, the ASMFC adopted the Charter to establish standards and procedures for the preparation and adoption of the FMPs. Once an FMP was amended to incorporate the standards and procedures in the ISFMP Charter, the Commission could adopt management requirements that can be enforced through the Act. The Omnibus Amendment updates the spot FMP with the Act and Charter requirements and initiated annual trigger exercises to monitor the status of the spot resource while also directing the board to consider management action depending on the results of the trigger exercise (ASMFC 2012). Without coast-wide minimum management measures, the trigger exercises did little to provide effective management in between stock assessments. Because of this, Addendum I to the Amendment was developed establishing the use of the Traffic Light Approach (Caddy and Mahon 1995; Caddy 1998; Caddy 1999) with a precautionary management framework for spot. The management framework utilizing the Traffic Light Approach replaced the management triggers established in the Omnibus Amendment.

A benchmark stock assessment was completed in 2017 but did not pass peer review and was not recommended for management use (ASMFC 2017b). The TLA will continue to be used to guide management decisions between stock assessments. Recommendations for a revised TLA

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framework were presented to the South Atlantic State/Federal Fisheries Management Board (hereinafter referred to as Board) in February 2018 and will be considered by the Board for management use in August 2018.

To ensure compliance with interstate requirements, North Carolina also manages this species 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) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC) are similar to the goals of the N.C. Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

Management Unit

Delaware through the east coast of Florida.

Goal and Objectives

The primary goal of the Omnibus Amendment is to bring the FMPs for Spanish mackerel, spot, and spotted seatrout under the authority of the Act, providing for more efficient and effective management and changes to management in the future. The objectives for spot under this amendment include:

1. Increase the level of research and monitoring of spot bycatch in other fisheries, to complete a coast-wide stock assessment.
2. Manage the spot fishery to encourage reduced mortality on spot stocks until age 1.
3. Develop research priorities that will further refine the spot management program to maximize the biological, social, and economic benefits derived from the spot population. The Omnibus Amendment does not require specific fishery management measures in either the recreational or commercial fisheries for states within the management unit range.

STATUS OF THE STOCK

Life History

Spot (*Leiostomus xanthurus*) are short lived, estuarine dependent members of the drum family, ranging from the Gulf of Maine to Florida but are most abundant from the Chesapeake Bay to South Carolina (ASMFC 2010). Spot generally reach maturity by age one or two (ASMFC 2010) and spawn in the ocean from late fall to early spring (Hildebrand and Schroeder 1928; Roelofs 1951; Dawson 1958; Hoese 1973). Wind and currents carry the young into the upper

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reaches of the estuaries where they remain throughout the spring (Warlen and Chester 1985; Govoni and Spach 1999; Hare et al. 1999; Odell et al. 2017). Adult spot migrate seasonally between estuarine and nearshore ocean waters but are rarely found in the upper reaches of the estuary (Hildebrand and Schroeder 1928; Dawson 1958; Hoese 1973; Odell et al. 2017). Spot are bottom feeders, eating mostly worms, small crustaceans, and mollusks (ASMFC 2010). Spot are most susceptible to commercial and recreational fishing activity during the fall when schools migrate from estuarine to oceanic waters (Pacheco 1962a).

Stock Status

The first benchmark stock assessment for spot was completed in 2017 but was not recommended for management use by a peer review panel (ASMFC 2017b). However, the review panel did not identify any major problems in the spot fishery that would require immediate management action. Because there is no currently approved stock assessment the stock status for spot with relation to overfishing or overfished is unknown.

Stock Assessment

A benchmark stock assessment, completed in 2017, did not pass peer review and will not be used for management. Uncertainty in assessment results was due to disagreement between trends in harvest and abundance. Abundance of spot in fishery independent surveys has generally been increasing whereas commercial and recreational harvest has been declining. The review panel noted that the estimation of spot discards from the shrimp trawl fishery was an improvement and recommended shrimp trawl discard estimates be incorporated into annual monitoring using the Traffic Light Analysis.

To evaluate the status of the stock between stock assessments, the Board reviews the Traffic Light Analysis (TLA) established under Addendum I. The name comes from assigning a color (red, yellow, green) to categorize relative levels of indicators on the condition of the population (abundance metric) or fishery (harvest metric). For example, as harvest or abundance decrease, the amount of red in that year becomes more predominant.

The TLA for spot was updated with data through 2016 following completion of the stock assessment. The updated TLA indicated the composite harvest metric would have triggered in 2015 and 2016 (Figure 1; ASMFC 2017a) while the composite abundance metric (National Oceanic and Atmospheric Administration (NOAA) and Southeast Area Monitoring and Assessment Program (SEAMAP) surveys) would not have triggered in either year (Figure 2: ASMFC 2017a). The decline in the harvest index was driven primarily by declining commercial landings rather than declining recreational harvest. Because the harvest index and adult abundance index did not both trip in 2015-2016, management action has not been triggered. Recommendations for a revised TLA framework were presented to the Board in February 2018 and decisions regarding the use of the revised TLA for management use will be considered in August 2018.

STATUS OF THE FISHERY

Current Regulations

There are no commercial or recreational regulations on spot in North Carolina.

Commercial Landings

Two gear types (gill nets and haul seines) are used in directed commercial trips and harvest of spot. Other gear types, including sciaenid pound nets, contribute minimally to spot commercial landings. Commercial landings since 1994 have averaged 1,593,777 pounds. Commercial spot landings have fluctuated but generally declined since 2001 (Figure 3). Commercial landings in 2016 were 235,670 pounds and increased to 413,995 pounds in 2017. Spot are a component of the scrap or bait fishery in North Carolina but this component generally makes up a small percentage of landings.

Recreational Landings

Spot are targeted recreationally by shore based anglers and those fishing from private vessels during the fall. Recreational angler harvest data are collected by the Marine Recreational Information Program (MRIP). Recreational spot harvest averaged 854,266 pounds from 1994 through 2017 (Table 1). Harvest of spot was steady from 1994 through 2007 with some fluctuation. Harvest decreased from 2007 through 2010 before rebounding slightly in 2011 then dropping to a then 24-year low of 230,250 pounds in 2012. Harvest increased in 2014 to 704,445 pounds before decreasing to 395,268 pounds in 2015. The 151,352 pounds of spot harvested in 2016 is the lowest amount in the past 24 years. Harvest of spot increased slightly in 2017 to 174,224 pounds. Number of releases has averaged 989,936 individuals from 1994 through 2017. The number of releases in 2017 (305,898) is a 24-year low.

There were no noticeable trends in mean fork length (FL) of spot measured by MRIP samplers from 2005-2017 (Table 2). Mean FL has ranged from 200 mm to 230 mm. In 2017, 98 spot were measured (13-year low) with a mean FL of 205 mm, a minimum of 159 mm, and a maximum of 269 mm.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Since 1994, the North Carolina Trip Ticket Program (NCTTP) has collected data on the commercial harvest of spot. Commercial fishing activity is also monitored through fishery dependent sampling conducted by the division since 1982. Data collected in this program allow the size and age distribution of spot to be characterized by gear and fishery. Several North Carolina Division of Marine Fisheries (NCDMF) sampling programs collect biological data on commercial fisheries that harvest spot. The primary programs that collect length and age data for harvested spot include: Program 461 (estuarine gill net), Program 437 (long haul seine), and Program 434 (ocean gill net). Total number of measured spot has generally decreased since

2005 (Table 3). Mean, minimum, and maximum FL has fluctuated but generally has been stable. Mean FL ranged from 201 millimeters in 2007 to 223 millimeters in 2005. In 2017, 2,648 spot were measured from commercial fisheries with a mean FL of 210.6 millimeters, a minimum of 112 millimeters, and a maximum of 298 millimeters.

From 2004 through 2017 the size range of spot captured in the commercial fishery (excluding scrap landings) ranged from 110 to 340 millimeters fork length (Figure 4). Modal length was 220 millimeters in the 2004-2007 time block, 210-230 millimeters in the 2008-2011 time block, 210 millimeters in the 2012-2015 time block and 220 millimeters in the 2016-2017 time block. The length frequency distribution began to truncate during the 2012-2015 time block and truncated further in the 2016-2017 time block. Modal age of spot in the commercial fishery was one in every time block, with age one spot comprising 50-80 percent of the commercial catch (Figure 5).

Harvest data from the Recreational Commercial Gear License (RCGL) were collected from 2002 to 2008. The program was discontinued in 2009 due to lack of funding. From 2002-2008, an average of 10,917 RCGL trips harvested 203,383 pounds of spot per year (Table 4).

Fishery-Independent Monitoring

The number of spot aged in North Carolina from 2005 through 2017 has ranged from 268 in 2011 to 702 in 2014 (Table 5). Modal age was one in every year except 2016 when modal age was zero. Minimum age was zero in every year while maximum age ranged from three to six.

The Pamlico Sound Survey (Program 195) samples 54 randomly selected stations (grids) in June and September. Stations are randomly selected from strata based upon depth and geographic location. Tow duration is 20 minutes, using double rigged demersal mongoose trawls (9.1 m headrope, 1.0 X 0.6 m doors, 2.2-cm bar mesh body, 1.9-cm bar mesh cod end and a 100-mesh tailbag extension). Data from this survey are used to produce juvenile abundance indices for spot. Length cutoffs for juvenile spot are fish <120 mm FL in June, and fish <140 mm FL in September. The June index varied greatly with a peak of 1,347.4 individuals per tow in 2008 (Figure 6). The 2017 CPUE was 721 individuals per tow, an increase from the 2016 CPUE and above the time series average of 423 individuals per tow.

Modal length of spot from the June portion of the Pamlico Sound Survey was 100 mm FL and ranged from 40 millimeters to 200 millimeters FL (Figure 7). Modal length of spot from the September portion of the Pamlico Sound Survey was 100 millimeters FL and ranged from 80 to 210 millimeters FL. Spot captured during P195 sampling are age zero and age one (Figure 8). Based on otolith ages, all spot under 140 millimeters FL caught in June 2017 were age zero, and all spot over 140 millimeters FL were age one. Most spot under 180 millimeters FL, captured during the September portion of P195 sampling, were age zero and all spot greater than 190 millimeters FL were age one.

MANAGEMENT STRATEGY

Addendum I established use of a TLA to evaluate fisheries trends and develop state specific management actions (e.g. bag limits, size restrictions, time and area closures, and gear restrictions) when harvest and abundance thresholds are exceeded for two consecutive years. The TLA improves the management recommendations in response to declines in the stock or fishery. Since both population characteristics (harvest and abundance) were not above the 30 percent threshold for 2013-2014, management triggers were not tripped. The TLA for spot was updated with data through 2016 following completion of the stock assessment. The updated TLA indicated the composite harvest metric would have triggered in 2015 and 2016 while the composite abundance metric would not have triggered in either year. Recommendations for a revised TLA framework were presented to the Board in February 2018 and decisions regarding the use of the revised TLA for management will be considered in August 2018.

RESEARCH NEEDS

There are no research or monitoring programs required of the states except for the submission of an annual compliance report. However, several coastwide and state specific research recommendations have been identified through the FMP process, and the stock assessment peer review (ASMFC 2017b).

- Expand collection of life history data for examination of lengths and age, especially fishery dependent data sources – HIGH (Ongoing in North Carolina)
- Organize an otolith exchange and develop an ageing protocol between ageing labs – HIGH (Needed)
- Increase observer coverage for commercial discards, particularly the shrimp trawl fishery – HIGH (Ongoing in North Carolina)
- Develop a standardized, representative sampling protocol and pursue collection of individual lengths and ages of discarded finfish – HIGH (Ongoing in North Carolina)
- Continue state and multi-state fisheries independent surveys throughout the species range and subsample for individual lengths and ages. Ensure NEFSC trawl survey continues to take lengths and ages. Examine potential factors affecting catchability in long-term fishery independent surveys – HIGH (Ongoing in North Carolina)
- Continue to develop estimates of length-at-maturity and year-round reproductive dynamics throughout the species range. Assess whether temporal and/or density-dependent shifts in reproductive dynamics have occurred – HIGH (Needed)
- Re-examine historical ichthyoplankton studies for an indication of the magnitude of estuarine and coastal spawning, as well as for potential inclusion as indices of spawning stock biomass in future assessments. Pursue specific estuarine data sets from the states (NJ, VA, NC, SC, DE, ME) and coastal data sets (MARMAP, EcoMon) – HIGH (Needed)
- Develop and implement sampling programs for state-specific commercial scrap and bait fisheries in order to monitor the relative importance of Spot. Incorporate biological data collection into program – MEDIUM (Ongoing in North Carolina)
- Conduct studies of discard mortality for commercial fisheries. Ask commercial fishermen about catch processing behavior for spot when trawl/gill nets brought over the rail to determine if the discard mortality rate used in the assessment is reasonable – MEDIUM (Needed)

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- Conduct studies of discard mortality for recreational fisheries – MEDIUM (Needed)
- Collect data to develop gear-specific fishing effort estimates and investigate methods to develop historical estimates of effort – MEDIUM (Needed)
- Identify stocks and determine coastal movements and the extent of stock mixing, via genetic and tagging studies – MEDIUM (Needed)
- Investigate environmental and recruitment/ natural mortality covariates and develop a time series of potential covariates to be used in stock assessment models – MEDIUM (Needed)
- Investigate environmental covariates in stock assessment models, including climate cycles (e.g., Atlantic Multi-decadal Oscillation, AMO, and El Niño Southern Oscillation, El Niño) and recruitment and/or year class strength, spawning stock biomass, stock distribution, maturity schedules, and habitat degradation – MEDIUM (Needed)
- Investigate the effects of environmental changes (especially climate change) on maturity schedules for spot, particularly because this is an early maturing species, and because the sSPR estimates are sensitive to changes in the proportion mature – MEDIUM (Needed)
- Investigate environmental and oceanic processes in order to develop better understanding of larval migration patterns into nursery grounds – MEDIUM (Needed)
- Investigate the relationship between estuarine nursery areas and their proportional contribution to adult biomass (i.e., are select nursery areas along Atlantic coast contributing more to SSB than others, reflecting better juvenile habitat quality?) – MEDIUM (Needed)
- Develop estimates of gear-specific selectivity – MEDIUM (Needed)

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ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

TABLES

Table 1. North Carolina recreational harvest of spot with landings in number, pounds, and number released, 1994-2017. Percent Standard Error (PSE) is given for each. Data from 1994-2003 uses the old MRFSS calculation method and data from 2004-2017 uses the new MRIP calculation method.

| Year | Harvest Number | PSE | Weight | PSE | Number Released | PSE |
|---------|----------------|------|-----------|------|-----------------|------|
| 1994 | 5,929,269 | 9.3 | 1,842,379 | 9.5 | 1,363,884 | 7.4 |
| 1995 | 3,329,981 | 9.1 | 1,248,008 | 9.5 | 1,035,361 | 8.9 |
| 1996 | 2,007,071 | 8.6 | 710,094 | 9.1 | 924,204 | 7.2 |
| 1997 | 1,440,661 | 12.5 | 722,877 | 13.8 | 450,663 | 7.5 |
| 1998 | 2,865,190 | 13.8 | 1,249,555 | 15.0 | 650,157 | 9.1 |
| 1999 | 1,308,167 | 11.5 | 646,670 | 13.5 | 633,112 | 9.3 |
| 2000 | 1,924,107 | 12.4 | 893,844 | 15.9 | 481,995 | 8.8 |
| 2001 | 3,650,711 | 9.0 | 1,773,689 | 9.5 | 1,143,695 | 8.4 |
| 2002 | 2,586,313 | 10.4 | 984,909 | 10.7 | 671,669 | 9.2 |
| 2003 | 3,796,557 | 9.9 | 1,714,177 | 10.1 | 1,132,992 | 8.6 |
| 2004 | 3,825,768 | 11.1 | 1,749,843 | 12.0 | 1,257,887 | 13.3 |
| 2005 | 3,012,872 | 17.1 | 1,102,398 | 17.2 | 1,334,559 | 13.5 |
| 2006 | 2,978,506 | 24.6 | 1,059,852 | 24.8 | 2,588,647 | 20.0 |
| 2007 | 3,078,346 | 17.2 | 982,463 | 16.9 | 1,197,005 | 17.8 |
| 2008 | 1,843,343 | 18.0 | 670,511 | 19.4 | 1,322,408 | 14.4 |
| 2009 | 1,056,346 | 18.0 | 363,998 | 17.9 | 1,222,053 | 13.5 |
| 2010 | 834,560 | 14.2 | 260,341 | 13.8 | 871,054 | 13.8 |
| 2011 | 1,207,335 | 15.8 | 410,317 | 16.8 | 1,000,566 | 11.6 |
| 2012 | 784,272 | 22.1 | 230,250 | 24 | 759,081 | 11.9 |
| 2013 | 1,464,592 | 15.3 | 460,928 | 16.8 | 1,314,199 | 12.1 |
| 2014 | 2,111,880 | 20.5 | 704,445 | 21.8 | 890,831 | 12.1 |
| 2015 | 1,081,083 | 28 | 395,268 | 29.1 | 708,122 | 14.5 |
| 2016 | 513,320 | 23.1 | 151,352 | 23.2 | 498,424 | 19.2 |
| 2017 | 469,462 | 26.2 | 174,224 | 29.4 | 305,898 | 19.8 |
| Average | 2,212,488 | | 854,266 | | 989,936 | |

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

Table 2. Total number measured, mean, minimum, and maximum fork length (mm) of spot measured by MRIP sampling in North Carolina, 2005-2017.

| Year | Mean Length | Minimum Length | Maximum Length | Number Measured |
|------|-------------|----------------|----------------|-----------------|
| 2005 | 218 | 132 | 411 | 1,286 |
| 2006 | 226 | 122 | 342 | 1,216 |
| 2007 | 230 | 144 | 299 | 1,243 |
| 2008 | 213 | 128 | 311 | 1,344 |
| 2009 | 216 | 126 | 274 | 682 |
| 2010 | 209 | 147 | 306 | 1,096 |
| 2011 | 209 | 149 | 283 | 1,534 |
| 2012 | 200 | 141 | 298 | 611 |
| 2013 | 207 | 115 | 293 | 484 |
| 2014 | 210 | 121 | 258 | 344 |
| 2015 | 207 | 154 | 302 | 214 |
| 2016 | 200 | 160 | 263 | 107 |
| 2017 | 205 | 159 | 269 | 98 |

Table 3. Mean length, minimum length, maximum fork length (mm), and total number of spot measured from North Carolina commercial fish house samples, 2005-2017.

| Year | Mean Length | Minimum Length | Maximum Length | Number Measured |
|------|-------------|----------------|----------------|-----------------|
| 2005 | 223 | 102 | 332 | 15,126 |
| 2006 | 209 | 104 | 335 | 12,499 |
| 2007 | 201 | 100 | 306 | 13,052 |
| 2008 | 203 | 100 | 337 | 10,143 |
| 2009 | 206 | 100 | 298 | 9,059 |
| 2010 | 206 | 100 | 294 | 7,144 |
| 2011 | 207 | 110 | 334 | 7,580 |
| 2012 | 203 | 105 | 300 | 4,282 |
| 2013 | 212 | 107 | 339 | 4,693 |
| 2014 | 207 | 104 | 334 | 6,594 |
| 2015 | 208 | 109 | 324 | 4,445 |
| 2016 | 204 | 125 | 325 | 2,193 |
| 2017 | 211 | 112 | 298 | 2,648 |

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

Table 4. North Carolina RCGL harvest of spot 2002-2008, with number of trips and landings in pounds. Estimates of trips and landings are from a RCGL survey conducted from 2002-2008; funding was discontinued in 2009.

| Year | Trips | Pounds |
|---------|--------|---------|
| 2002 | 16,731 | 339,077 |
| 2003 | 11,799 | 255,060 |
| 2004 | 12,610 | 252,291 |
| 2005 | 9,703 | 193,769 |
| 2006 | 10,511 | 180,342 |
| 2007 | 7,399 | 97,753 |
| 2008 | 7,664 | 105,392 |
| Average | 10,917 | 203,383 |

Table 5. Total number aged, modal, minimum, and maximum age of spot in North Carolina, 2005-2017. Age data from 2014, 2016 and 2017 is preliminary.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|-------|-----------|-------------|-------------|-------------------|
| 2005 | 1 | 0 | 6 | 529 |
| 2006 | 1 | 0 | 5 | 501 |
| 2007 | 1 | 0 | 3 | 284 |
| 2008 | 1 | 0 | 3 | 408 |
| 2009 | 1 | 0 | 3 | 365 |
| 2010 | 1 | 0 | 3 | 268 |
| 2011 | 1 | 0 | 3 | 413 |
| 2012 | 1 | 0 | 4 | 230 |
| 2013 | 1 | 0 | 3 | 360 |
| 2014* | 1 | 0 | 3 | 702 |
| 2015 | 1 | 0 | 3 | 505 |
| 2016* | 0 | 0 | 3 | 374 |
| 2017* | 1 | 0 | 3 | 439 |

*Data is preliminary

FIGURES

Harvest Composite Index (using a 1989-2012 reference period)

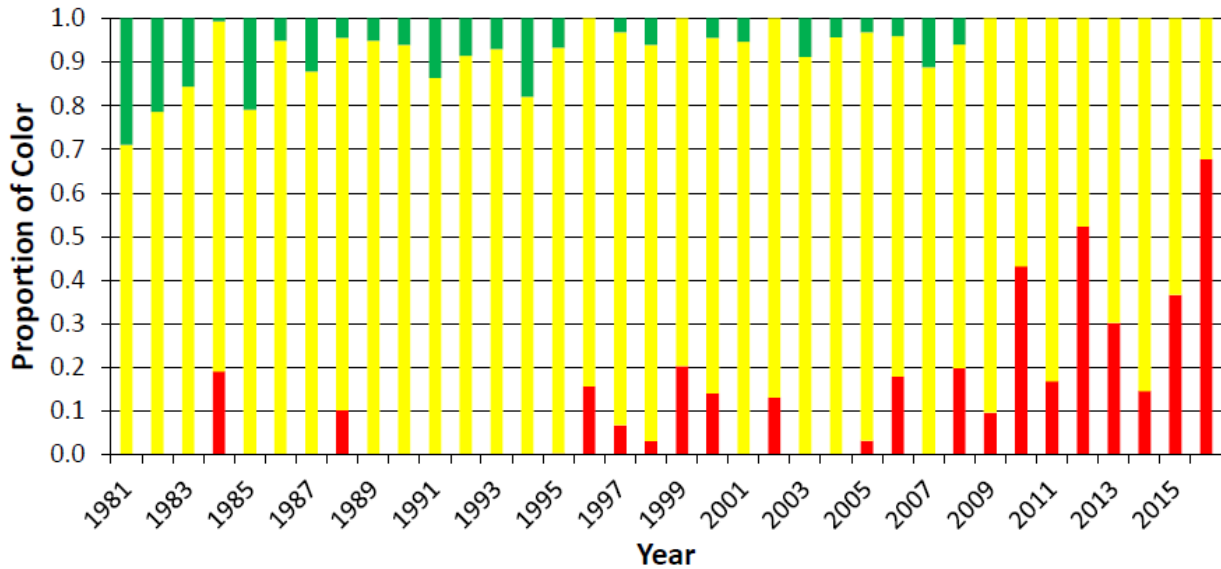


Figure 1. Annual color proportions for the harvest composite TLA (using a 1989-2012 reference period) of spot recreational and commercial landings, 1981-2016 (ASMFC 2017a).

Abundance Composite Index (using a 1989-2012 reference period)

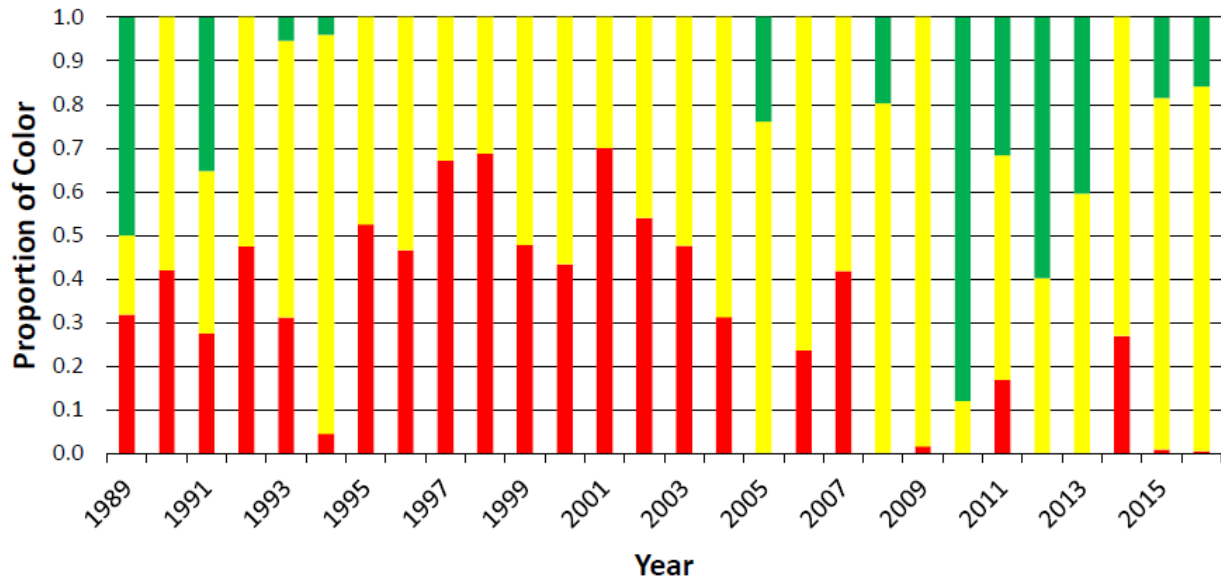


Figure 2. Abundance composite index (using a 1989-2012 reference period), 1989-2016 (ASMFC 2017a).

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

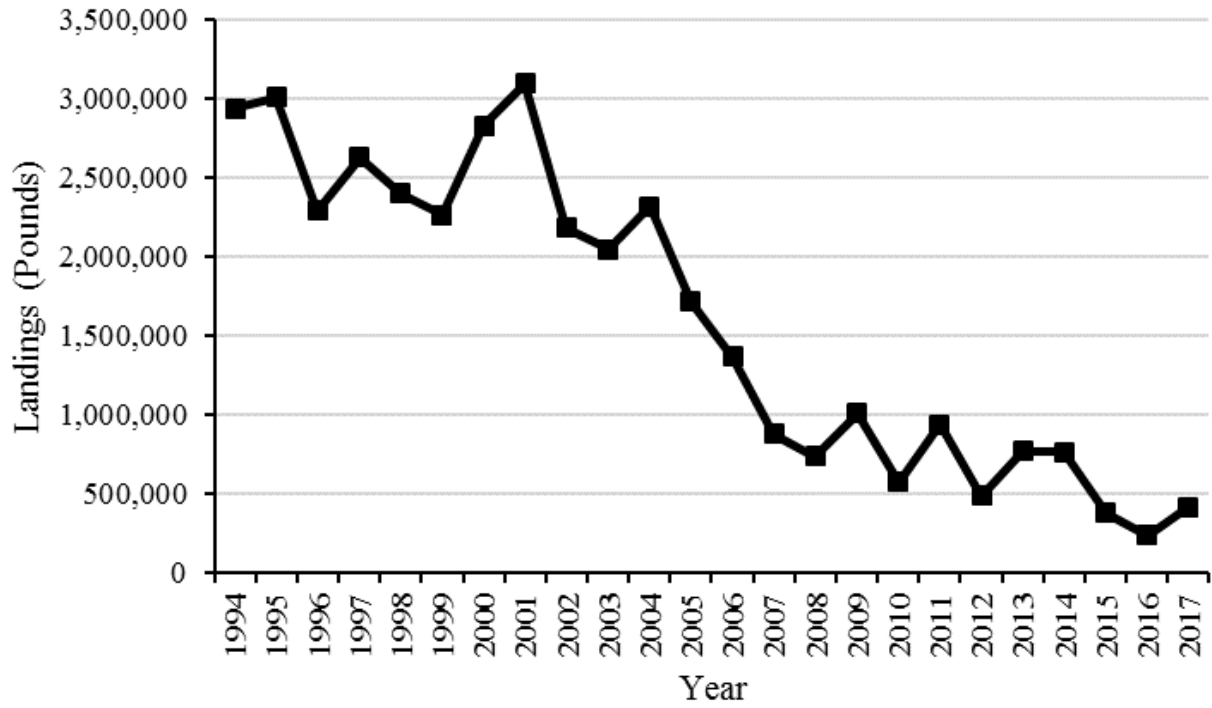


Figure 3. North Carolina commercial landings of spot, 1994-2017.

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

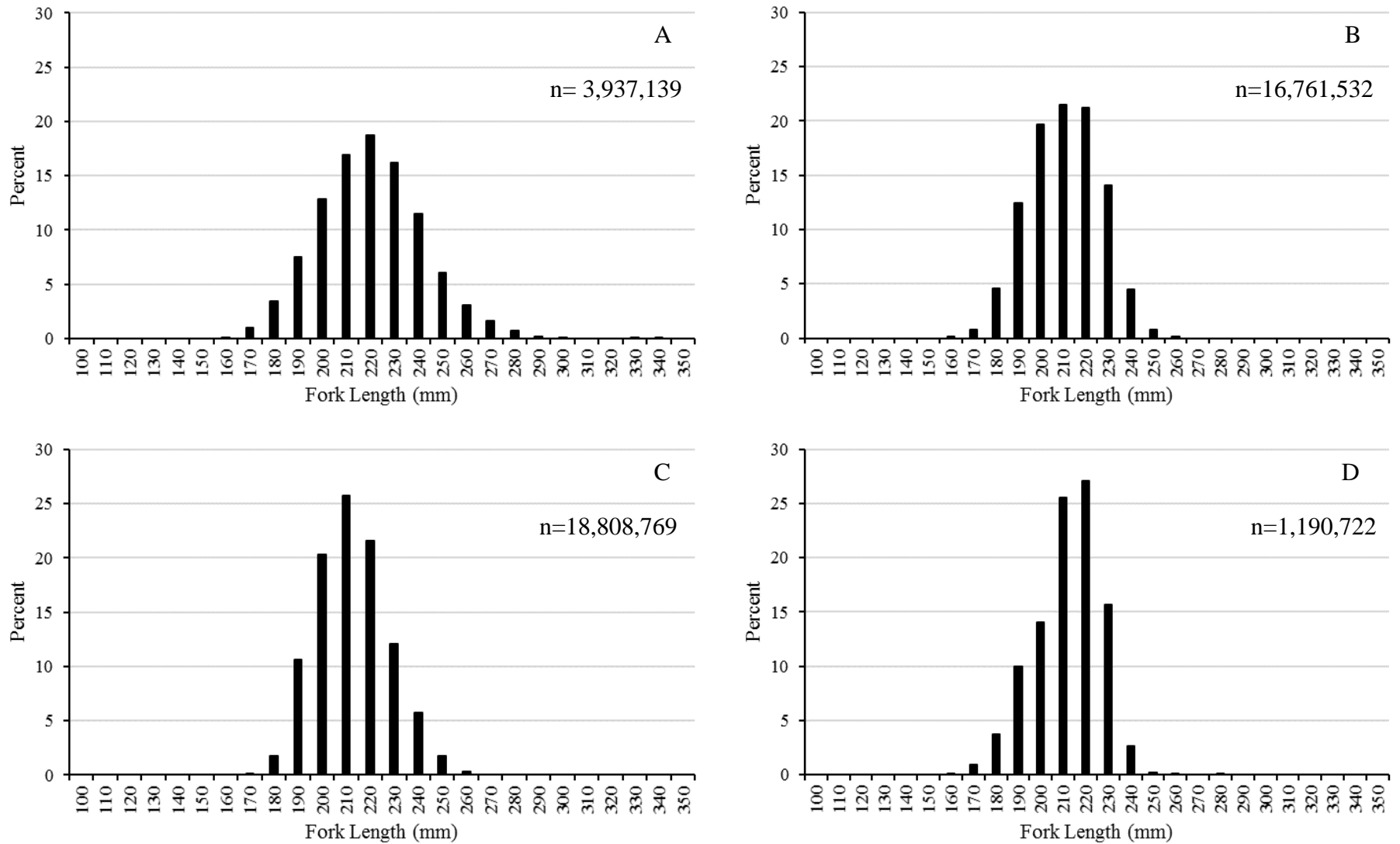


Figure 4. Expanded length-frequency of spot from the commercial fishery (excluding scrap samples) based on NCDMF fish house sampling, 2004-2017. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017.

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

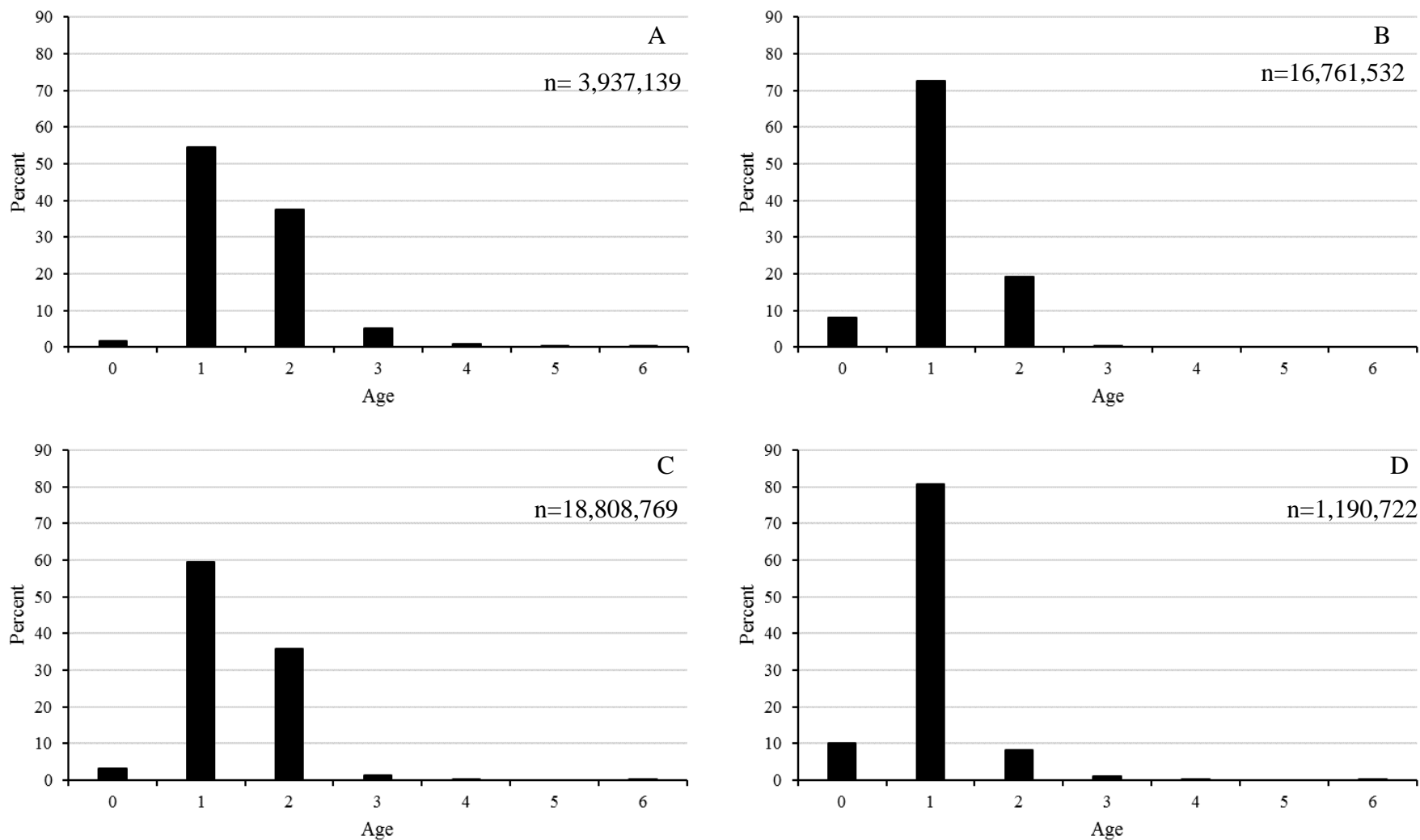


Figure 5. Expanded age-frequency of spot from the commercial fishery (excluding scrap samples) based on otolith ages, 2004-2017. Panel A is 2004-2007; Panel B is 2008-2011; Panel C is 2012-2015; and Panel D is 2016-2017. Age data from 2014, 2016 and 2017 is preliminary.

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

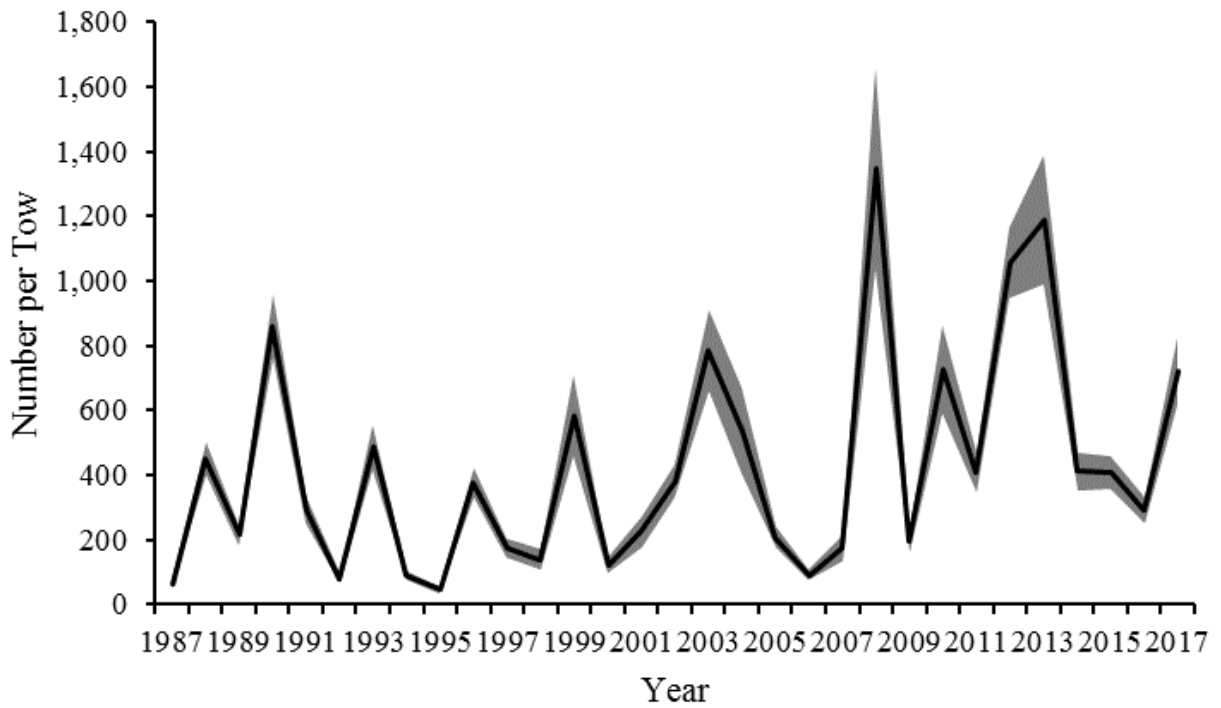


Figure 6. Spot juvenile (<120 mm) abundance index (CPUE; number per tow) for June from the Pamlico Sound Survey, 1987-2017. Shaded area represents standard error.

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

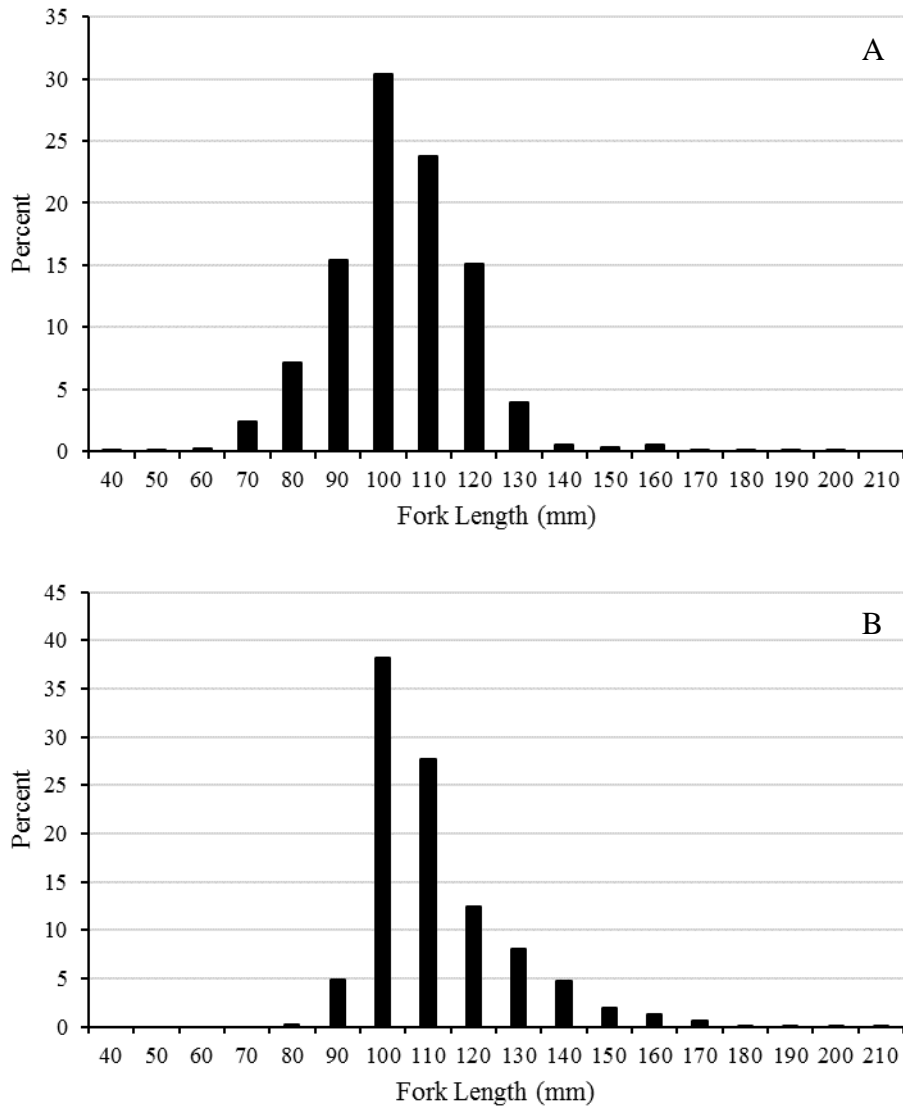


Figure 7. Expanded length frequency of spot captured in P195 sampling during June (A) and September (B), 2017.

ASMFC- AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SPOT

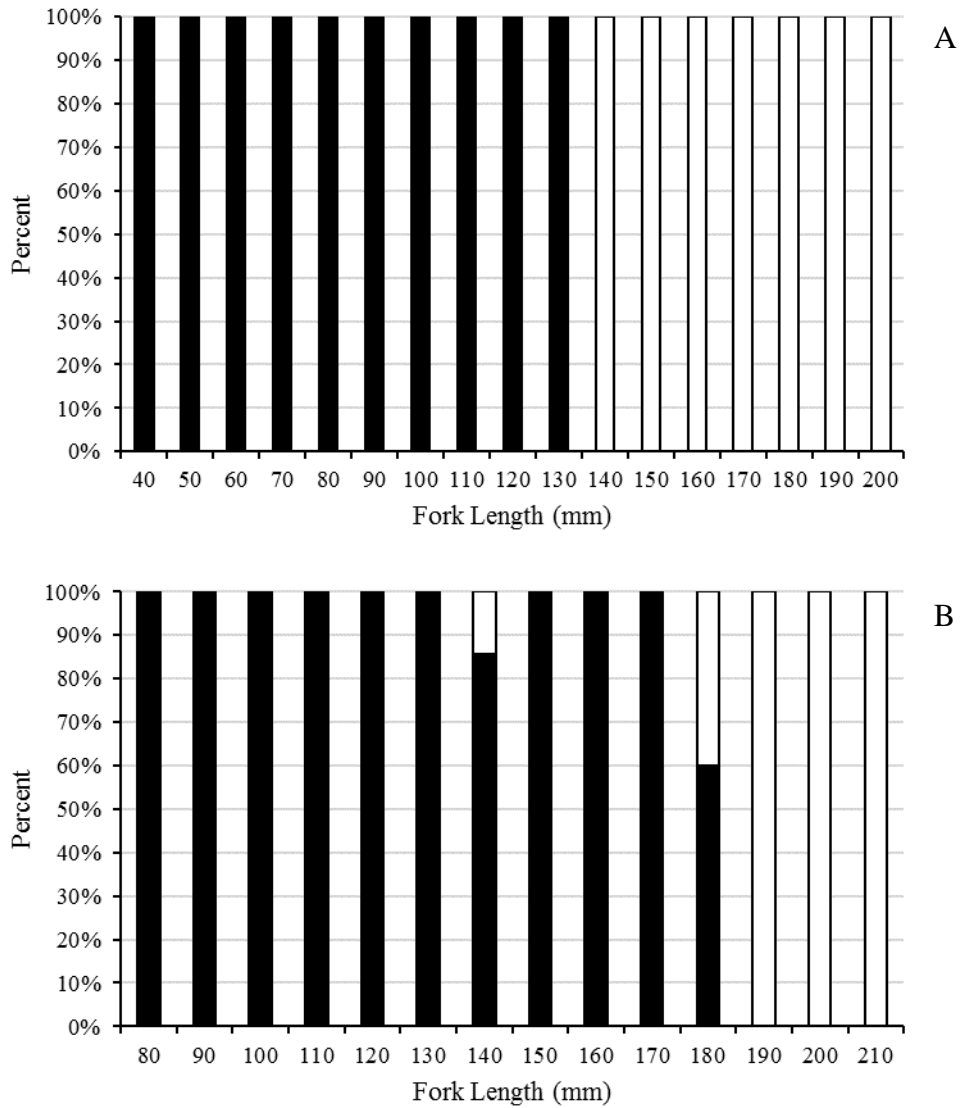


Figure 8. Percentage of age 0 (black) and age 1 (white) spot captured during P195 sampling in June (A) and September (B) based on otolith ages, 2017. Age data from 2017 is preliminary.

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

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | October 1981 |
| Amendments: | Amendment 1 – 1984 Amendment 2 – 1984 Amendment 3 – October 1985 Amendment 4 – 1989 October Addendum I – 1991 Addendum II – 1992 Addendum III – 1993 Addendum IV – 1994 Amendment 5 – March 1995 Addendum I – January 1997 Addendum II – October 1997 Source Document to Amendment 5 January 1998 Addendum III – October 1998 Addendum IV – October 1999 Addendum V – January 2001 Amendment 6 – February 2003 Addendum I – November 2007 Addendum II – November 2010 Addendum III – August 2012 Addendum IV – October 2014 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | 2018 |

The Atlantic States Marine Fisheries Commission (ASMFC) developed a fisheries management plan (FMP) for Atlantic Striped Bass in 1981 in response to declining juvenile recruitment and landings. The FMP recommended increased restrictions on commercial and recreational fisheries, such as minimum size limits and harvest closures on spawning grounds. Two

amendments were passed in 1984 recommending additional management measures to reduce fishing mortality. To strengthen the management response and improve compliance and enforcement, the Atlantic Striped Bass Conservation Act (P.L. 98-613) was passed in late 1984, which mandated the implementation of striped bass regulations passed by the ASMFC, and gave the ASMFC authority to recommend to the Secretaries of Commerce and Interior that states be found out of compliance when they failed to implement management measures consistent with the FMP.

The first enforceable plan, Amendment 3, was approved in 1985, and required size regulations to protect the 1982 year-class, which was the first modest size cohort since the previous decade. The objective was to increase size limits to allow at least 95 percent of the females in the cohort to spawn at least once. Smaller size limits were permitted in producer areas than along the coast. Several states, beginning with Maryland in 1985, opted for a more conservative approach and imposed a total moratorium on striped bass landings for several years. The amendment contained a trigger mechanism to reopen the fisheries when the three-year moving average of the Maryland juvenile abundance index (JAI) exceeded an arithmetic mean of 8.0. That level was attained with the recruitment of the 1989-year class.

Consequently, Amendment 4 was adopted to allow state fisheries to reopen in 1990 under a target fishing mortality (F) of 0.25, which was half the estimated F needed to achieve maximum sustainable yield (MSY). The amendment allowed an increase in the target F once spawning stock biomass (SSB) was restored to levels estimated during the late 1960s and early 1970s. The dual size limit concept was maintained, and a recreational trip limit and commercial season implemented to reduce the harvest to 20 percent of that in the period of 1972-1979. The amendment and its four addenda aimed to rebuild the resource, rather than maximize yield.

In 1995, coastal striped bass were declared restored by the ASMFC, and Amendment 5 was adopted to increase the target F to 0.33, midway between the existing F target (0.25) and FMSY, which was revised to 0.40. Regulations were developed to allow 70 percent of the historic harvest and achieve the target F, although states could submit proposals for alternative regulations that were conservationally equivalent. From 1997 to 2000, a series of five addenda were implemented to respond to the latest stock status information. The Albemarle/Roanoke stock of striped bass was declared restored in 1997, and is currently assessed by an independent stock assessment by the State of North Carolina using catch and abundance data specific to the Albemarle/Roanoke stock. The stock is managed with ASMFC Striped Bass Management Board approval through a separate North Carolina Estuarine Striped Bass FMP (NCDMF 2014).

In 2003, Amendment 6 was adopted to address five limitations within the management program: 1) potential inability to prevent the Amendment 5 exploitation target from being exceeded; 2) perceived decrease in availability or abundance of large striped bass in the coastal migratory population; 3) a lack of management direction with respect to target and threshold biomass levels; 4) inequitable effects of regulations on the recreational and commercial fisheries, and coastal and producer area sectors; 5) and excessively frequent changes to the management program. Amendment 6 was fully implemented by January 1, 2004, and completely replaced all previous plans for Atlantic striped bass (ASMFC 2003).

Amendment 6 modified the F targets and thresholds, and introduced a new set of biological reference points (BRPs) based on female spawning stock biomass (SSB), as well as a list of management triggers based on the BRPs. The coastal commercial quotas for striped bass were restored to 100 percent of the states' average landings during the 1972-1979 period, except for Delaware's coastal commercial quota, which remained at the level allocated in 2002. In the recreational fisheries, all states were required to implement a two-fish bag limit with a minimum size limit of 28-inches total length, except for the Chesapeake Bay fisheries, fisheries that operate in the Albemarle Sound and Roanoke River, and states with approved alternative regulations. The Chesapeake Bay and Albemarle/Roanoke regulatory programs were predicated on a more conservative F target than the coastal migratory stock, which allowed these jurisdictions to implement separate seasons, harvest caps, and size and bag limits if they remain under that F target. No minimum size limit can be less than 18-inches total length under Amendment 6. The same minimum size standards regulate the commercial fisheries as the recreational fisheries, except for a minimum 20-inches total length size limit in the Delaware Bay spring gillnet fishery.

States are permitted the flexibility to deviate from these standards by submitting proposals for review by the striped bass Technical Committee, Advisory Panel, and Plan Review Team and contingent upon the approval of the Management Board. A state may request a change only if it can demonstrate that the action is "conservationally equivalent" to the management standards or will not contribute to the overfishing of the resource. This practice has resulted in a variety of regulations among states.

In 2007, Addendum I was implemented to establish a bycatch monitoring and research program to increase the accuracy of data on striped bass discards and recommend development of a web-based angler education program.

In May 2009, the Management Board initiated the development of an addendum to consider options to roll over unused coastal commercial quota up to 50 percent, and approved sending the draft addendum out for public comment in August 2009. In November 2009, the Board voted for status quo management in regards to unused quota rollover.

In February 2010, the Management Board initiated the development of an addendum to consider options to increase the coastal commercial quota. The Board approved the draft addendum for public comment in May 2010, with the addition of an option to consider adopting a Technical Committee recommendation to revise the JAI management trigger. Adopting the Technical Committee recommendation would modify the definition of recruitment failure, such that each index would have a fixed numerical value indicating failure, rather than one that changes from year to year. The Board approved Addendum II, and the revised JAI management triggers, in November 2010 but did not take any action to increase the coastal commercial quota. The new definition of recruitment failure is a value that is below 75 percent of all values in a fixed time series appropriate to each juvenile abundance index.

In 2012, Addendum III was approved by the Board. This addendum requires all states and jurisdictions with a commercial fishery to implement a commercial harvest tagging program. The

addendum was initiated in response to significant poaching events in the Chesapeake Bay and aims to limit illegal commercial harvest of striped bass.

The Board approved Addendum IV in 2014 in response to the 2013 benchmark assessment which indicated a steady decline in spawning stock biomass since the mid-2000s. The Addendum established new fishing mortality reference points (F target and threshold), and required coastal states to reduce removals and decrease F to a level at or below the new target (i.e., 25 percent reduction from 2013 removals for the coastal fishery and 20.5 percent reduction from 2012 removals for Chesapeake Bay fishery). Additionally, since current analysis of tag return data indicates the Albemarle/Roanoke stock contributes minimally to the coastwide complex, Addendum IV defers management of the Albemarle/Roanoke stock to the State of North Carolina using stock-specific BRPs approved by the Management Board. The 18-inch total length minimum size limit still applies.

The Exclusive Economic Zone (EEZ) has been closed to the harvest and possession of striped bass since 1990, except for a defined route to and from Block Island in Rhode Island. A recommendation was made in Amendment 6, and submitted to the Secretary of Commerce, to re-open federal waters to commercial and recreational fisheries. Starting in July 2003 and continuing for several years, the National Oceanic and Atmospheric Administration (NOAA) Fisheries took steps in the rulemaking process to consider the proposal. In September 2006, NOAA Fisheries concluded that it would be imprudent to open the EEZ to striped bass fishing and chose not to proceed further in its rulemaking. Specifically, NOAA Fisheries concluded that: 1) it could not be certain, especially after taking into account the overwhelming public perception that large trophy sized fish congregate in the EEZ, that opening the EEZ would not increase effort and lead to an increase in mortality that would exceed the threshold, and 2) both the ASMFC's and NOAA Fisheries' ability to immediately respond to an overfishing and/or overfished situation is a potential issue, particularly given the timeframe within which Amendment 6 was created, and given the lag time in which a given year's data is available to management (71 FR 54261-54262). Additionally, in October 2007, President George W. Bush issued an Executive Order (E.O. 13449) prohibiting the sale of striped bass (and red drum) caught within the EEZ. The Order also requires the Secretary of Commerce to encourage management for conservation of the resources, including State designation as gamefish where the State determines appropriate under applicable law, and to periodically review the status of the populations within US jurisdictional waters. The 2011 report (submitted in 2012) is the most recent report to Congress on the status of the Striped bass population (NOAA 2012). The 2015 Striped Bass Report to Congress is scheduled for completion at the end of August.

To ensure compliance with interstate requirements, North Carolina also manages this species 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).

Management Unit

Migratory stocks of Atlantic striped bass from Maine through North Carolina.

Goals and Objectives

The goal of Amendment 6 is to perpetuate, through cooperative interstate management, migratory stocks of Striped bass; to allow commercial and recreational fisheries consistent with the long-term maintenance of a broad age structure, a self-sustaining spawning stock; and also to provide for the restoration and maintenance of their essential habitat. In support of this goal, the following objectives are included:

1. Manage Striped bass fisheries under a control rule designed to maintain stock size at or above the target female spawning stock biomass level and a level of fishing mortality at or below the target exploitation rate.
2. Manage fishing mortality to maintain an age structure that provides adequate spawning potential to sustain long-term abundance of Striped bass populations.
3. Provide a management plan that strives, to the extent practical, to maintain coastwide consistency of implemented measures, while allowing the States defined flexibility to implement alternative strategies that accomplish the objectives of the FMP.
4. Foster quality and economically viable recreational, for-hire, and commercial fisheries.
5. Maximize cost effectiveness of current information gathering and prioritize state obligations in order to minimize costs of monitoring and management.
6. Adopt a long-term management regime that minimizes or eliminates the need to make annual changes or modifications to management measures.
7. Establish a fishing mortality target that will result in a net increase in the abundance (pounds) of age 15 and older striped bass in the population, relative to the 2000 estimate.

STATUS OF THE STOCK

Stock Status

In 2015, the Atlantic striped bass stock was not overfished or experiencing overfishing based on the point estimates of fully-recruited (F) and SSB relative to the reference points defined in the Atlantic Striped Bass FMP. The SSB was estimated at 58,853 metric tons (129 million pounds) which is above the SSB threshold of 57,626 mt, but below the SSB target of 72,032 mt (Figure

1). Total F was estimated at 0.16 which is below the F threshold of 0.22 and below the F target of 0.18(Figure 2) (NEFSC. 2013a and b.).

| | <i>Female Spawning Stock Biomass</i> | <i>Fully-Recruited Fishing Mortality</i> |
|------------------|---|--|
| Threshold | SSB ₁₉₉₅ = 57,626 mt (127,043,432 lb) | F _{msy} = 0.219 |
| Target | SSB _{threshold} x 1.25 = 72, 032 mt (158,803,188 lb) | F _{target} = 0.180 |

Stock Assessment

The 2016 stock assessment updated the 2013 benchmark assessment with catch and index data from 1982 through 2015. See the Stock Assessment Review Committee (SARC) document for a complete description of the striped bass statistical-catch-at-age model (NEFSC. 2013a. and b.). The 2013 benchmark assessment, and the new F reference points, were approved by the Board for management use at its October 2013 meeting.

Although the stock is not overfished, female spawning stock biomass (SSB) has continued to decline since the peak of 2004. Despite recent declines, the current estimate of SSB is still well above the estimates during the moratorium that was in place in the mid-late 1980s. Atlantic striped bass experienced a period of strong recruitment (i.e., number of age-1 fish entering the population) from 1993 to 2004, followed by a period of lower recruitment from 2005 to 2011 (although not as low as the 1980's stock collapse). Recruitment of the 2011 year-class was high, but was followed by the second lowest recruitment estimate on record going back to 1982. However, in 2015, recruitment was again high and estimated at 122.8 million age-1 fish (the 2014-year class), the 7th highest on record (Figure 2).

Total removals in 2015 were estimated at 3.02 million fish. It is projected that if catch remains constant at 3.02 million fish each year for 2016-2018, there is a 39 percent chance of SSB falling below the threshold level in 2016, but only a 20 percent chance of this in 2018. This trend is largely driven by the presence of the 2011-year class (now age 6) which is presently maturing into the spawning stock, and is beginning its migration from the Chesapeake Bay into the coastal migratory population.

STATUS OF THE FISHERY

Current Regulations

Striped bass regulations in the coastal waters (0-3 miles) of the Atlantic Ocean are under the jurisdiction of ASMFC, while striped bass regulations in the inshore coastal (i.e. estuarine), joint, and inland waters are under the jurisdiction of the North Carolina Division of Marine Fisheries and Wildlife Resources Commission. Striped bass regulations in the EEZ are under the jurisdiction of the NOAA Fisheries. Commercial and recreational harvest of striped bass is not allowed in the EEZ, which is from three to 200 miles offshore. Striped bass cannot even be targeted for recreational catch-and-release fishing in the EEZ.

Commercial harvest is currently constrained by a 360,360 pound annual quota and a 28-inch total length minimum length size limit. The quota is split evenly between three gears: ocean beach seine, ocean gill net, and ocean trawl. Usually only one gear is open at a time and any quota overages in a gear are taken away from the offending gear during the next year. Atlantic striped bass overwinter in North Carolina ocean waters during the winter months, from December through February, therefore the quota year is set from December 1 through November 30 each year.

Recreational harvest is constrained by a one fish per person daily possession limit and a 28-inch total length minimum total length size limit. When striped bass are inside state coastal waters they form large schools that are easily accessed by anglers, and harvest can be significant with releases even larger.

The Atlantic Ocean waters from about Oregon Inlet to the N.C./V.A. state line are the southernmost extension of the overwintering grounds for Atlantic striped bass. Therefore, annual landings are dependent on how far down and offshore striped bass stocks migrate each winter. Since 2011 striped bass have been farther north and offshore than normal. In recent years large schools of striped bass have been up to 30 miles offshore. Since 2012 there has been no commercial or recreational harvest of overwintering migratory striped bass in North Carolina's coastal ocean waters during the winter months. Overall stock abundance is still at high levels however.

Commercial Landings

Commercial landings of striped bass in the Atlantic Ocean have been controlled by a quota since 1991. Due to the relatively small individual gear quota and the ability to harvest tens of thousands of pounds in just a single day, specific gear overages were common, but the overall quota was rarely exceeded. Landings reached the quota in most years and averaged 361,555 pound a year from 1995/1996-2006/2007. Starting in 2008/2009 shifting migratory patterns and decreasing stock abundance led to less availability of fish inside three miles. Since 2012/2013 no striped bass have been landed from the Atlantic Ocean because striped bass have stayed outside of three miles and in southern Virginia waters while overwintering (Table 1, Figures 3 and 4).

Recreational Landings

Recreational landings were low through the early 2000s. As the Atlantic striped bass stock recovered and abundance increased, recreational landings increased as well, with peak landings of 5.5 million pounds in 2004 (Figure 4). When striped bass are inside state coastal waters they form large schools that are easily accessed by anglers, and harvest can be significant and releases even larger. Landings have fluctuated since, often due to winter weather conditions and the migratory behavior in the near shore ocean during January and February. From 2006 to 2011 landings averaged about one million pounds. Due to the stocks being outside of three miles and not migrating down into North Carolina state waters in recent years, no recreational landings have occurred since 2012 (Table 1 Figure 4.).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

The length, weight, sex, and age composition of the commercial harvest has been consistently monitored through sampling at fish houses conducted by the division since 1982. The annual harvest quota is split equally between three gear types, beach seine, gill net, and trawl. Any overages from one year are deducted from next year's quota. Because of the 28-inch total length minimum size limit and gear regulations, most fish harvested average about 38-inches total length and are between 9 and 15 years old (Tables 2 and 3). North Carolina also augments NOAA Fisheries Marine Recreational Information Program (MRIP), which estimates the annual harvest and releases of marine recreational fisheries. Mean fork length is usually around 36-inches, with fish as large as 51-inches measured. Total number of fish measured for 2006-2011 ranged from 67 to 609. There has been no estimated harvest (and therefore no fish measured) since 2012 (Table 4).

Fishery-Independent Monitoring

North Carolina has no fishery independent sampling indices of abundance for Atlantic striped bass. However, we do participate in the coastwide striped bass tagging program administered through the United States Fish and Wildlife Service (USFWS). In 2011, the DMF started contracting charter trips to collect striped bass using hook-and-line gear to tag striped bass on their overwintering grounds, usually in the vicinity of the VA/NC border. Tagging takes place in January and/or February. Dates and actual location of tagging are dependent on striped bass annual migration patterns. Tags used are USFWS tags and all tagging information is housed in the USFWS tagging database. The striped bass Winter Cooperative Tagging Program is a critical component of overall coastwide striped bass management, as it is the only tagging program that tags the mixed, migratory stock on their overwintering grounds (off the VA/NC coast, from the mouth of the Chesapeake Bay down to Oregon Inlet). This means that fish from all producer areas, including Chesapeake Bay, Delaware River, Hudson River, and Albemarle/Roanoke stocks are available for tagging. Tag returns provide managers with an estimate of the percent contribution of the individual producer areas to the migratory portion of the stock and fishing mortality on the stock. Length frequencies average about 37-inches total length, and about 1,000 fish are collected each year (Table 5). Nearly all of these fish are large, mature females that are staging on their overwintering grounds in preparation for the spring spawning run to their respective spawning grounds.

MANAGEMENT STRATEGY

Atlantic striped bass are managed under Amendment 6 (and subsequent addenda) to ASMFC's Interstate FMP for Atlantic Striped Bass. The plan identifies spawning stock biomass and fishing mortality reference points to maintain adequate stock size and age structure, and to prevent overfishing. Stock status is determined by a formal, peer reviewed statistical catch-at-age stock assessment. The FMP requires several independent and dependent monitoring programs to be in place in each state, although these programs vary by state. States have the flexibility to implement different size limits, bag limits, and commercial quotas, if they are deemed to meet

conservation equivalency by the Technical Committee and are approved by the Management Board.

RESEARCH NEEDS

The following management issues and research needs are identified in Amendment 6 and from the peer reviewed stock assessment.

Fishery Dependent Priorities

High

- Continue collection of paired scale and otolith samples, particularly from larger striped bass, to facilitate the development of otolith-based age-length keys for scale-otolith conversion matrices.

Moderate

- Develop studies to provide information on gear specific discard mortality rates and to determine the magnitude of bycatch mortality.
- Improve estimates of striped bass harvest removals in coastal areas during wave 1 and in inland waters of all jurisdictions year round.
- Evaluate the percentage of fishermen using circle hooks.

Fishery Independent Priorities

Moderate

- Develop a refined and cost-efficient, fisheries-independent coastal population index for striped bass stocks.
 - The PRT recommends the SBTC be tasked with exploring whether the Cooperative Winter Tagging Cruise, NEAMAP, and/or NOAA Fisheries Trawl Survey datasets would prove useful in this respect.

Modeling/Quantitative Priorities

High

- Develop a method to integrate catch-at-age and tagging models to produce a single estimate of F and stock status.
- Develop a spatially and temporally explicit catch-at-age model incorporating tag based movement information.
 - The PRT recommends that the SAS be tasked with reviewing recent published literature examining tag-based movement information to see if they would contribute to the development of such a model (e.g., Callihan et al., 2014).
- Review model averaging approach to estimate annual fishing mortality with tag based models. Review validity and sensitivity to year groupings.
- Develop methods for combining tag results from programs releasing fish from different areas on different dates.
- Examine potential biases associated with the number of tagged individuals, such as gear specific mortality (associated with trawls, pound nets, gill nets, and electrofishing), tag induced mortality, and tag loss.

- Develop field or modeling studies to aid in estimation of natural mortality or other factors affecting the tag return rate.

Moderate

- Develop maturity ogives applicable to coastal migratory stocks.
- Examine methods to estimate annual variation in natural mortality.
- Develop reliable estimates of poaching loss from striped bass fisheries.
- Improve methods for determining population sex ratio for use in estimates of SSB and biological reference points.
- Evaluate truncated matrices and covariate based tagging models.

Low

- Examine issues with time saturated tagging models for the 18-inch length group.
- Develop tag based reference points

Life History, Biological, and Habitat Priorities

High

- Continue in-depth analysis of migrations, stock compositions, etc. using mark-recapture data.
- Continue evaluation of striped bass dietary needs in relation to health condition.
- Continue analysis to determine linkages between the mycobacteriosis outbreak in Chesapeake Bay and sex ration of Chesapeake spawning stock, Chesapeake juvenile production, and recruitment success into coastal fisheries.

Moderate

- Examine causes of different tag based survival estimates among programs estimating similar segments of the population.
- Continue to conduct research to determine limiting factors affecting recruitment and possible density implications.
- Conduct study to calculate the emigration rates from producer areas now that population levels are high and conduct multi-year study to determine inter-annual variation in emigration rates.

Low

- Determine inherent viability of eggs and larvae.
- Conduct additional research to determine the pathogenicity of the IPN virus isolated from striped bass to other warm water marine species, such as flounder, menhaden, shad, and largemouth bass.

Management, Law Enforcement, and Socioeconomic Priorities

Moderate

- Examine the potential public health trade-offs between the continued reliance on the use of high minimum size limits (28-inches) on coastal recreational anglers and its long-term effects on enhanced PCB contamination among recreational stakeholders.
- Evaluate striped bass angler preferences for size of harvested fish and trade-offs with bag limits.

Habitat Recommendations

- Passage facilities should be designed specifically for passing striped bass for optimum efficiency at passing this species.
- Conduct studies to determine whether passing migrating adults upstream earlier in the year in some rivers would increase striped bass production and larval survival, and opening downstream bypass facilities sooner would reduce mortality of early emigrants (both adult and early-hatched juveniles).
- All state and federal agencies responsible for reviewing impact statements and permit applications for projects or facilities proposed for striped bass spawning and nursery areas shall ensure that those projects will have no or only minimal impact on local stocks, especially natal rivers of stocks considered depressed or undergoing restoration.
- Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known to be accumulated in “striped bass tissues and which pose a threat to human health or striped bass health.
- Water quality criteria for striped bass spawning and nursery areas should be established, or existing criteria should be upgraded to levels that are sufficient to ensure successful striped bass reproduction.
- Each state should implement protection for the striped bass habitat within its jurisdiction to ensure the sustainability of that portion of the migratory stock. Such a program should include inventory of historical habitats. Identification of habitats presently used, specification areas targeted for restoration, and imposition or encouragement of measures to retain or increase the quantity and quality of striped bass essential habitats.
- States in which striped bass spawning occurs should make every effort to declare striped bass spawning and nursery areas to be in need of special protection, such as declaration should be accompanied by requirements of non-degradation of habitat quality, including minimization of non-point source runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into an area. For those agencies without water quality regulatory authority, protocols and schedules for providing input on water quality needs of striped bass stocks are met.
- ASMFC should designate important habitats for striped bass spawning and nursery areas as HAPC.
- Each state should survey existing literature and data to determine the historical extent of striped bass occurrence and use within its jurisdiction. An assessment should be conducted of those areas not presently used for which restoration is feasible.

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TABLES

Table 1. North Carolina’s striped bass commercial and recreational landings and releases (recreational only) in numbers and pounds in the Atlantic Ocean, 2007-2016.

| Year | Recreational | | | Quota Year* | Commercial | |
|------|--------------|--------------|---------------|-------------|--------------|---------------|
| | Landings (N) | Releases (N) | Landings (lb) | | Landings (N) | Landings (lb) |
| 2007 | 37,376 | 13,838 | 876,206 | 2006/2007 | 18,396 | 424,723 |
| 2008 | 25,750 | 10,776 | 525,891 | 2007/2008 | 13,803 | 299,162 |
| 2009 | 5,650 | 5,407 | 160,922 | 2008/2009 | 8,585 | 189,995 |
| 2010 | 23,778 | 20,365 | 435,756 | 2009/2010 | 14,627 | 272,418 |
| 2011 | 94,182 | 110,150 | 2,042,981 | 2010/2011 | 13,532 | 250,383 |
| 2012 | 0 | 1,615 | 0 | 2011/2012 | 333 | 7,282 |
| 2013 | 0 | 1,057 | 0 | 2012/2013 | 0 | 0 |
| 2014 | 0 | 626 | 0 | 2013/2014 | 0 | 0 |
| 2015 | 0 | 0 | 0 | 2014/2015 | 0 | 0 |
| 2016 | 0 | 0 | 0 | 2015/2016 | 0 | 0 |

* Quota year is December 1 through November 30.

Table 2. Summary of striped bass total length (inches) samples collected from the Atlantic Ocean commercial fisheries, 2006/2007-2015/2016.

| Year | Mean Total Length | Minimum Total Length | Maximum Total Length | Total Number Measured |
|-----------|-------------------|----------------------|----------------------|-----------------------|
| 2006/2007 | 38 | 28 | 48 | 843 |
| 2007/2008 | 39 | 29 | 49 | 317 |
| 2008/2009 | 39 | 30 | 49 | 175 |
| 2009/2010 | 37 | 28 | 50 | 456 |
| 2010/2011 | 36 | 28 | 48 | 388 |
| 2011/2012 | 38 | 34 | 47 | 21 |
| 2012/2013 | | | | 0 |
| 2013/2014 | | | | 0 |
| 2014/2015 | | | | 0 |
| 2015/2016 | | | | 0 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – ATLANTIC STRIPED BASS

Table 3. Summary of striped bass age samples collected from the Atlantic Ocean commercial fisheries, 2006/2007-2015/2016.

| Year | Modal Age | Minimum Age | Maximum Age | Total Number Aged |
|-----------|-----------|-------------|-------------|-------------------|
| 2006/2007 | 10 | 6 | 16 | 427 |
| 2007/2008 | 11 | 7 | 17 | 191 |
| 2008/2009 | 11 | 7 | 17 | 179 |
| 2009/2010 | 9 | 6 | 18 | 292 |
| 2010/2011 | 8 | 6 | 17 | 226 |
| 2011/2012 | 9 | 8 | 15 | 21 |
| 2012/2013 | | | | 0 |
| 2013/2014 | | | | 0 |
| 2014/2015 | | | | 0 |
| 2015/2016 | | | | 0 |

Table 4. Striped bass fork length (inches) data from MRIP recreational samples, Atlantic Ocean only, 2006-2015.

| Year | Mean Fork Length | Minimum Fork Length | Maximum Fork Length | Total Number Measured |
|------|------------------|---------------------|---------------------|-----------------------|
| 2007 | 36 | 28 | 46 | 375 |
| 2008 | 36 | 26 | 47 | 304 |
| 2009 | 38 | 28 | 49 | 67 |
| 2010 | 35 | 27 | 51 | 95 |
| 2011 | 36 | 26 | 48 | 609 |
| 2012 | | | | 0 |
| 2013 | | | | 0 |
| 2014 | | | | 0 |
| 2015 | | | | 0 |
| 2016 | | | | 0 |

Table 5. Striped bass total length (inches) and tagging data from the Cooperative Winter Tagging Program, Hook and Line portion, 2011-2016.

| Year | Number of Trips | Number Caught | Number Tagged | Mean Total Length | Minimum Total Length | Maximum Total Length |
|------|-----------------|---------------|---------------|-------------------|----------------------|----------------------|
| 2011 | 1 | 109 | 108 | 32 | 26 | 43 |
| 2012 | 1 | 6 | 6 | 36 | 25 | 46 |
| 2013 | 10 | 1,129 | 1,121 | 37 | 26 | 49 |
| 2014 | 10 | 925 | 921 | 37 | 27 | 53 |
| 2015 | 10 | 1,057 | 1,042 | 38 | 29 | 52 |
| 2016 | 10 | 1,273 | 1,239 | 39 | 27 | 48 |

FIGURES

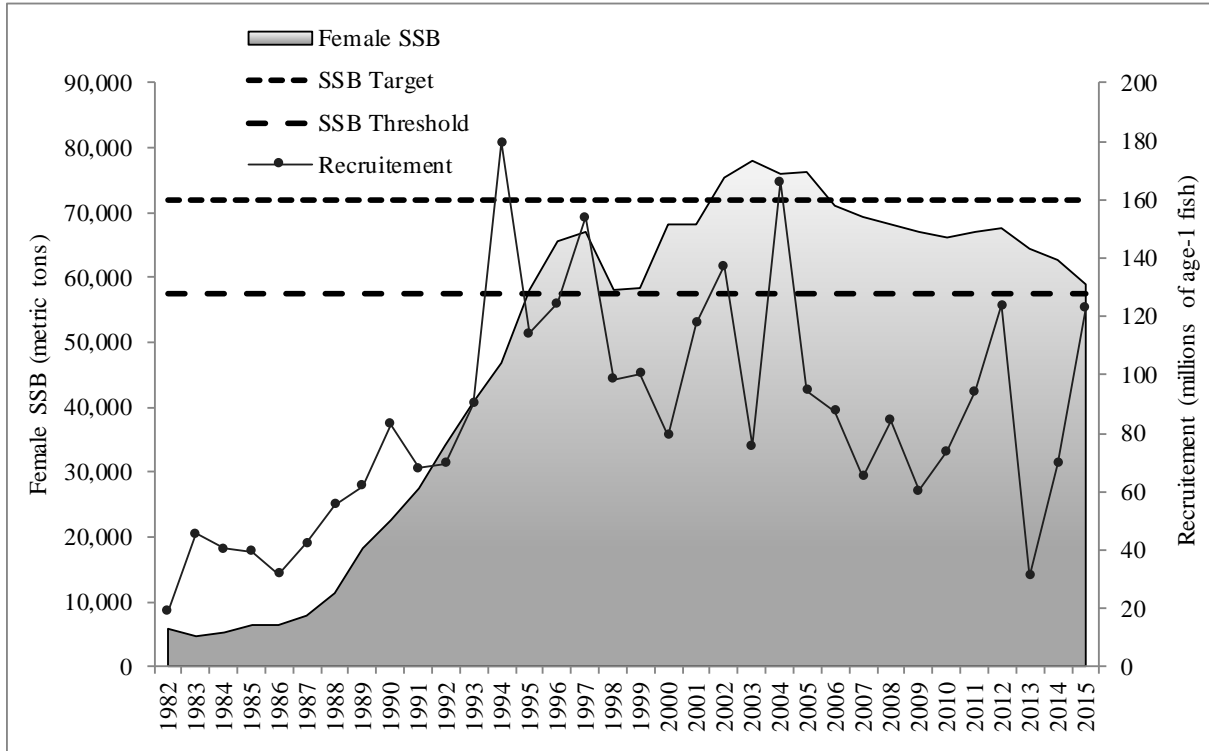


Figure 1. Atlantic striped bass female spawning stock biomass and recruitment (abundance of age-1). Source: ASMFC Atlantic Striped Bass Stock Assessment Update 2016.

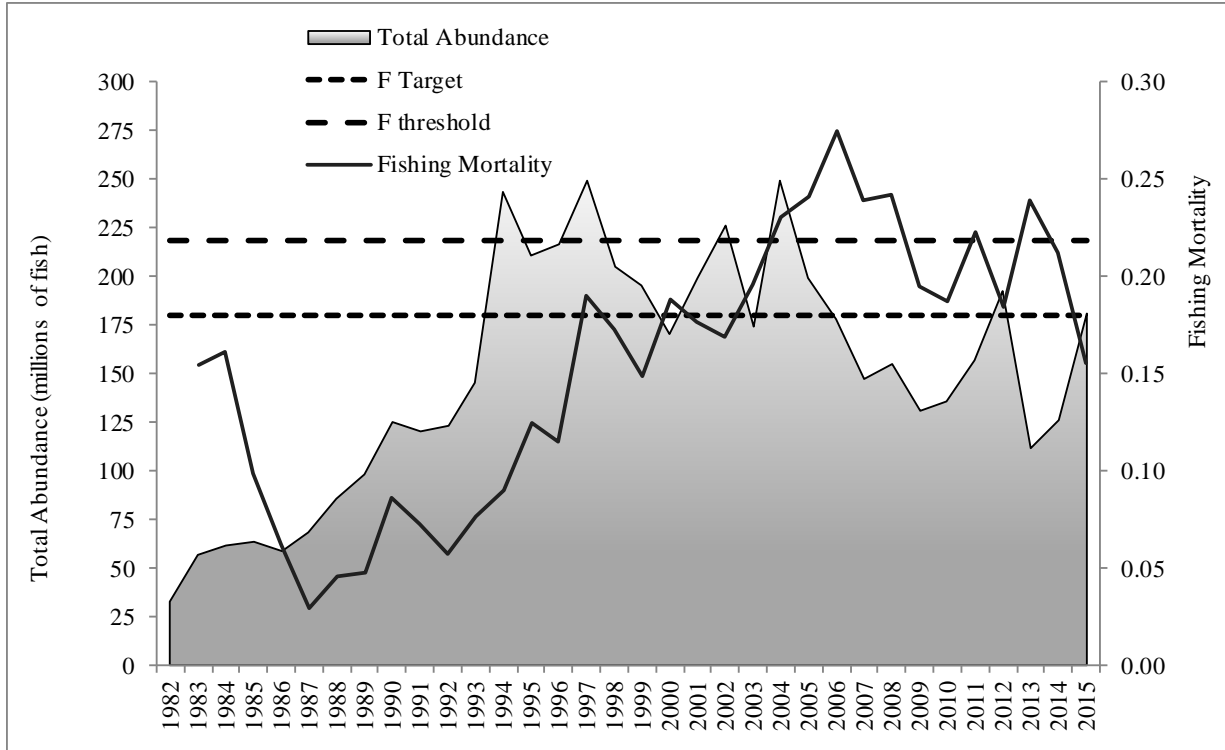


Figure 2. Atlantic striped bass total stock abundance and Fishing mortality (F). Source: ASMFC Atlantic Striped Bass Stock Assessment Update 2016.

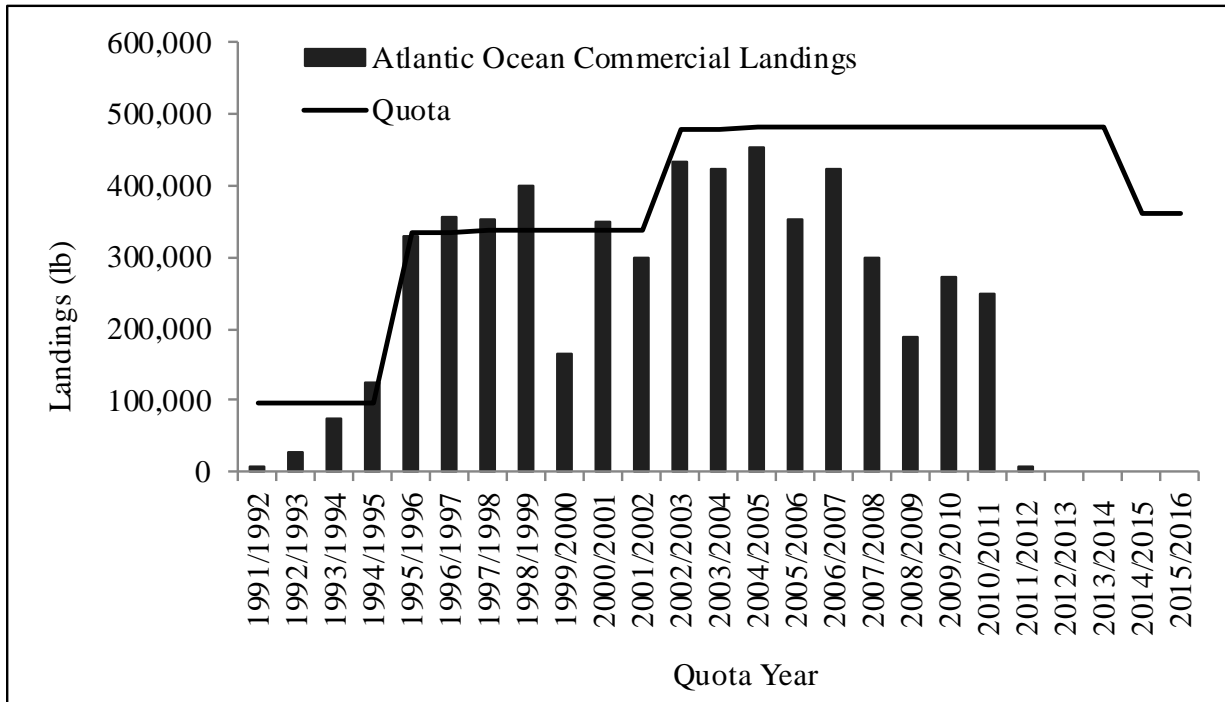


Figure 3. North Carolina's commercial striped bass landings in the Atlantic Ocean by quota year, 1991/1992-2015/2016.

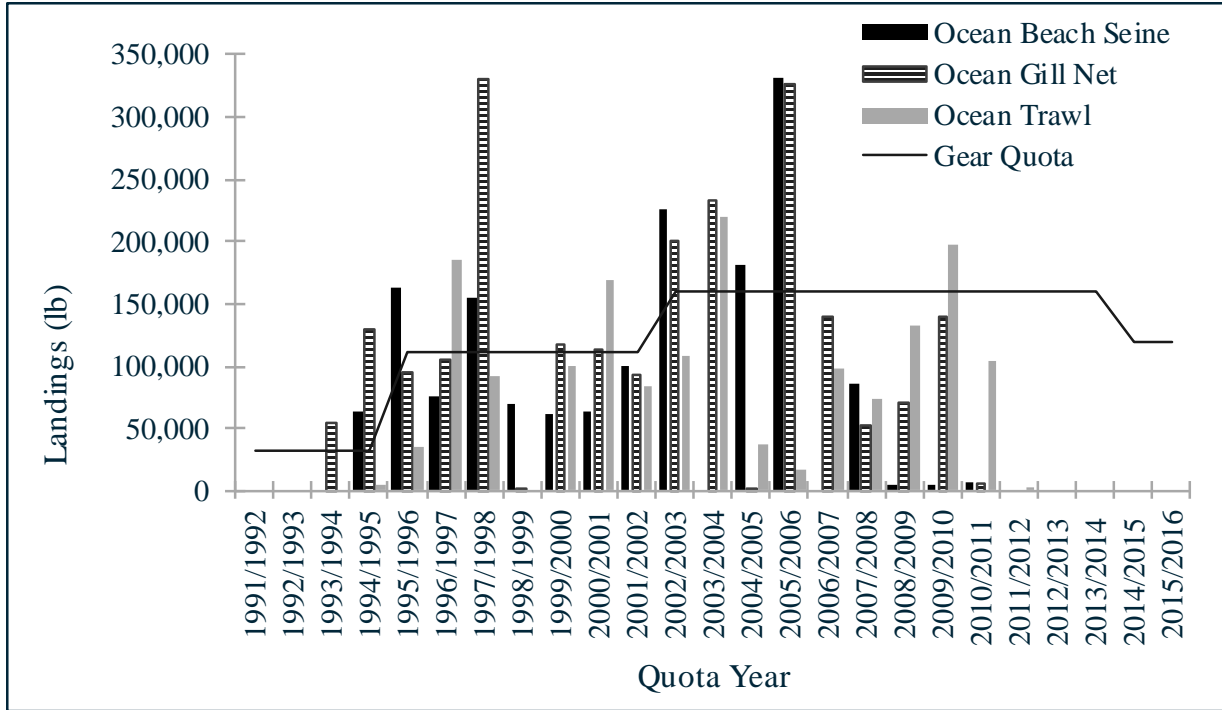


Figure 4. North Carolina’s commercial striped bass landings in the Atlantic Ocean by gear and quota year, 1991/1992-2015/2016.

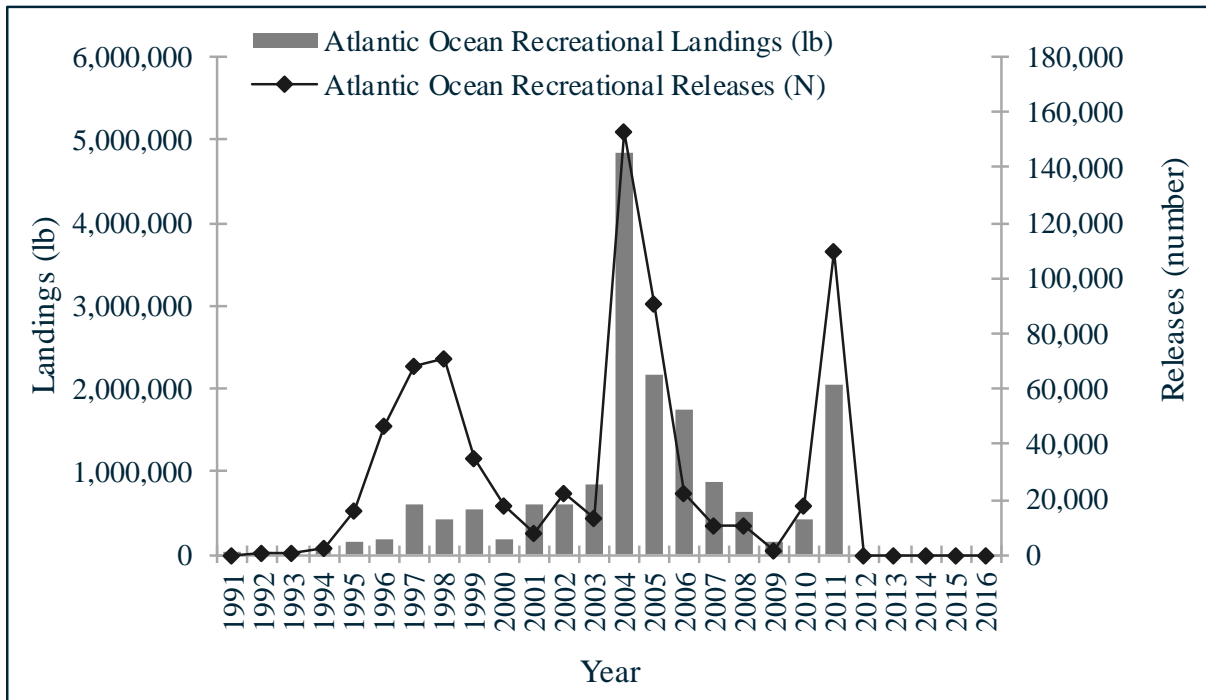


Figure 5. North Carolina’s recreational striped bass landings in the Atlantic Ocean, 1991-2015.

**FISHERY MANAGEMENT PLAN UPDATE
SUMMER FLOUNDER
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption: Adopted by the ASMFC in 1982 and the MAFMC in 1988

Amendments:

- Amendment 1 in 1991
- Amendment 2 in 1993
- Amendment 3 in 1993
- Amendment 4 in 1993
- Amendment 5 in 1993
- Amendment 6 in 1994
- Amendment 7 in 1995
- Amendment 10 in 1997
- Amendment 11 in 1998
- Amendment 12 in 1999
 - Framework 1 in 2001
 - Framework 2 in 2001
 - Addendum III in 2001
 - Addendum IV in 2001
 - Framework 5 in 2004
 - Addendum VIII in 2004
 - Addendum XIV in 2004
 - Addendum XV in 2004
 - Addendum XVI in 2005
 - Addendum XVII in 2005
 - Framework 6 in 2006
 - Addendum XVIII in 2006
 - Framework 7 in 2007
 - Addendum XIX in 2007
- Amendment 16 in 2007
- Amendment 15 in 2011
- Amendment 19 (Recreational Accountability Amendment) in 2013
 - Addendum XXV in 2014
- Amendment 17 in 2015
 - Addendum XXVI in 2015
- Amendment 18 in 2015
 - Addendum XXVII in 2016
 - Addendum XXVIII in 2017
- Amendment 20 in 2017

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SUMMER FLOUNDER

Framework 10 in 2017

Framework 11 in 2018

Framework 12 in 2018

| | |
|------------------------|--|
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | A stock assessment update was completed in 2016 and a benchmark stock assessment is scheduled for late 2018. |

Because of their presence in, and movement between state waters (0-3 miles) and federal waters (3-200 miles), the Mid-Atlantic Fisheries Management Council (MAFMC) manages summer flounder (*Paralichthys dentatus*) cooperatively with the Atlantic States Marine Fisheries Commission (ASMFC). The two management entities work in conjunction with the National Marine Fisheries Service (NMFS) as the federal implementation and enforcement entity. The Summer Flounder, Scup and Black Sea Bass Fishery Management Plan (FMP) and amendments use output controls (catch and landings limits) as the primary management tool, with landings divided between the commercial (60 percent) and recreational (40 percent) fisheries. The FMP also includes minimum fish sizes, bag limits, seasons, gear restrictions, permit requirements, and other provisions to prevent overfishing and ensure sustainability of the fisheries. Recreational bag and size limits and seasons are determined on a regional basis using conservation equivalency. The commercial quota is divided into state-by-state quotas.

Specific details for each Amendment include:

Amendment 1 - established an overfishing definition for summer flounder.

Amendment 2 - established rebuilding schedule, commercial quotas, recreational harvest limits, size limits, gear restrictions, permits, and reporting requirements for summer flounder; created the summer flounder monitoring committee.

Amendment 3 - revised the exempted fishery line for summer flounder; increased the large mesh net threshold for summer flounder; established otter trawl retention requirements for large mesh use in the summer flounder fishery.

Amendment 4 - revised state-specific shares for summer flounder commercial quota allocation.

Amendment 5 - allowed states to combine or transfer summer flounder commercial quota.

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SUMMER FLOUNDER

Amendment 6 - set criteria for allowance of multiple nets on board commercial vessels for summer flounder; established deadline for publishing catch limits; established commercial management measures for summer flounder.

Amendment 7 - revised the fishing mortality rate reduction schedule for summer flounder.

Amendment 10 – modified commercial minimum mesh requirements; continued commercial vessel moratorium; prohibited transfer of summer flounder at sea; established a special permit for the summer flounder party/charter sector.

Amendment 11 - modified certain provisions related to vessel replacement and upgrading, permit history transfer, splitting, and permit renewal regulations.

Amendment 12 - revised Summer Flounder, Scup, and Black Sea Bass FMP to comply with the Sustainable Fisheries Act and established a framework adjustment process; established quota set-aside for research for summer flounder, scup and black sea bass; established state-specific conservation equivalency measures; allowed the rollover of the winter scup quota; revised the start date for the scup summer quota period; established a system to transfer scup at sea.

Framework 1 – established quota set-aside for research for summer flounder, scup and black sea bass.

Framework 2 – established state-specific conservation equivalency measures for the recreational summer flounder fishery.

Addendum III – established recreational fishing specifications for 2001 for summer flounder and scup.

Addendum IV – provided that upon the recommendation of the relevant monitoring committee and joint consideration with the Mid-Atlantic Fishery Management Council, the Mid-Atlantic Fishery Management Board will decide the state regulations rather than forward a recommendation to the National Marine Fisheries Science center; made states responsible for implementing the Mid-Atlantic Fishery Management Boards decisions on regulations.

Framework 5 – established multi-year specification setting of quota for summer flounder, scup, and black sea bass.

Addendum VIII – established a program wherein any state which exceeds its recreational harvest limit for summer flounder in 2003 and beyond will receive a reduction from its future recreational harvest limits.

Addendum XIV – implemented a system of conservation equivalency for the recreational fishery of summer flounder to achieve the annual recreational harvest limit.

Addendum XV – established an allocation program for the increase in commercial total allowable landings in the summer flounder fishery for 2005 and 2006 only.

Addendum XVI – provided a species-specific mechanism of ensuring that a state meet its obligations under the plan in a way that minimizes the probability that a state’s delay in complying does not adversely affect other states fisheries or conservation of the resource. Addendum XVII – established a program wherein the ASMFC Management Board has the ability to sub-divide the recreational summer flounder coastwide allocations into voluntary regions.

Framework 6 – established region-specific conservation equivalency measures for summer flounder.

Addendum XVIII – stabilized fishing rules as close to those that existed in 2005, in part, to minimize the drastic reductions facing three states.

Framework 7 – built flexibility into process to define and update status determination criteria for summer flounder, scup and black sea bass.

Addendum XIX – continued the state-by-state black sea bass commercial management measures, without a sunset clause; broadened the descriptions of stock status determination criteria contained within the Summer Flounder, Scup, and Black Sea Bass FMP to allow greater flexibility in those definitions, while maintaining objective and measurable status determination criteria for identifying when stocks or stock complexes covered by the fishery management plan are overfished.

Amendment 16 - standardized bycatch reporting methodology.

Amendment 15 - established annual catch limits and accountability measures.

Amendment 19 (Recreational Accountability Amendment) – modified the accountability measures for the MAFMC recreational fisheries.

Addendum XXV - established regional management for the 2014 recreational black sea bass and summer flounder fishery.

Amendment 17 – implemented standardized bycatch reporting methodology.

Addendum XXVI - established alternate regional management for the 2015 recreational summer flounder fishery.

Amendment 18 – eliminated the requirement for vessel owners to submit “did not fish” reports for the months or weeks when their vessel was not fishing; removed some of the restrictions for upgrading vessels listed on federal fishing permits.

Addendum XXVII to the Summer Flounder, Scup and Black Sea Bass FMP, continued regional management of the recreational summer flounder fishery, extended ad hoc regional management of the black sea bass recreational fishery for the 2016 and 2017 fishing year and addressed the discrepancies in recreational summer flounder management measures within Delaware Bay.

Addendum XXVIII to the Summer Flounder, Scup and Black Sea Bass FMP, initiated an addendum to consider adaptive management, including regional approaches, for the 2017 summer flounder recreational fishery.

Amendment 20 (Unmanaged Forage Omnibus Amendment) – implemented management measures to prevent the development of new, and the expansion of existing, commercial fisheries on certain forage species in the Mid-Atlantic.

Framework 10 (Omnibus For-Hire Electronic Trip Report Framework) – implemented a requirement for vessels that hold party/charter permits for Council-managed species to submit vessel trip reports electronically (eVTRS) while on a trip carrying passengers for hire.

Framework 11 (Omnibus Acceptable Biological Catch Framework) – established a process for setting constant multi-year Acceptable Biological Catch (ABC) limits for Council-managed fisheries, clarified that the Atlantic Bluefish, Tilefish, and Atlantic Mackerel, Squid, and Butterfish FMPs will now automatically incorporate the best available scientific information in calculating ABCs (as all other Mid-Atlantic management plans do) rather than requiring a separate management action to adopt them, clarified the process for setting ABCs for each of the four types of ABC control rules.

Specific details for each amendment under development include:

Summer Flounder Amendment – This amendment will review and update the Summer Flounder, Scup, and Black Sea Bass FMP goals and objectives and will consider changes to commercial summer flounder management in both state and federal waters.

Summer Flounder, Scup, and Black Sea Bass Commercial Accountability Measures Framework – This framework will consider changes in commercial accountability measures for summer flounder, scup, and black sea bass.

Summer Flounder, Scup, and Black Sea Bass Recreational Management Framework – This framework seeks to develop a joint framework action and addendum to include additional management measures into the summer flounder, scup, and black sea bass Fishery Management Plan.

To ensure compliance with interstate requirements, North Carolina also manages this species 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 MAFMC, 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).

Management Unit

U.S. waters in the western Atlantic Ocean from the southern border of North Carolina northward to the U.S.-Canadian border.

Goal and Objectives

The objectives of the Summer Flounder, Scup and Black Sea Bass FMP are to:

1. Reduce fishing mortality in the summer flounder, scup and black sea bass fisheries to assure that overfishing does not occur;
2. Reduce fishing mortality on immature summer flounder, scup and black sea bass to increase spawning stock biomass;
3. Improve the yield from these fisheries;
4. Promote compatible management regulations between state and federal jurisdictions;
5. Promote uniform and effective enforcement of regulations;
6. Minimize regulations to achieve the management objectives stated above.

The 2011 Omnibus Amendment contains Amendment 15 to the Summer Flounder, Scup and Black Sea Bass FMP. The amendment is intended to formalize the process of addressing scientific and management uncertainty when setting catch limits for the upcoming fishing year(s) and to establish a comprehensive system of accountability for catch (including both landings and discards) relative to those limits, for each of the managed resources subject to this requirement. Specifically: (1) Establish allowable biological catch control rules, (2) Establish a MAFMC risk policy, which is one variable needed for the allowable biological catch control rules, (3) Establish annual catch limits, (4) Establish a system of comprehensive accountability, which addresses all components of the catch, (5) Describe the process by which the performance of the annual catch limit and comprehensive accountability system will be reviewed, (6) Describe the process to modify the measures above in 1-5 in the future.

STATUS OF THE STOCK

Life History

Summer flounder are estuarine dependent members of the left eyed flounder family that includes southern flounder (*Paralichthys lethostigma*) and gulf flounder (*Paralichthys albigutta*), all of which occur in North Carolina waters. Summer flounder are found in both inshore and offshore waters from Nova Scotia, Canada to Florida but are most abundant from Cape Cod, Massachusetts to Cape Fear, North Carolina. Spawning typically occurs at age 2 to 3 during the months of November to March as they move offshore. Juveniles move inshore to coastal and

estuarine areas for about one year and later begin to join adults offshore. Summer flounder typically mature by age 1 with females maturing at 11 inches in total length and males maturing at 10 inches in total length. Summer flounder have a maximum age of 19 years. They like to burrow into sandy substrates and ambush prey such as small fish, crabs, shrimp, squid and worms (Packer 1999).

Stock Status

The 2016 summer flounder stock assessment update included data through 2015 and indicated that the stock was not overfished but overfishing was occurring in 2015. A summer flounder benchmark stock assessment is scheduled for late 2018.

Stock Assessment

The 2016 summer flounder stock assessment update estimated fishing mortality rates and stock sizes using a statistical catch at age model calculated by using the Age Structured Assessment Program. This indicated that overfishing was occurring in 2015 relative to the biological reference points established in the 2013 benchmark stock assessment. Fishing mortality estimates were higher in recent years than previously projected and poor recruitment persisted from 2010 to 2015. However, spawning stock biomass was above the threshold biomass reference point so the stock was not overfished in 2015.

STATUS OF THE FISHERY

Current Regulations

Commercial

There is a 14-inch total length minimum size limit in Atlantic Ocean waters and a 15-inch total length minimum size limit in internal coastal waters as well as harvest seasons and minimum mesh size requirements for the flounder trawl fishery. Trip limits are set for landings windows established by proclamation to constrain harvest to the quota allocation (see most recent North Carolina Division of Marine Fisheries (NCDMF) proclamation on commercial summer flounder fishery). A bycatch trip limit of 100 pounds is in place during the closed trawl season. A license to land flounder from the Atlantic Ocean is required to land more than 100 pounds per trip.

Recreational

There is a 15-inch total length minimum size limit and 4-fish creel limit in the Atlantic Ocean and internal coastal waters.

Commercial Landings

Any landings reported as caught in the Atlantic Ocean are considered to be summer flounder by the North Carolina Trip Ticket Program. Most summer flounder landings were from trawls although gill nets and other gears such as hook and line catch much smaller numbers of summer flounder in the ocean. Landings are constrained by the coastwide quota of which North Carolina has an allocation of 27.4 percent. Landings peaked in 2004 and have been generally stable since

2007 aside from the lowest landings in the time-series in 2012 and 2013 (Figure 1). The low landings in 2012 and 2013 were primarily due to the closure of Oregon Inlet to large vessels (such as trawlers) due to shoaling and the consequent transfer of most of North Carolina's quota allocation to Virginia and other states. In 2014, more winter trawl vessels returned to North Carolina to land catches. Trends in commercial trips have generally followed landings trends (Figure 1). Trips include the number of trip ticket records with landings of summer flounder reported. Trips may represent more than one day of fishing, especially for trawling.

Recreational Landings

Summer flounder harvest is reported through the NCDMF Marine Recreational Information Program. Recreational harvest of summer flounder varied annually but remained relatively high from 1992-2002. After that time, harvest declined and has remained consistently low. This value increased in 2017 (Figure 2).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Several NCDMF sampling programs collect biological data on commercial and recreational fisheries that catch summer flounder. Program 433 (winter trawl fishery) is the primary program that collects length and age data for harvested summer flounder. Other programs that collect information include: 461 (estuarine gill net and seine), 476 (gig and spear), 432 (flounder pound net) and 434 (ocean gill net). Programs 466 (sea turtle bycatch monitoring) and 570 (commercial shrimp trawl fishery characterization) collect length data on harvested and discarded flounder. Recreational fishery sampling for harvest, releases and lengths occurs through the Marine Recreational Information Program. Age data from the recreational fishery are collected through voluntary angler donations of carcasses.

There were no clear trends in commercial length data from 2008-2017 (Table 1). Annual mean lengths were fairly consistent at approximately 500 mm total length. The number of fish measured in 2014 through 2017 was considerably higher than in 2012 and 2013 (due to low landings 2012-2013) but similar to prior years.

There were no clear trends in recreational length data from 2008 to 2017 (Table 2). The mean length in 2017 of 408 mm was similar to prior years. The 2017 maximum length of 619 mm was the largest fish observed in the 10-year time series.

Fishery-Independent Monitoring

Several NCDMF independent sampling programs collect biological data on summer flounder (Table 3). However, most surveys do not catch summer flounder regularly enough to provide consistent length, age or abundance data. The main exception is Program 195 (the Pamlico Sound Trawl Survey), which employs a random stratified survey design in waters of Pamlico Sound and its major river tributaries. Stations are randomly selected from strata based upon depth and geographic location. Randomly selected stations are optimally allocated among the strata based upon all previous sampling in order to provide the most accurate abundance

estimates (PSE <20). Tow duration is 20 minutes; using double rigged demersal mongoose trawls (9.1m headrope, 1.0m X 0.6m doors, 2.2-cm bar mesh body, 1.9-cm bar mesh cod end and a 100-mesh tail bag extension). The survey takes place in June and September with the samples collected in June serving as a juvenile abundance index (JAI) for summer flounder in North Carolina. A total of 559 summer flounder were caught in the survey in 2017 and the JAI value was 5.29 fish per tow. The 1987-2017 average JAI value was 9.11 with data from 1999 being excluded from the average due to sampling occurring in July instead of June (Table 4, Figure 3). The summer flounder JAI from the Pamlico Sound Survey is one of the recruitment indices provided for the annual coastwide stock assessment of summer flounder and was used in the 2016 stock assessment update.

To characterize age structure, summer flounder otoliths are primarily collected from the commercial winter trawl fishery but are also collected from other dependent (recreational) and various independent (scientific surveys) throughout the year. In 2017, 1,179 summer flounder were collected ranging in age from 0 to 19 years (Table 5). The maximum age in 2017 was also the oldest in the time-series. Maximum ages since 2010 were higher than previous years, suggesting expansion of the stock age structure. The number of age samples collected and aged in 2017 was the highest in the time-series.

MANAGEMENT STRATEGY

An update of the summer flounder stock assessment is completed each year by NMFS Northeast Fisheries Science Center (NEFSC). Data are analyzed from the previous year based on decisions made for the previous benchmark assessment. Projections based on stock assessments are used to set the coastwide quota level each year. Amendments to the FMP are undertaken as issues arise that require action. North Carolina has several specific management strategies for summer flounder (Table 6).

RESEARCH NEEDS

The following research needs were reviewed (existing needs) or developed (new) during the 2013 Stock Assessment Workshop by the Southern Demersal Working Group and the MAFMC Scientific and Statistical Committee. Text in parenthesis indicates known progress made to address needs.

- Develop a program to annually sample the length and age frequency of summer flounder discards from the recreational fishery (progress has been made in some states outside NC, but more synoptic data and potentially less biased data are needed including the length, age, and sex-frequency of discards).
- A comprehensive collection of otoliths, for all components of the catch-at-age matrix, needs to be collected on a continuing basis for fish larger than 60 cm (~7 years). The collection of otoliths and the proportion at sex for all the catch components could provide a better indicator of stock productivity (ongoing through NEFSC, NCDMF and other organizations).
- A reference collection of summer flounder scales and otoliths should be developed to facilitate future quality control of summer flounder production aging. In addition, a

comparison study between scales and otoliths as aging structures for summer flounder should be completed (an ageing workshop was held in 2015 to compare scales and otoliths, research is ongoing).

- Collect information on overall fecundity for the stock, as both egg condition and production may be a better indicator of stock productivity than weight (ongoing research by NEFSC Sandy Hook Laboratory to address, may require additional data collection).
- Investigate trends in sex ratios and mean lengths and weights of summer flounder in state agency and federal surveys catches (analyzed for the federal survey, state agency data may still need to be analyzed).
- Use NEFSC fishery observer age-length keys for 1994 and later years (as they become available) to supplement NEFSC survey data in aging the commercial fishery discard (progress unknown - age data may not yet be available).
- Consider use of management strategy evaluation techniques to address the implications of harvest policies that incorporate consideration of retrospective patterns (retrospective pattern has changed since this recommendation was developed - i.e., smaller and less problematic – so this recommendation is no longer considered relevant).
- Consider treating scallop closed areas as separate strata in calculations of summer flounder discards in the commercial fisheries (has not been addressed but may not be an issue in the current discard estimation methods).
- Examine the sensitivity of the summer flounder assessment to the various unit stock hypotheses and evaluate spatial aspects of the stock to facilitate sex and spatially-explicit modeling of summer flounder (progress has been made on aspects of this recommendation, detailed in working papers for 2013 benchmark stock assessment).
- Conduct further research to examine the predator-prey interactions of summer flounder and other species, including food habitat studies, to better understand the influence of these other factors on the summer flounder population (research needed).
- Collect and evaluate information on the reporting accuracy of recreational discard estimates in the recreational fishery (some research has been conducted in the recreational for-hire fishery, but comprehensive work across all fishing modes has not been completed).
- Examine male female ratio at age-0 and potential factors (e.g., environmental) that may influence determination of that ratio (sex ratio was updated, some research completed but more may be needed).
- Evaluate potential changes in fishery selectivity relative to the spawning potential of the stock; analysis should consider the potential influence of the recreational and commercial fisheries (some progress has been made on this topic in a report prepared for the MAFMC Scientific and Statistical Committee describing a management strategy evaluation for the recreational fishery).
- Collect data to determine the sex ratio for all catch components (through a Protogynous Hermaphrodite Modeling Workshop Study, 2 years of data collection has occurred to determine sex ratios in the commercial and recreational landings).
- Determine the appropriate level for the steepness of the S-R relationship and investigate how that influences the biological reference points (some research completed)
- 16).
- Evaluate uncertainties in biomass to determine potential modifications to default overfishing limit CV (progress unknown).

- Evaluate the size distribution of landed and discarded fish, by sex, in the summer flounder fisheries (progress unknown).
- Evaluate past and possible future changes to size regulations on retention and selectivity in stock assessments and projections (progress unknown).
- Incorporate sex -specific differences in size at age into the stock assessment (progress unknown).
- Evaluate range expansion and change in distribution and their implications for stock assessment and management (research ongoing).
- Continued evaluation of natural mortality and the differences between males and females. This should include efforts to estimate natural mortality, such as through mark-recapture programs, telemetry (tagging studies ongoing).
- Further work examining aspects that create greater realism to the summer flounder assessment (e.g., sexually dimorphic growth, sex-specific F, differences in spatial structure [or distribution by size?] should be conducted (progress unknown)

This could include:

- Simulation studies to determine the critical data and model components that are necessary to provide reliable advice, and need to determine how simple a model can be while still providing reliable advice on stock status for management use, and should evaluate both simple and most complex model configurations.
 - Development of models incorporating these factors that would create greater realism.
 - These first steps (a or b) can be used to prioritize data collection, and determine if additional investment in data streams (e.g., collection of sex at age and sex at length and maturity data from the catch, additional information on spatial structure and movement, etc.) are worthwhile in terms of providing more reliable assessment results.
 - The modeling infrastructure should be simultaneously developed to support these types of modeling approaches (flexibility in model framework, MCMC and bootstrap framework, projection framework).
- Develop comprehensive study to determine the contribution of summer flounder nursery area to the overall summer flounder population, based off approaches similar to those developed in WPA12 (otolith microchemistry research ongoing).
 - Develop an ongoing sampling program for the recreational fishery landings and discards (i.e., collect age, length, sex) to develop appropriate age-length keys for ageing the recreational catch (progress unknown).
 - Apply standardization techniques to all state and academic-run surveys, to be evaluated for potential inclusion in the assessment (some progress made).
 - Continue efforts to improve understanding of sexually dimorphic mortality and growth patterns. This should include monitoring sex ratios and associated biological information in the fisheries and all ongoing surveys to allow development of sex structured models in the future (progress unknown).
 - Conduct sensitivity analyses to identify potential causes of the recent retrospective pattern. Efforts should focus on identifying factors in both survey and catch data that

could contribute to the decrease in cohort abundance between initial estimates based largely on survey observations and subsequent estimates influenced by fishery dependent data as the cohort recruits to the fishery (progress unknown).

- Develop methods that more fully characterize uncertainty and ensure coherence between assessments, reference point calculation and projections (progress unknown).

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TABLES

Table 1. Summary of summer flounder length (total length, mm) data for NCDMF commercial fishery sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 507 | 186 | 792 | 27,918 |
| 2009 | 495 | 172 | 788 | 19,808 |
| 2010 | 499 | 217 | 846 | 23,383 |
| 2011 | 492 | 179 | 1,095 | 17,207 |
| 2012 | 503 | 327 | 846 | 7,682 |
| 2013 | 522 | 332 | 794 | 6,452 |
| 2014 | 512 | 236 | 900 | 20,844 |
| 2015 | 503 | 329 | 888 | 28,107 |
| 2016 | 505 | 196 | 817 | 24,277 |
| 2017 | 505 | 194 | 835 | 14,282 |

Table 2. Summary of summer flounder length (total length, mm) data from NCDMF Marine Recreational Information Program

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 399 | 331 | 485 | 88 |
| 2009 | 400 | 330 | 518 | 136 |
| 2010 | 395 | 310 | 550 | 259 |
| 2011 | 412 | 336 | 608 | 213 |
| 2012 | 410 | 283 | 608 | 228 |
| 2013 | 408 | 345 | 584 | 114 |
| 2014 | 398 | 338 | 476 | 137 |
| 2015 | 409 | 351 | 514 | 116 |
| 2016 | 412 | 337 | 529 | 58 |
| 2017 | 408 | 330 | 619 | 129 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SUMMER FLOUNDER

Table 3. Summary of summer flounder length (total length, mm) data for NCDMF fishery-independent sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 159 | 35 | 426 | 1,256 |
| 2009 | 179 | 37 | 490 | 716 |
| 2010 | 156 | 46 | 422 | 770 |
| 2011 | 163 | 39 | 431 | 789 |
| 2012 | 169 | 38 | 456 | 837 |
| 2013 | 154 | 30 | 431 | 1,413 |
| 2014 | 151 | 33 | 484 | 698 |
| 2015 | 168 | 37 | 442 | 526 |
| 2016 | 158 | 36 | 453 | 300 |
| 2017 | 164 | 50 | 426 | 589 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SUMMER FLOUNDER

Table 4. Catch per unit effort (arithmetic mean) for summer flounder in Program 195 (Pamlico Sound Trawl Survey) 1987-2017.

| Year | CPUE (number of fish per tow) | Standard Error |
|------------------------------------|-------------------------------|----------------|
| 1987 | 19.86 | 2.70 |
| 1988 | 2.38 | 0.68 |
| 1989 | 6.93 | 1.17 |
| 1990 | 4.27 | 0.77 |
| 1991 | 5.85 | 1.41 |
| 1992 | 9.14 | 1.71 |
| 1993 | 5.13 | 1.22 |
| 1994 | 8.17 | 1.94 |
| 1995 | 6.65 | 1.65 |
| 1996 | 30.67 | 5.61 |
| 1997 | 14.14 | 3.00 |
| 1998 | 10.44 | 4.32 |
| 1999* | 3.24 | 0.58 |
| 2000 | 3.94 | 0.81 |
| 2001 | 22.03 | 3.31 |
| 2002 | 18.28 | 3.22 |
| 2003 | 7.23 | 1.73 |
| 2004 | 5.90 | 1.32 |
| 2005 | 9.79 | 1.76 |
| 2006 | 1.96 | 0.47 |
| 2007 | 3.62 | 0.67 |
| 2008 | 14.40 | 3.53 |
| 2009 | 4.53 | 1.22 |
| 2010 | 14.28 | 3.72 |
| 2011 | 6.64 | 1.11 |
| 2012 | 9.26 | 2.39 |
| 2013 | 9.80 | 1.92 |
| 2014 | 6.55 | 1.61 |
| 2015 | 3.40 | 0.74 |
| 2016 | 2.76 | 0.64 |
| 2017 | 5.29 | 0.90 |
| 1987-2017 avg. (excludes 1999*) | 9.11 | |
| 2008-2017 avg. | 7.69 | |

*Sampling occurred in July instead of June

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SUMMER FLOUNDER

Table 5. Summary of summer flounder age samples collected from both dependent (commercial and recreational fisheries) and independent (surveys) programs from 2008-2017.

| Year | Age Structure | Mean Age | Minimum Age | Maximum Age | Total Aged |
|------|-----------------|----------|-------------|-------------|------------|
| 2008 | Otoliths/Scales | 5 | 1 | 11 | 751 |
| 2009 | Otoliths/Scales | 5 | 1 | 11 | 723 |
| 2010 | Otoliths/Scales | 5 | 1 | 14 | 783 |
| 2011 | Otoliths/Scales | 6 | 2 | 12 | 417 |
| 2012 | Otoliths/Scales | 5 | 1 | 13 | 541 |
| 2013 | Otoliths/Scales | 5 | 0 | 13 | 610 |
| 2014 | Otoliths/Scales | 5 | 1 | 16 | 1128 |
| 2015 | Otoliths/Scales | 5 | 0 | 17 | 890 |
| 2016 | Otoliths | 5 | 0 | 18 | 998 |
| 2017 | Otoliths | 5 | 0 | 19 | 1179 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – SUMMER FLOUNDER

Table 6. Summary of management strategies by North Carolina for summer flounder.

| Management Strategy | Outcome |
|---|---|
| 14-inch total length (Atlantic Ocean waters) and 15-inch total length (internal coastal waters) minimum size limit for the commercial fishery | Size limit accomplished by rule 3M.0503(a) |
| Minimum trawl stretched mesh size of $\geq 5 \frac{1}{2}$ -inches (diamond) or ≥ 6 -inches (square) throughout the body, extensions and tailbag to not possess more than 100 pounds of flounder (May 1-October 31) or more than 200 pounds of flounder (November 1-April 30) (flynets are exempt from minimum trawl mesh requirements) | Rules 3M.0503(b) 3M.0503(f) 3M.0503(g) 3M.0503(h)(1-3) |
| Licenses to land flounder in Atlantic Ocean and to purchase or offload flounder from the Atlantic Ocean required to possess ≥ 100 pounds | Rules 3M.0503(c)(1-4) |
| Commercial seasons that allocate 80 percent of the quota to the winter season (starting January 1), a bycatch trip limit of 100 pounds during the closed season and the remaining quota allocated to the fall season (starting no earlier than November 1) | Rules 3M.0503(i)(1-3). Rule suspended for 2013 and 2014 fishing seasons. |
| Trip limits established for the open seasons | Rule 3M.0503(j) Specific trip limits by Proclamation Authority |
| 15-inch total length (Atlantic Ocean and internal coastal waters) minimum size and 4 fish creel limit for recreational fishery in all joint and coastal waters | Proclamation FF-4-2017 |

FIGURES

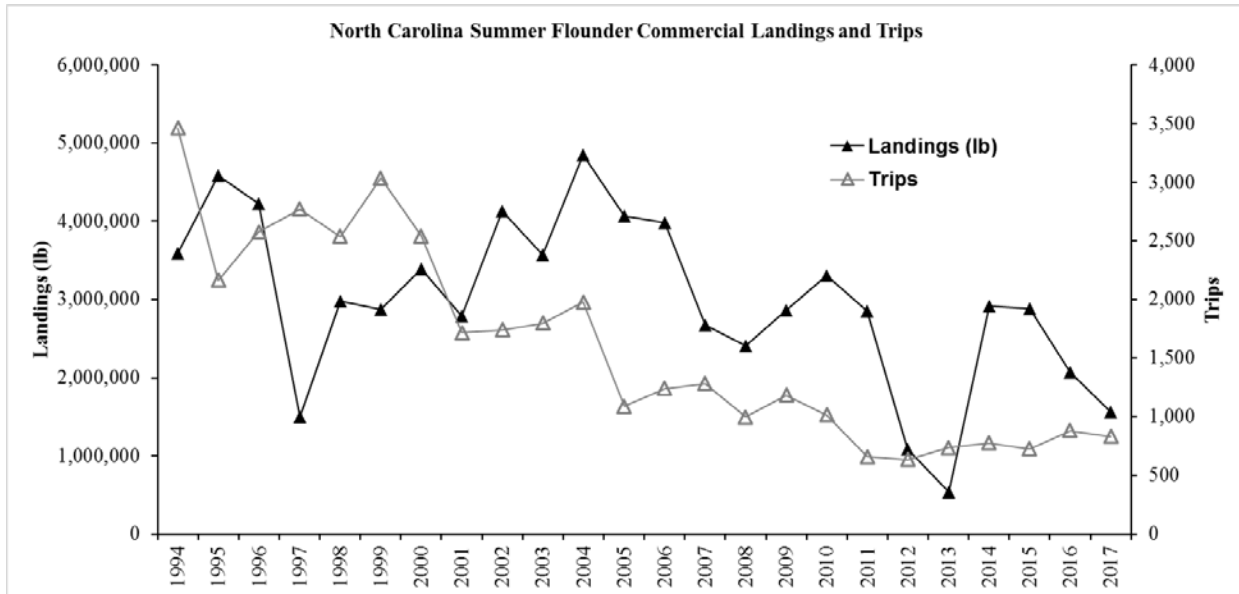


Figure 1. North Carolina commercial landings (total pounds, lb) and trips for summer flounder 1994-2017.

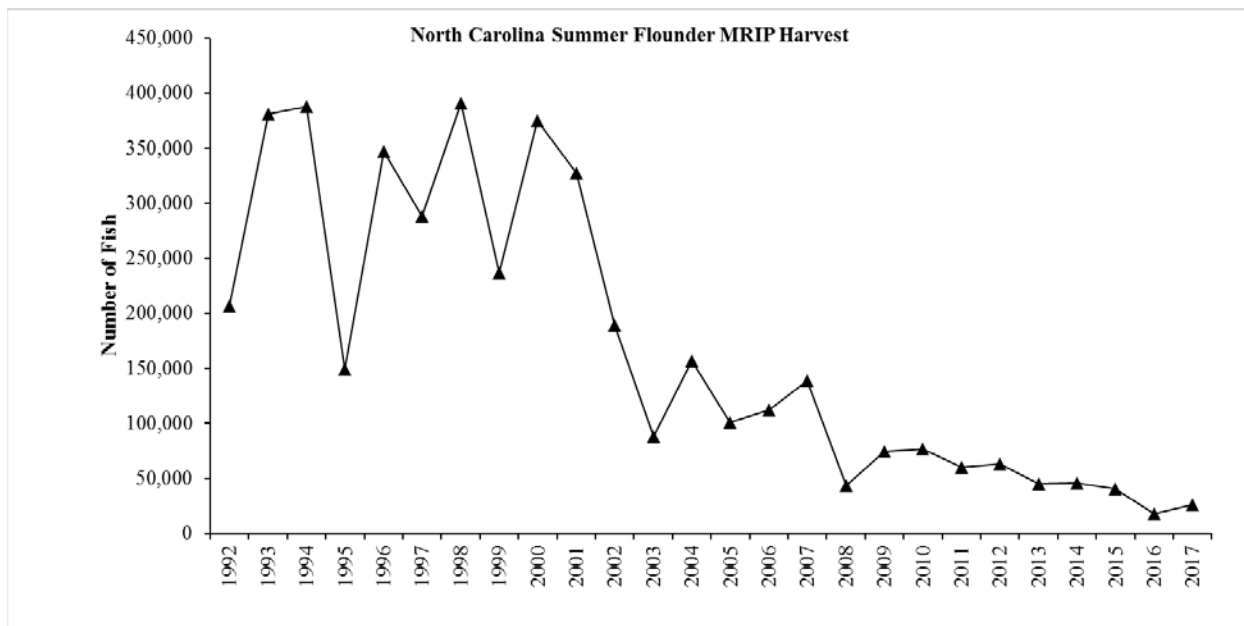


Figure 2. Recreational hook and line harvest (in numbers of fish) of all summer flounder from the NCDMF Marine Recreational Information Program Data 1992-2017.

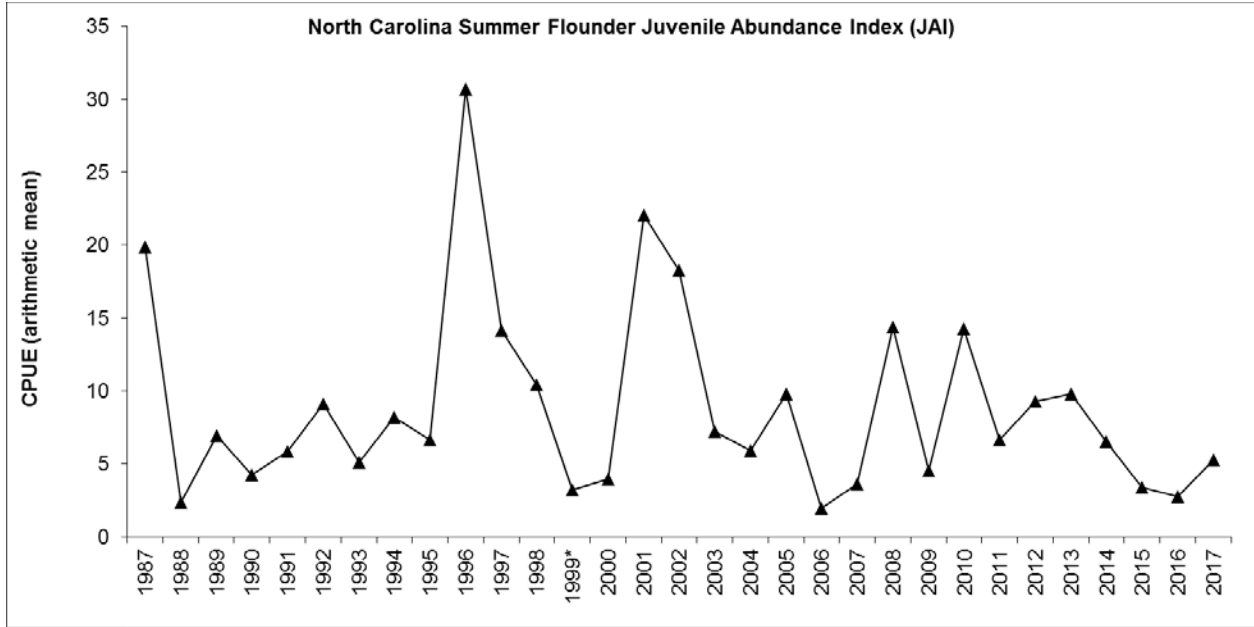


Figure 3. Catch per unit effort (arithmetic mean) for juvenile summer flounder in Program 195 (Pamlico Sound Trawl Survey) 1987-2017.

**FISHERY MANAGEMENT PLAN UPDATE
WEAKFISH
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | ASMFC – October 1985 |
| Amendments: | Amendment 1 – March 1992 Amendment 2 – October 1994 Amendment 3 – May 1996 Amendment 4 – November 2002 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | Assessment update scheduled 2018 |

Weakfish (*Cynoscion regalis*) are managed under Amendment 4 to the Interstate Fishery Management Plan (FMP) for Weakfish (Atlantic States Marine Fisheries Commission (ASMFC) 2002). The ASMFC adopted its first FMP for weakfish in 1985 (ASMFC 1985). Amendment 1 to the FMP (ASMFC 1992) unsuccessfully aimed to improve the status of weakfish. Amendment 2 (ASMFC 1994) resulted in some improvement to the stock, but several signs indicated that further improvement was necessary. Thus, Amendment 3 (ASMFC 1996) was implemented to increase the sustainability of the fishery. Addendum I to Amendment 3 was approved in 2000 in order to extend the existing management program until the Weakfish Management Board could approve Amendment 4.

Weakfish are currently managed under the management program contained in Amendment 4 (ASMFC 2002) and its subsequent addenda. The ASMFC adopted Addendum I to Amendment 4 (ASMFC 2005) to replace the biological sampling program. In response to a significant decline in stock abundance and increasing total mortality since 1999, the Board approved Addendum II to Amendment 4 (ASMFC 2007a) to reduce the recreational creel limit and commercial bycatch limit, and set landings levels that, when met, will trigger the Board to re-evaluate management measures. Addendum III to Amendment 4 (ASMFC 2007b) altered the bycatch reduction device certification requirements of Amendment 4 for consistency with the South Atlantic Fishery Management Council's (SAFMC) Shrimp FMP.

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – WEAKFISH

To ensure compliance with interstate requirements, North Carolina also manages this species 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, SAFMC, 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 similar to the goals of the Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

The findings of the 2009 weakfish stock assessment indicated that weakfish are currently in a severely depleted state with natural mortality (M) rather than fishing mortality (F) believed to be the primary culprit in the decline (ASMFC 2016). In response to the continued decline in the weakfish population, the ASMFC Weakfish Management Board passed Addendum IV to Amendment 4 (2009). This Addendum required all states along the east coast to implement severe harvest restrictions on weakfish.

Harvest restrictions included a one fish daily recreational bag limit and a 100 pound daily commercial trip limit. North Carolina made a request that was approved by the Weakfish Management Board in August of 2010, to implement a 10 percent bycatch allowance for weakfish in lieu of the 100 pound daily trip limit. This request was considered to be conservationally equivalent to the 100 pound daily trip limit. The alternate management action allowed weakfish to be landed provided they make up less than 10 percent of the weight of all finfish landed up to 1,000 pounds per trip or day, whichever is longer. In November of 2012, based on the recommendation of the North Carolina Marine Fisheries Commission (NCMFC), the alternate management was halted and North Carolina reverted back to the 100 pound daily trip limit consistent with Addendum IV. The Weakfish Management Board, as part of Addendum IV, noted that reductions in harvest would not be adequate to rebuild the depleted weakfish stocks until other confounding factors (i.e. natural mortality) become more favorable for weakfish survival. The Board’s actions were taken to reduce harvest and poise weakfish for a recovery.

A new benchmark stock assessment for weakfish was completed in 2016 (ASMFC 2016) and approved for management by the Weakfish Management Board at the 2016 Spring Meeting of the ASMFC. Results from the current assessment still indicate that weakfish are overfished and that continued high levels of natural mortality (M) are the cause of the decline. Fishing mortality (F) has decreased substantially since 2010 and overfishing on the stock is not occurring. The Board reviewed the results of the assessment at their May 2016 meeting and decided that no new management action was warranted. The management program implemented under Addendum IV remains in effect. An assessment update has been scheduled for late 2018.

Management Unit

Weakfish are managed under this plan as a single stock throughout their coastal range. All Atlantic coast states from Massachusetts through Florida and the Potomac River Fisheries

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – WEAKFISH

Commission have a declared interest in weakfish. Responsibility for the FMP is assigned to the ASMFC Weakfish Management Board, Plan Review Team, Technical Committee, Stock Assessment Sub-Committee, and Advisory Panel.

Goal and Objectives

The goal of Amendment 4 of the ASMFC FMP is to utilize interstate management so that Atlantic coastal weakfish recover to healthy levels that will maintain commercial and recreational harvest consistent with a self-sustaining spawning stock and to provide for restoration and maintenance of essential habitat (ASMFC 2002). The management objectives are to:

1. Establish and maintain an overfishing definition that includes target and threshold fishing mortality rates and a threshold spawning stock biomass to prevent overfishing and maintain a sustainable weakfish population;
2. Restore the weakfish age and size structure to that necessary for the restoration of the fishery;
3. Return weakfish to their previous geographic range;
4. Achieve compatible and equitable management measures among jurisdictions throughout the fishery management unit, including states' waters and the federal EEZ;
5. Promote cooperative interstate research, monitoring and law enforcement necessary to support management of weakfish;
6. Promote identification and conservation of habitat essential for the long term stability in the population of weakfish; and
7. Establish standards and procedures for both the implementation of Amendment 4 and for determination of states' compliance with provisions of the management plan.

STATUS OF THE STOCK

Life History

Weakfish, also called gray trout, are known to inhabit waters of the Atlantic from southern Florida to Nova Scotia, Canada but are most prevalent from North Carolina to New York. They are members of the drum family and are closely related to spotted seatrout. Compared to spotted seatrout, weakfish occur in higher salinity areas of the estuary and are seasonally encountered around coastal inlets and in offshore waters. Weakfish migrate into more inshore environments and north along the U.S. Atlantic Coast in the spring and summer as water temperatures rise. Spawning occurs during this time on sandy bottom around oyster beds and deep sandy bottoms around the coastal inlets. Males drum to attract females and spawning activity usually occurs around dusk. Juvenile weakfish use the estuarine waters as a nursery area until the fall when water temperatures drop and they move into the offshore environment. Peak spawning in North Carolina is typically around April or May but females will spawn multiple times (batch spawners) throughout the spring and summer months. Most weakfish are sexually mature by age 1 and at 11 to 12 inches in length. Juvenile weakfish are opportunistic feeders, feeding on invertebrates and microscopic animals early in their life, then switching to mostly piscivorous feeding on small to moderately sized fish, depending on their size.

Stock Status

According to the last stock assessment, completed in 2016, the weakfish stock is depleted and overfishing is not occurring (ASMFC 2016). The stock is considered depleted and has been for the last 13 years. Current SSB levels are well below the recommended minimum threshold (Figure 1).

Stock Assessment

The assessment completed in 2016 employed a new spatially structured forward projecting statistical catch at age model with time-varying natural mortality. This model accounts for varying population spatial distribution and changing natural mortality through time. Results of the assessment show that the weakfish stock is depleted and has been for the past 13 years. Under conditions of time-varying natural mortality, there is no long-term stable equilibrium population size, so an SSB target is not informative for management. After review of the assessment results, the Weakfish Technical Committee (TC) recommended an SSB threshold of 15.2 million pounds that is equivalent to 30 percent of the projected SSB under average natural mortality and no fishing (SSB30%). When SSB is below that threshold, the stock is considered depleted. In 2014, SSB was 5.62 million pounds (Figure 1). The model indicated natural mortality has been increasing since the mid-1990s, from approximately 0.16 at the beginning of the time-series to an average of 0.93 from 2007-2014 (Figure 2). Even though fishing mortality has been at low levels in recent years, the weakfish population has been experiencing very high levels of total mortality which has prevented the stock from recovering. The preferred model does indicate some positive signs in the weakfish stock in the most recent years, with a slight increase in SSB and total abundance; however, the stock is still well below the SSB threshold.

The current stock assessment will be updated in 2018.

STATUS OF THE FISHERY

Current Regulations

The NCDMF allows for the recreational harvest of weakfish seven days a week with a 12-inch total length minimum size and a one fish per day bag limit. The commercial harvest of weakfish is limited to a 100 pounds daily limit and 12-inches total length with the following exceptions: from April 1 through November 15, weakfish 10 inches total length or more may lawfully be taken in North Carolina internal waters by use of long haul seines or pound nets only and commercial flounder trawl and flynet operations are allowed to land a tolerance of no more than 100 undersized (less than 12 inch total length) weakfish per day or trip, whichever is longer and it is unlawful to sell undersized weakfish.

Commercial Landings

Commercial landings of weakfish peaked in 1980 at 20,343,952 pounds. Landings have since steadily dropped and reached their lowest point in 2011 (65,897 pounds; Table 1). Recent years have shown little increase, due to low abundance and commercial harvest restrictions. Total

commercial landings for 2017 were 85,440 pounds. Addendum IV reduced commercial harvest to 100 pounds per trip achieving an estimated reduction of 61 percent from the 2005-2008 harvest levels.

Recreational Landings

Recreational harvest has been variable since 1994 with a peak in 2004 at 244,023 pounds. Harvest since 2009 have decreased considerably due to the implementation of a one-fish bag limit in November 2009 as part of the harvest reductions from Addendum IV, which was estimated to reduce recreational harvest by 53 percent for North Carolina. Average harvest since 2010 is 33,448 pounds and have varied from a high of 46,081 in 2012 to a low of 17,621 in 2011. Recreational harvest in 2017 was 18,708, near the time series low for the period of 2010-2017 (Table 1). A total of 16 recreational citations were issued for weakfish in 2017 (Table 2).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Commercial fish houses are sampled monthly to provide length, weight, and age data to describe the commercial fisheries. The number of weakfish samples has declined in the last 10 years following a similar trend to the commercial landings (Tables 1 and 3). Samples are collected from the ocean fisheries as well as the estuarine fisheries. The ocean sink net fishery and estuarine gill net fishery dominate the catches of weakfish accounting for 93 percent of the overall commercial catch. The pound net fishery and the historically dominant long haul seine fishery account for about five percent of the remaining commercial harvest with various gears including trawls, crab pots, and rod-n-reels making up the rest. Minimum and average lengths of fish harvested in the commercial fishery have remained consistent over the last 10 years (Table 3). The ocean gill net fishery lands smaller fish (average total length = 352 mm) than the estuarine gill net fishery (average total length = 365 mm). The ocean fishery typically targets spot, croaker, and kingfish using smaller mesh than the estuarine fishery and selects for a smaller fish. The difference in selectivity between the two fisheries is notable in the maximum sizes of fish landed from ocean (average maximum size = 575 mm) and estuarine (average maximum size = 718 mm) catches.

Recreational lengths and weights are collected as part of the Marine Recreational Informational Program (MRIP) by recreational port agents. The mean and maximum lengths of weakfish sampled from the recreational fishery are similar in size to fish sampled from the commercial fishery (Table 3).

Fishery-Independent Monitoring

Fishery independent data are collected through both the Program 195 Pamlico Sound Survey and Program 915 Independent Gill Net Survey. The Program 195 survey provides an age-0 index calculated from the September stations and an age-1+ index calculated from the June stations. Both Program 195 indices have been used in the ASMFC stock assessments and show a variable trend over the years (Figures 3 and 4). Program 915 collects information in the Pamlico Sound,

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – WEAKFISH

Pamlico, Pungo, and Neuse rivers, and the Cape Fear and New rivers. The Pamlico Sound portion is used in the ASMFC stock assessment and has shown a declining trend since 2006 (Figure 6). The Pamlico, Pungo, and Neuse rivers survey is not used in the assessment as there are minimal catches of weakfish.

Age samples are collected through both dependent and independent sampling. Age samples are collected from all gears possible and during all months. Target sample numbers are set monthly and the number of samples collected has ranged from 263 to 1,695. Ages have ranged from 0 to 15 years with an average modal age of two years (Table 4; Figure 6).

MANAGEMENT STRATEGY

Weakfish are currently managed under Addendum IV to Amendment 4 of the Weakfish FMP and requires all the Atlantic States to implement a one fish per person bag limit, a 100 pound commercial bycatch trip limit, and a 100 fish undersized trip limit allowance for the trawl fishery. Based off of results from the 2016 assessment, the Weakfish TC recommended that a 30 percent SSB threshold be used as a reference point to determine if the stock is depleted. The TC also noted that there is no long-term stable equilibrium population of weakfish due to time varying natural mortality, so they recommended managing the stock based off Z-based (total mortality) targets and thresholds of 20 percent and 30 percent. Because the total mortality of the stock in the terminal year of the assessment (2014) was below the Z threshold, the TC recommended and the board approved no new management measures at this time.

RESEARCH NEEDS

Biological

High

- Collect catch and effort data including size and age composition of the catch, determine stock mortality throughout the range, and define gear characteristics. In particular, increase length-frequency sampling in fisheries from Maryland north.
- Derive estimates of discard mortality rates and the magnitude of discards for all commercial gear types from both directed and non-directed fisheries. In particular, quantify trawl bycatch, refine estimates of mortality for below minimum size fish, and focus on factors such as distance from shore and geographical differences.
- Conduct an age validation study.
- Identify stocks and determine coastal movements and the extent of stock mixing, including characterization of stocks in over-wintering grounds (e.g., tagging).
- Conduct spatial and temporal analysis of the fishery independent survey data. The analysis should assess the impact of the variability of the surveys in regards to gear, time of year, and geographic coverage on their (survey) use as stock indicators.
- Analyze the spawner recruit relationship and examine the relationships between parental stock size and environmental factors on year-class strength.

Medium

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- Biological studies should be conducted to better understand migratory aspects and how this relates to observed trends in weight at age. Test for individual growth difference and the geospatial pattern, as well as the geospatial pattern of the catch rate surveys.
- Define reproductive biology of weakfish, including size at sexual maturity, maturity schedules, fecundity, and spawning periodicity. Continue research on female spawning patterns: what is the seasonal and geographical extent of "batch" spawning; do females exhibit spawning site fidelity?
- Continue studies on mesh-size selectivity, particularly for trawl fisheries.
- Continue studies on recreational hook-and-release mortality rates, including factors such as depth, warmer water temperatures, and fish size in the analysis. Studies are needed in deep and warm water conditions. Further consideration of release mortality in both the recreational and commercial fisheries is needed, and methods investigated to improve survival among released fish.

Low

- Develop a coastwide tagging database.

Social and Economic

- Assemble socio-demographic-economic data as it becomes available from ACCSP.
- Detailed information on production activities (e.g., fishing effort and labor used by gear, vessel characteristics, areas fished, etc.) and costs and earnings for the harvesting and processing sectors.
- Information on retail sales and demand for weakfish in order to estimate the demand and economic benefits of at-home and away-from home consumption of weakfish.
- Development of bio-economic models that link the underlying population dynamics to the economic aspects of the commercial and recreational fisheries.
- Distribution of weakfish to the various markets and across states.
- Information on the margins of various stages of processing and marketing also need to be obtained; this information is necessary to construct mathematical models that can be used to estimate the economic impacts of management and regulation.
- A directed data collection program for weakfish including the same variables presently collected by National Oceanic and Atmospheric Administration Fisheries in support of MRFSS and by the economic add-on. Data collected includes information on travel distance, mode of angling, expenditures, area fished, catch on previous trips, and other information.
- Development of commercial decision-making or behavioral models to explain how fishers might respond to various regulations.
- Estimation and assessment of consumer (net economic benefits to consumers) and producer (net economic benefits or profits to producers) surplus; the sum of consumer and producer surplus is a measure of the net economic value to society of a good or service.
- Development of input/output models for all states having commercial weakfish activity, or alternatively, full-blown economic impact models, which might consist of input/output models or General Equilibrium models.
- Determination of the economic value derived from recreational angling including the economic value of a catch and release fishery

Habitat

- Conduct hydrophonic studies to delineate weakfish spawning habitat locations and environmental preferences (temperature, depth, substrate, etc.) and enable quantification of spawning habitat.
- Compile existing data on larval and juvenile distribution from existing databases in order to obtain preliminary indications of spawning and nursery habitat location and extent.
- Document the impact of power plants and other water intakes on larval, post larval and juvenile weakfish mortality in spawning and nursery areas, and calculate the resulting impacts on adult stock size.
- Define restrictions necessary for implementation of projects in spawning and over-wintering areas and develop policies on limiting development projects seasonally or spatially.

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TABLES

Table 1. Recreational harvest (number of fish released and weight) and releases (number of fish) and commercial harvest (weight in pounds) of weakfish from North Carolina, 2008-2017.

| Year | Recreational | | Commercial | | Total Weight Harvested (lb) |
|------|--------------|-----------|------------|----------------|-----------------------------|
| | Released | Harvested | Harvested | Harvested (lb) | |
| 2008 | 195,776 | 108,389 | 114,192 | 162,516 | 276,708 |
| 2009 | 220,121 | 68,553 | 89,652 | 163,148 | 252,800 |
| 2010 | 225,246 | 41,598 | 38,721 | 106,328 | 145,049 |
| 2011 | 111,574 | 13,464 | 17,621 | 65,998 | 83,619 |
| 2012 | 173,843 | 40,299 | 46,081 | 91,384 | 137,465 |
| 2013 | 111,524 | 33,851 | 34,731 | 120,191 | 154,922 |
| 2014 | 281,335 | 26,308 | 25,957 | 105,246 | 131,203 |
| 2015 | 520,782 | 39,842 | 50,903 | 80,235 | 131,138 |
| 2016 | 423,482 | 33,585 | 34,860 | 79,640 | 114,500 |
| 2017 | 110,064 | 16,320 | 18,708 | 85,440 | 104,148 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – WEAKFISH

Table 2. Total number of awarded citations for weakfish (>24-inches total length for release or > 5 lb landed) from the North Carolina Saltwater Fishing Tournament from 2008-2017.

| Year | Total Citations | Release Citations ⁺ | % Release |
|------|-----------------|--------------------------------|-----------|
| 2008 | 4 | 0 | 0 |
| 2009 | 3 | 0 | 0 |
| 2010 | 1 | 0 | 0 |
| 2011 | 1 | 0 | 0 |
| 2012 | 2 | 1 | 50 |
| 2013 | 4 | 0 | 0 |
| 2014 | 3 | 0 | 0 |
| 2015 | 2 | 0 | 0 |
| 2016 | 7 | 0 | 0 |
| 2017 | 16 | 0 | 0 |

Table 3. Mean, minimum, and maximum lengths (total length, millimeters) of weakfish sampled from the commercial and recreational fisheries of North Carolina from 2008-2017.

| Year | Commercial | | | | Recreational | | | |
|------|-------------|----------------|----------------|-----------------------|--------------|----------------|----------------|-----------------------|
| | Mean Length | Minimum Length | Maximum Length | Total Number Measured | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 322 | 127 | 668 | 3,185 | 355 | 297 | 519 | 145 |
| 2009 | 333 | 160 | 857 | 2,631 | 383 | 247 | 555 | 132 |
| 2010 | 322 | 130 | 880 | 2,074 | 345 | 235 | 440 | 96 |
| 2011 | 333 | 97 | 637 | 1,701 | 375 | 294 | 780 | 41 |
| 2012 | 350 | 127 | 591 | 2,623 | 367 | 259 | 529 | 81 |
| 2013 | 360 | 202 | 718 | 3,323 | 356 | 192 | 580 | 74 |
| 2014 | 358 | 127 | 620 | 3,322 | 352 | 277 | 515 | 71 |
| 2015 | 356 | 137 | 704 | 2,371 | 373 | 311 | 482 | 34 |
| 2016 | 359 | 220 | 600 | 2,588 | 353 | 261 | 457 | 76 |
| 2017 | 365 | 215 | 717 | 1,197 | 366 | 220 | 432 | 51 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – WEAKFISH

Table 4. Modal age, minimum age, maximum age, and number aged for weakfish collected through NCDMF sampling programs from 1988 through 2017.

| Year | Modal Age | Minimum Age | Maximum Age | Number Aged |
|------|-----------|-------------|-------------|-------------|
| 1988 | 2 | 0 | 6 | 419 |
| 1989 | 2 | 0 | 7 | 356 |
| 1990 | 2 | 1 | 11 | 272 |
| 1991 | 2 | 0 | 5 | 481 |
| 1992 | 2 | 0 | 6 | 597 |
| 1993 | 2 | 0 | 6 | 710 |
| 1994 | 2 | 0 | 7 | 689 |
| 1995 | 3 | 0 | 6 | 1,408 |
| 1996 | 4 | 0 | 6 | 1,695 |
| 1997 | 3 | 0 | 7 | 1,101 |
| 1998 | 3 | 0 | 7 | 703 |
| 1999 | 3 | 0 | 8 | 659 |
| 2000 | 1 | 0 | 9 | 616 |
| 2001 | 2 | 0 | 10 | 630 |
| 2002 | 3 | 0 | 10 | 512 |
| 2003 | 4 | 0 | 8 | 491 |
| 2004 | 2 | 0 | 11 | 589 |
| 2005 | 2 | 0 | 12 | 561 |
| 2006 | 3 | 0 | 7 | 752 |
| 2007 | 2 | 0 | 6 | 560 |
| 2008 | 1 | 0 | 5 | 480 |
| 2009 | 1 | 0 | 15 | 263 |
| 2010 | 2 | 0 | 5 | 507 |
| 2011 | 2 | 0 | 4 | 378 |
| 2012 | 3 | 0 | 4 | 497 |
| 2013 | 2 | 0 | 5 | 546 |
| 2014 | 1 | 0 | 4 | 508 |
| 2015 | 2 | 0 | 4 | 326 |
| 2016 | 1 | 0 | 5 | 570 |
| 2017 | 1 | 0 | 5 | 359 |

FIGURES

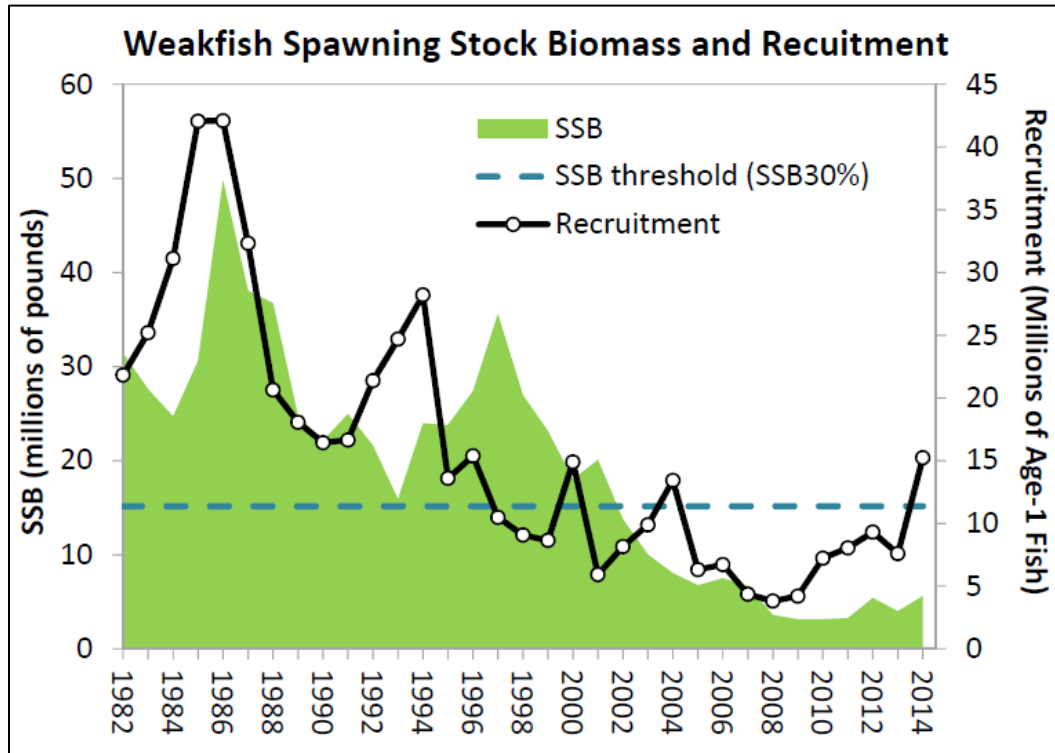


Figure 1. Spawning stock biomass (SSB) and recruitment of age-1 weakfish estimated along the U.S. Atlantic coast from 1982 to 2014 (ASMFC Year). Dashed line represents the 30% spawning stock biomass (SSB) threshold of 15.17 million pounds.

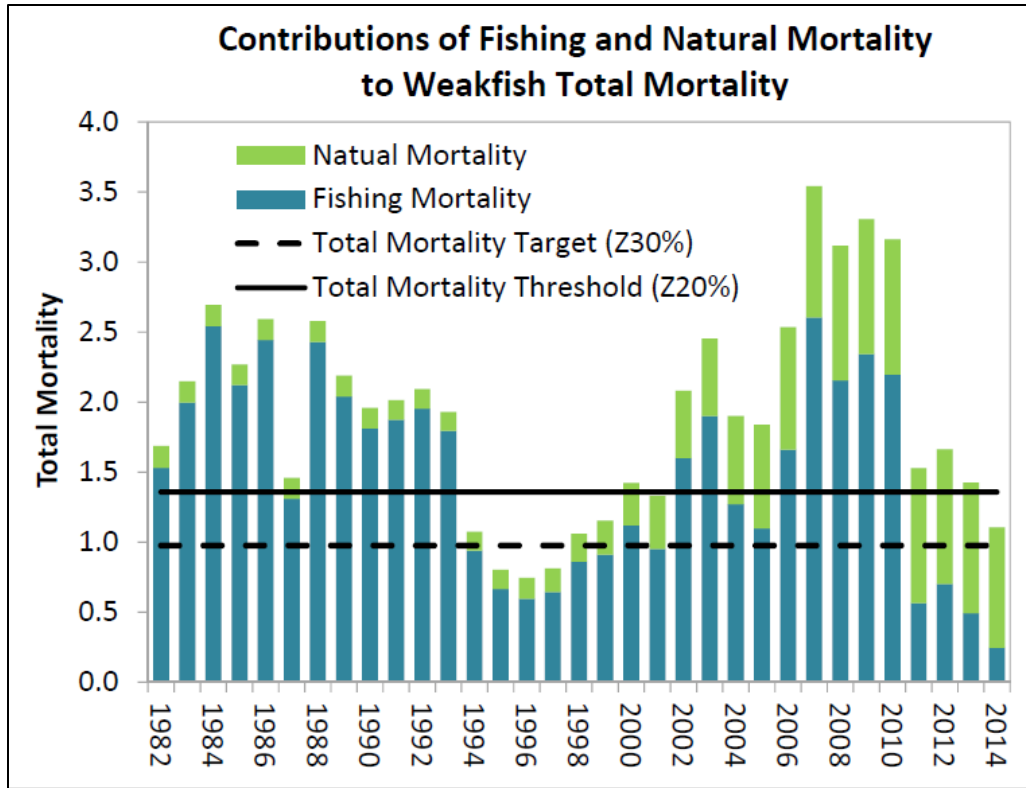


Figure 2. Natural mortality (M) and fishing mortality (F) estimated for all weakfish along the U.S. Atlantic east coast, 1982 to 2014 (ASMFC year). Solid and dashed lines represent total mortality targets (Z30% = 0.93) and thresholds (Z20% = 1.36) used to determine if the stock is being overfished.

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – WEAKFISH

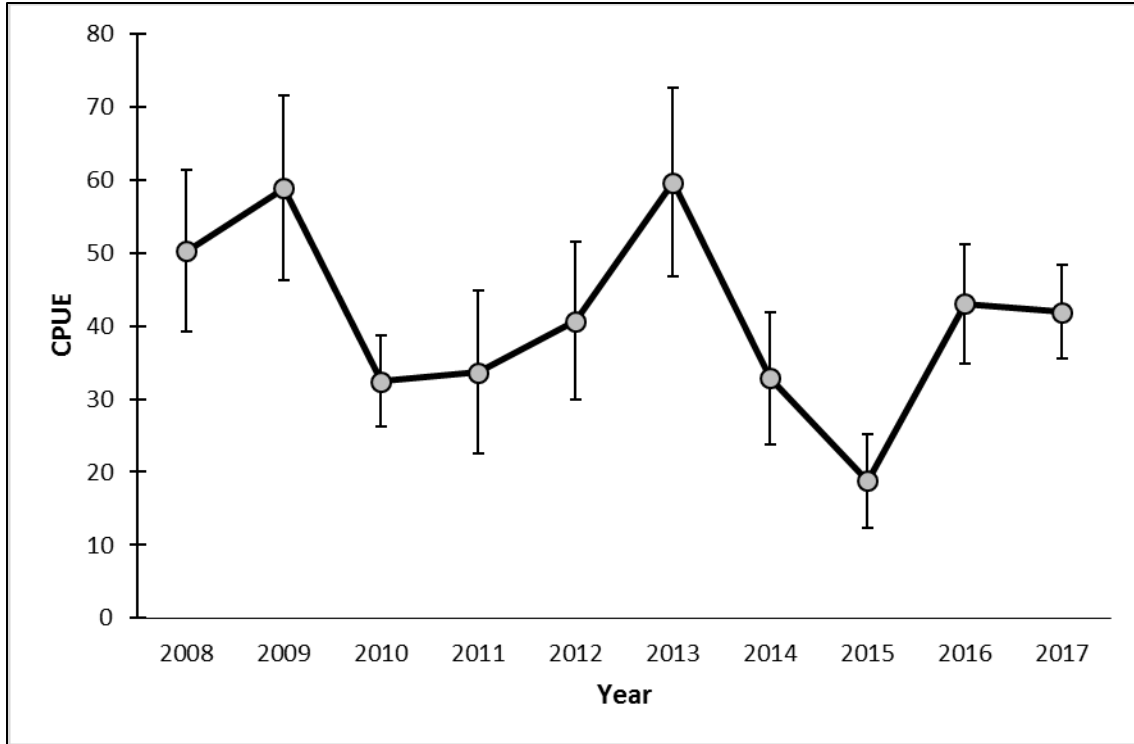


Figure 3. Catch Per Unit Effort (fish per tow) from the Pamlico Sound Survey (Program 195) in North Carolina of Age-0 weakfish collected during September with a total length less than 200 mm from 2008 through 2017. Error bars represent \pm one standard error (SE).

ASMFC AND FEDERALLY-MANAGED SPECIES WITH N.C. INDICES – WEAKFISH

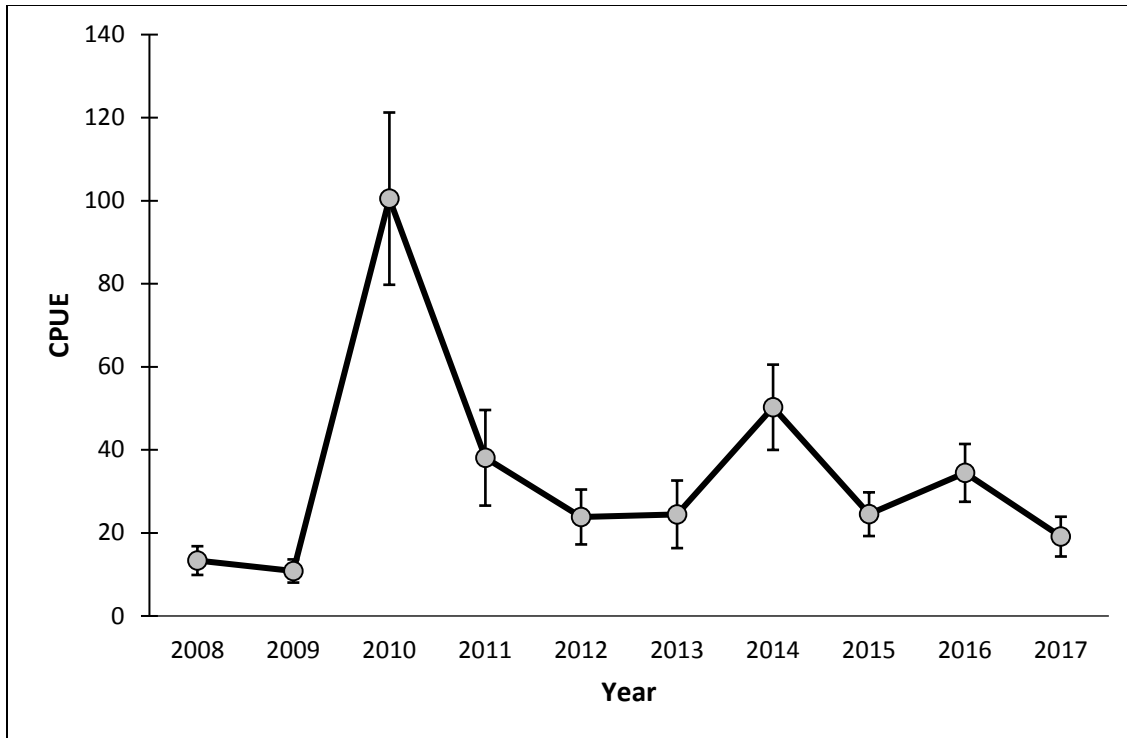


Figure 4. Catch Per Unit Effort (fish per tow) from the Pamlico Sound Survey (Program 195) in North Carolina of Age-1+ weakfish collected during June with a total length greater than 140 mm from 2008 through 2017. Error bars represent \pm one standard error (SE).

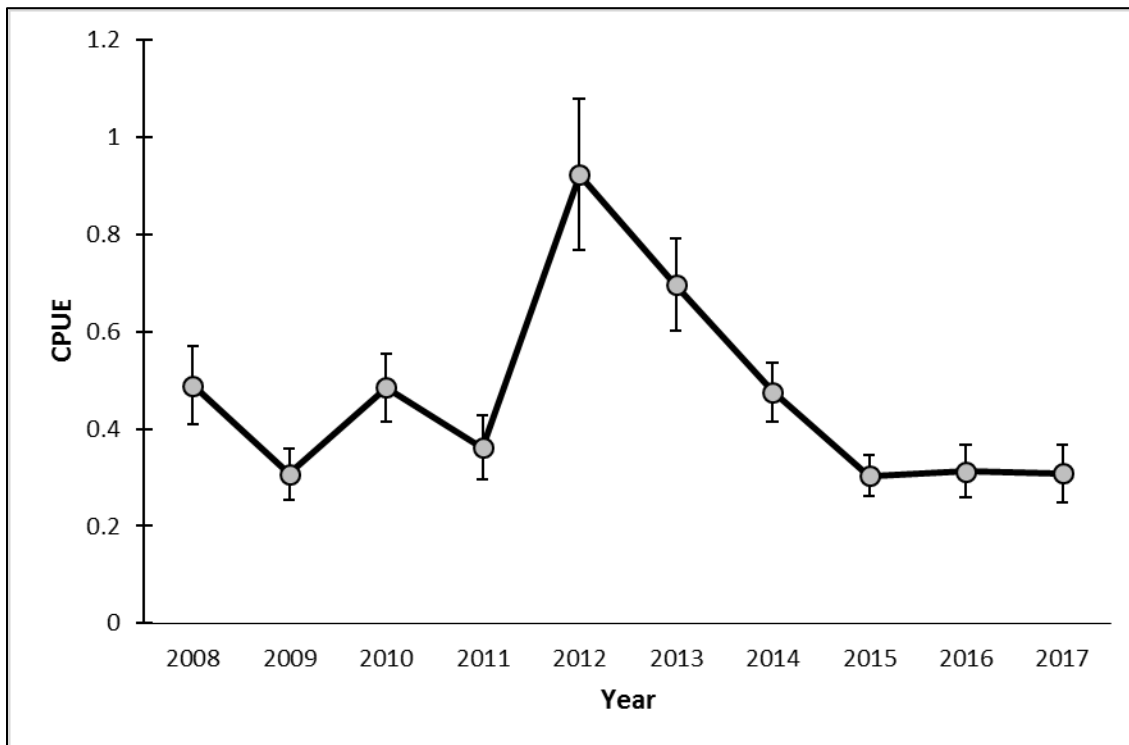


Figure 5. Catch Per Unit Effort (fish per station set) from the Pamlico Sound portion of the Independent Gill Net Survey (Program 915) in North Carolina, 2008 - 2017. Error bars represent \pm one standard error (SE).

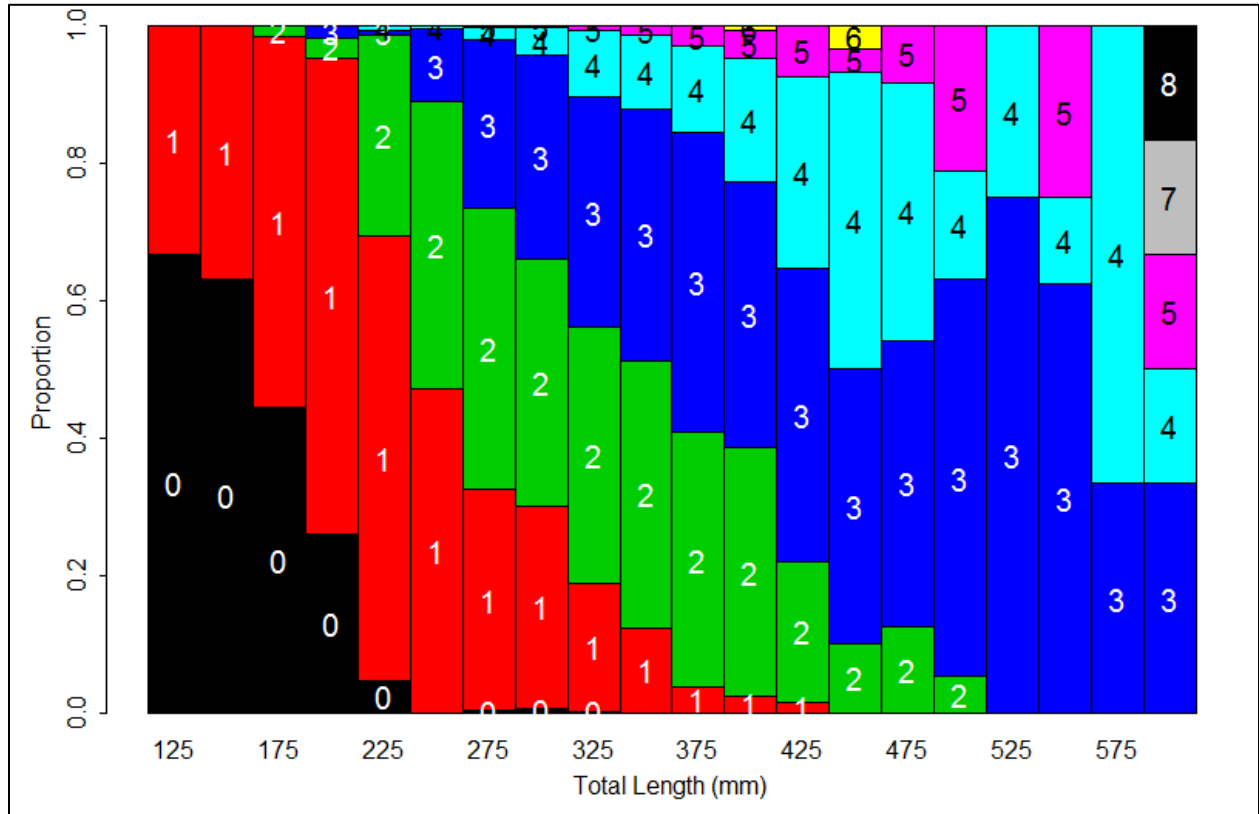


Figure 6. Proportion of ages by size class (25 millimeter size bins) of all weakfish aged from the Independent Gill Net Survey (Program 915) from 2001 - 2017.

**FISHERY MANAGEMENT PLAN UPDATE -
AMERICAN EEL
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | November 1999 Addendum I – February 2006 Addendum II – October 2008 Addendum III – August 2013 Addendum IV – October 2014 |
| Amendments: | None |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | To be determined |

American eel is managed under the Atlantic States Marine Fisheries Commission (ASMFC) Interstate Fishery Management Plan (FMP) for American Eel. The initial FMP was approved in 1999, reviewed and updated in 2006 and 2008. In May 2012, the benchmark American eel stock assessment was completed and accepted for use in management. In 2013 and again in 2014, the FMP was reviewed and updated. In 2017, the 2012 American eel benchmark stock assessment was updated with data from 2010-2016. The FMP implements management measures to protect and enhance the abundance of American eel, while allowing commercial and recreational fisheries to continue.

Addendum I, approved November 2006, required states to establish a mandatory trip-level catch and effort monitoring program, including the documentation of the amount of gear fished and soak time (ASMFC 2006). Addendum II, approved in October 2008, maintained status quo on state management measures and placed increased emphasis on improving the upstream and downstream passage of American eel (ASMFC 2008). In August 2013, Addendum III to the ASMFC Interstate FMP for American Eel was approved for management. This addendum predominately focused on commercial yellow eel and recreational fishery management measures. Addendum III implemented new size and possession limits as well as new pot mesh size requirements and seasonal gear closures (Table 1). Following approval of Addendum III, the ASMFC American Eel Management Board initiated the development of Addendum IV, which

was approved and adopted in October 2014. This addendum addressed concerns and issues in the commercial glass and silver eel fisheries, domestic eel aquaculture, and established a coast-wide catch cap that set up an automatic implementation of a state-by-state commercial yellow eel quota if the catch cap is exceeded. As the second phase of management in response to the 2012 stock assessment, the goal of Addendum IV is to continue to reduce overall mortality and increase overall conservation of American eel stocks. Information about abundance and status at all life stages, as well as habitat requirements, is very limited. The life history of the species, such as late age of maturity and a tendency for certain life stages to aggregate, can make this species particularly vulnerable to overharvest.

To ensure compliance with interstate requirements, North Carolina also manages this species 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) and the Atlantic Coastal Fisheries Cooperative Management Act (ASMFC) are similar to the goals of the N.C. Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

Management Unit

The American eel is managed as a coast wide stock under the ASMFC Interstate FMP for American Eel (ASMFC 2000). The American eel's range extends beyond U.S. borders and more specifically ASMFC member states' territorial waters. However, the management unit is limited to ASMFC member states' territorial waters.

Goal and Objectives

The goal of the ASMFC American Eel FMP is to protect and enhance the abundance of American eel in inland and territorial waters of the Atlantic states and jurisdictions, and contribute to the viability of the American eel spawning population; and provide for sustainable commercial, subsistence, and recreational fisheries by preventing over-harvest of any eel life stage. The following objectives will be used to achieve this goal:

1. Improve knowledge of eel utilization at all life stages through mandatory reporting of harvest and effort by commercial fishers and dealers, and enhanced recreational fisheries monitoring.
2. Increase understanding of factors affecting eel population dynamics and life history through increased research and monitoring.
3. Protect and enhance American eel abundance in all watersheds where eel now occur.

4. Where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.
5. Investigate the abundance level of eel at the various life stages necessary to provide adequate forage for natural predators and support ecosystem health and food chain structure.

STATUS OF THE STOCK

Life History

The American eel is a catadromous species, meaning they are born in saltwater, then migrate into freshwater as juveniles where they grow into adults before migrating back into the ocean to spawn. All American eel comprise one panmictic population, meaning that they are a single breeding population that exhibits random mating. Thus, for example, an American eel from the northern portion of the range could mate with an American eel from the southern portion of the range, and their offspring could inhabit any portion of the range. As a result, recruits to a particular system are likely not the offspring of the adults that migrated out of that system (ASMFC 2000). American eels require multiple habitats including the ocean, estuaries, fresh water streams, rivers and lakes. Its catadromous life cycle requires migration back to the Sargasso Sea (a large portion of the western Atlantic Ocean south of Bermuda and east of the Bahamas) to spawn, while spending most its life in brackish and freshwater river systems from South America to Canada (Facey and Van den Avyle 1987). Larvae develop at sea and change from glass eels (transparent post-larval stage) into elvers (pigmented young eels) in nearshore ocean waters and estuaries (ASMFC 2000). Elvers either remain in the estuary or migrate upstream. At approximately 2 years of age, they change to the yellow eel stage and resemble the adult form (Ogden 1970). This stage, on average, lasts five to 20 years. In the yellow phase, American eels are nocturnal, swimming and feeding at night on a variety of invertebrates and smaller fish, and will also eat dead animal matter. American eels live in a variety of habitats, but they prefer areas where they can hide with soft bottom and vegetation. Female American eels can grow to 5 feet in length, and males usually reach about 3 feet (ASMFC 2000). The mature silver eel life stage occurs at the time of downstream migration, when they leave the estuaries for the Sargasso Sea to spawn then die (Facey and Van den Avyle 1987). This spawning migration occurs annually in the late summer and fall.

Stock Status

According to the 2017 stock assessment update, the American eel population remains depleted in U.S. waters. The stock is at or near historically low levels due to a combination of historical overfishing, habitat loss, food web alterations, predation, turbine mortality, environmental changes, toxins and contaminants, and disease. The assessment updates the 2012 American Eel Benchmark Stock Assessment with data from 2010-2016. Trend analyses of abundance indices indicated large declines in abundance of yellow eels during the 1980s through the early 1990s, with primarily neutral or stable abundance from the mid-1990s through 2016. Total landings remain low but stable. Based on these findings, the stock is still considered depleted. No overfishing determination can be made based on the analyses performed.

Stock Assessment

In May 2016, the American Eel Technical Committee (TC) and Stock Assessment Subcommittee (SAS) determined that there are not enough new data sets or program developments since the last benchmark assessment and therefore recommend doing an update in 2017 and continuing to make progress on the research recommendations to support a benchmark stock assessment in the future.

The 2012 benchmark stock assessment was updated in 2017 with data through 2016. All three trend analysis methods (Mann-Kendall, Manly, and ARIMA) detected significant downward trends in some indices. The Mann-Kendall test detected a significant downward trend in six of the 22 YOY indices, 5 of the 15 yellow eel indices, 3 of the 9 regional indices, and the 30-year and 40-year yellow-phase abundance indices. The remaining surveys tested had no trend, except for two which had positive trends. The Manly meta-analysis showed a decline in at least one of the indices for both yellow and YOY life stages. For the ARIMA results, the probabilities of being less than the 25th percentile reference points in the terminal year for each of the surveys were similar to those in the 2012 stock assessment and currently three of the 14 surveys in the analysis have a greater than 50% probability of the terminal year of each survey being less than the 25th percentile reference point. Overall, the occurrence of some significant downward trends in surveys across the coast remains a cause for concern and the assessment maintained that the stock remains depleted. While it is highly likely the American eel stock is depleted, no overfishing determination can be made now based solely on the trend analyses performed. The overfishing and overfished status in relation to the biomass and fishing mortality reference points cannot be stated with confidence.

STATUS OF THE FISHERY

Current Regulations

New management measures for yellow eels went into effect on January 1, 2014 under North Carolina Marine Fisheries Commission (NCMFC) Rule 15A NCAC 03M .0510. These measures included a nine-inch total length (TL) minimum size limit for both the commercial and recreational fisheries, a new bag limit for the recreational fishery (25 eels / person / day), and crew members involved in for-hire employment are allowed to maintain the current 50 eels / day bag limit for bait purposes. The rule also made the possession of American eels illegal from September 1 through December 31 except when taken by baited pots. NCMFC Rule 15A NCAC 03J .0301 established a ½ by ½ inch minimum mesh size requirement for the commercial eel pot fishery. Eel pots with an escape panel consisting of a 1 by ½ inch mesh are allowed until January 1, 2017.

Commercial Landings

The average commercial landings and value over a 10-year period (2008 – 2017) was 55,014 pounds and \$133,971; in 2017 the commercial landings and value was 20,211 pounds and \$11,839. Commercial American eel landings have fluctuated over the years; in 1979 and 1980

over 900,000 pounds of American eels were landed, however, since the late 1980s American eel landings have averaged less than 100,000 pounds (Figure 1).

Recreational Landings

There are no recreational landings data available for American eels, which are not typically a targeted species. Since American eels are caught incidentally in the estuarine environment by recreational fishermen by hook and line, the Marine Recreational Information Program (MRIP) does not provide reliable harvest data. Also, the survey design of MRIP does not provide information on the recreational harvest of American eel in inland waters. American eels are popular bait for many important recreational fisheries such as striped bass and cobia.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Not Available.

Fishery-Independent Monitoring

Currently, the National Oceanic and Atmospheric Administration (NOAA) conducts the Beaufort Bridgenet Ichthyoplankton Sampling Program (BBISP), a year-round ichthyoplankton survey at Beaufort Inlet, which is used to develop a North Carolina young-of-year relative abundance index for American eel (Figure 2). Because the BBISP is a generally unfunded program, a backlog of unsorted larval fish samples had arisen, and larval fish data were only available from 1987-2010. A N.C. Coastal Recreational Fishing License (CRFL) grant was used to process the backlog, and the resulting data were incorporated into the recently revised and error-checked BBISP database, furthering the BBISP time series to 1985-2013. The BBISP has continued their long-term sampling program and currently there is approximately a three-year backlog of unsorted samples (2014 to 2016). In 2017, new CRFL funds were secured to process the newly generated backlog of post-2013 samples and new data collections through 2019.

The NCDMF has no other fishery-independent monitoring programs specifically for American eel, however, the North Carolina Estuarine Trawl Survey (Program 120) collects information on American eels caught incidentally. American eel catch data from Program 120 were used in the 2012 benchmark stock assessment (Figure 3).

MANAGEMENT STRATEGY

Currently, the commercial yellow eel fishery is regulated through an annual coast wide catch cap set at 907,671 pounds (1998 – 2010 harvest level; ASMFC 2014). Contained within Addendum IV are two management triggers (see below), which, if either trigger is exceeded, there would be automatic implementation of a state-by-state commercial yellow eel quota. The annual coast wide quota is set at 907,669 pounds, with allocations to each state. North Carolina would receive an 11.8 percent allocation (107,054 pounds).

Management Triggers

1. The coastwide catch cap is exceeded by more than 10 percent in a given year (998,438 pounds)
2. The coastwide catch cap is exceeded for two consecutive years, regardless of the percent overage.

In October 2017, the ASMFC American Eel Management Board initiated Draft Addendum V in response to concerns that the current management triggers do not account for annual fluctuations in landings and the immediate implementation of state-by-state quotas would pose significant administrative challenges. Draft Addendum V proposes alternative coastwide landings caps, management triggers, state-by-state allocations, and transfer provisions for the yellow eel commercial fishery; as well as alternatives to the current Maine glass eel commercial quota and the aquaculture provisions of the plan.

RESEARCH NEEDS

The bulleted items listed below identify research needs as described in Addendum III to the American Eel FMP and lists progress made towards accomplishing those objectives.

- Mandatory trip level reporting by life stage, including number or units fished and unit soak time - (Ongoing through the American Eel Logbook Reporting Program)
- Mandatory young-of-year survey in two river systems over a six-week period - (In 2009, funding was cut for the NCDMF YOY survey; however, the NOAA BBISP is currently used for the YOY survey, as approved by the ASMFC American Eel Management Board)
- Mandatory cross-referencing between dealer and fishery reported harvest - (Ongoing through the NC Trip Ticket Program and the American Eel Logbook Reporting Program)
- Development of quantifiable eel habitat enhancement goals through the creation of a coast-wide eel habitat GIS database. The goal of the database would be the generation of coast-wide, regional, state, and watershed maps that would quantify the amount of available habitat relative to historical habitat and identify major barriers to eel migration. This information would allow the ASMFC to prioritize eel habitat enhancement programs at coast-wide, regional, and state scales. Efforts should be coordinated with existing GIS efforts already underway in Canada. Potential funding and coordination with the Atlantic Fish Habitat Partnership should be considered. This project is considered a high priority item and should be completed either prior to the start of the next benchmark stock assessment or in conjunction with the stock assessment - (No Action)
- Work with other appropriate ASMFC committees to develop materials to support states of jurisdictions interested in making recommendations to the Federal Energy Regulatory Commission (FERC) for upstream and downstream fish passage provisions for American eels in the hydropower licensing and relicensing process - (No Action)
- Work with states and jurisdictions to develop a list of non-FERC licensed dams and other impoundments which impact eel movements and migration. The Nature Conservancy recently completed an online, interactive inventory of dams from Maine to Virginia (see: The Northeast Aquatic Connectivity and Assessment of Dams) which could be adapted to meet this goal. An evaluation should be conducted on each general type of impoundment to assess

the potential for eel passage without assistance (i.e. no eel passage constructed) or determine what type of eel passage for each type of impoundment would be most beneficial for all, or specific, life stages. The recommendations from the workshop proceedings (in preparation) from the ASMFC American Eel Passage Workshop held in Gloucester, MA, (March 2011) should be a useful document to assist in the completion of this task - (No Action)

- Develop a timeline and target for 1) the amount of habitat to open through creation of fish passage or dam removal, where feasible and/or 2) the amount of habitat to enhance to increase survival for all, or specific, life stages - (No Action)
- Assess and provide recommendations related to other potential impacts caused by water supply and withdrawal operations, water diversions, and agricultural water use - (No Action)
- Increase coordination with the ASMFC Fish Passage, Habitat, and FERC Guidance Committees. The state marine fisheries agencies should also encourage increased communication and collaboration with their inland fisheries agencies counterparts where applicable. The Commission should also continue the development of a Memorandum of Understanding between the Great Lakes Fisheries Commission, U.S. Fish and Wildlife Service, and NOAA Fisheries in order to reduce mortality on eels throughout their range, as well as improving access to suitable habitat - (No Action)
- Collect biological information by life stage including length, weight, age, and sex of eels caught in fishery-independent sampling programs; at a minimum, length samples should be routinely collected from fishery-independent or fisheries-dependent surveys - (Collecting length of eels caught in independent sampling programs)
- Implement surveys that directly target and measure abundance of yellow- and silver-stage American eels, especially in states where few targeted eel surveys are conducted - (No Action)
- Coast-wide sampling program for yellow and silver American eels should be developed using standardized and statistically robust methodologies - (No Action)
- State marine agencies work with their state inland counterparts, where applicable, to standardize reporting of trip-level landings and effort data that occur in inland waters on diadromous populations of eels - (No Action)

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TABLES

Table 1. Summary of management strategies and their implementation status from Addendum IV and previous Addendums.

| Management Strategy | Implementation Status |
|---|--|
| Establish a Coastwide Cap (907,671 pounds) | Accomplished with Addendum IV |
| Nine (9) inch minimum size limit for both commercial and recreational fisheries. | Accomplished by N.C. Marine Fisheries Commission Rule 15A NCAC 03M .0510 |
| Minimum eel pot mesh size of one-half by one-half inch. | Accomplished by N.C. Marine Fisheries Commission Rule 15A NCAC 03J .0301 |
| Recreational possession limit of 25 eels / person / day. | Accomplished by N.C. Marine Fisheries Commission Rule 15A NCAC 03M .0510 |
| No possession of American eels from September 1 to December 31 unless they are taken with baited pots | Accomplished by N.C. Marine Fisheries Commission Rule 15A NCAC 03M .0510 |
| Mandatory trip level reporting by life stage, including number of units fished and unit soak time. | Accomplished by N.C. G.S. 113-170.3 and the American Eel Logbook Reporting Program where fishermen are notified by letter of the monthly reporting requirement |

FIGURES

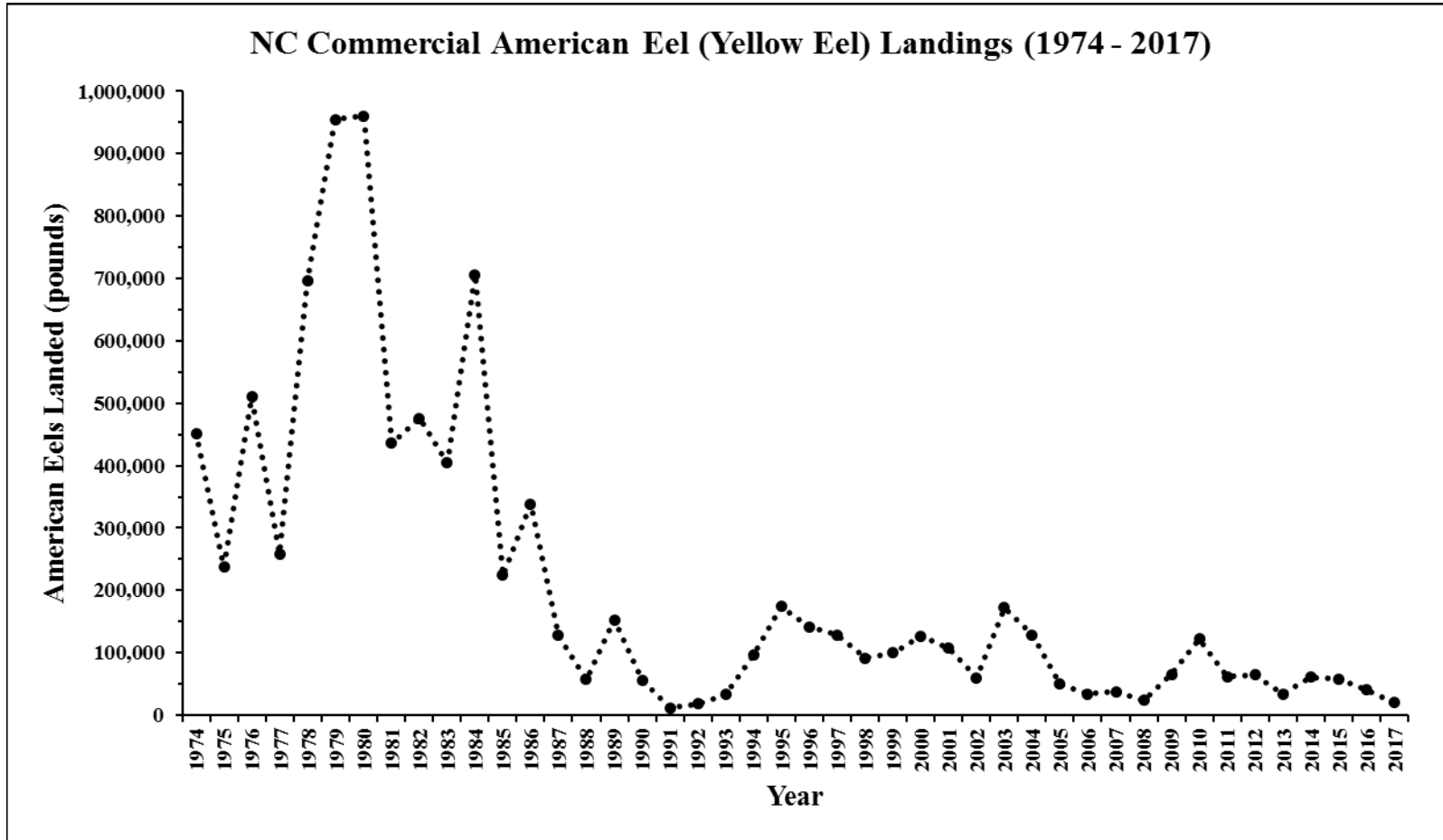


Figure 1. American eel (yellow eel) commercial landings in N.C., 1974 – 2017.

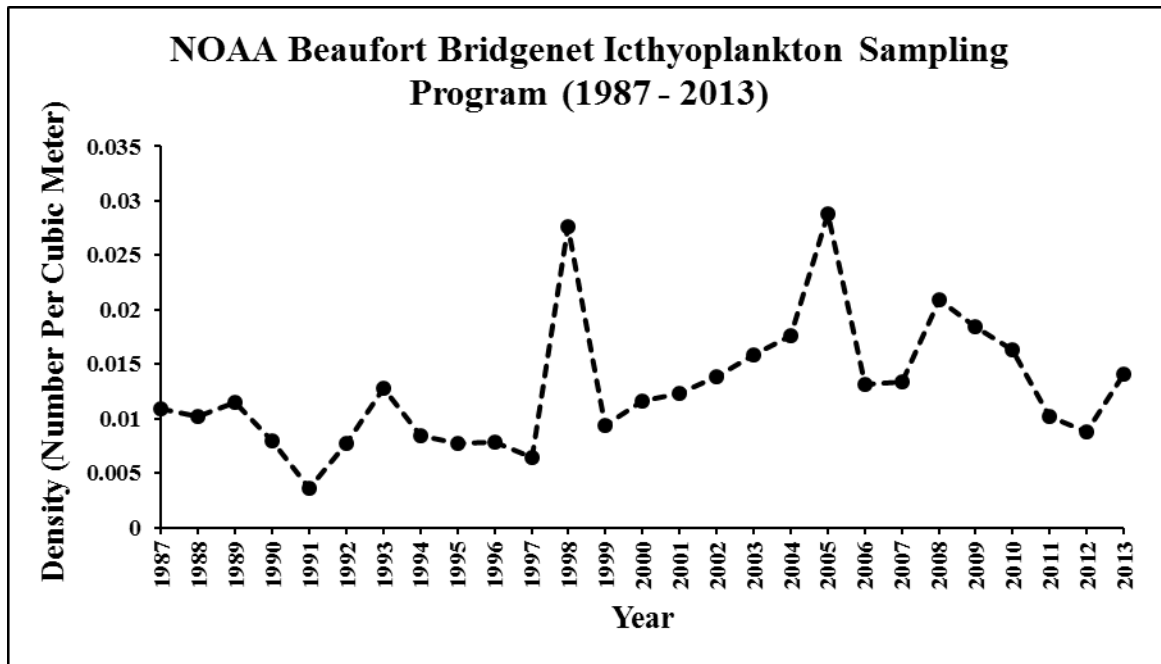


Figure 2. Average annual density (number of larvae per cubic meter) of American eel (glass eel) in the BBISP, 1987 - 2013.

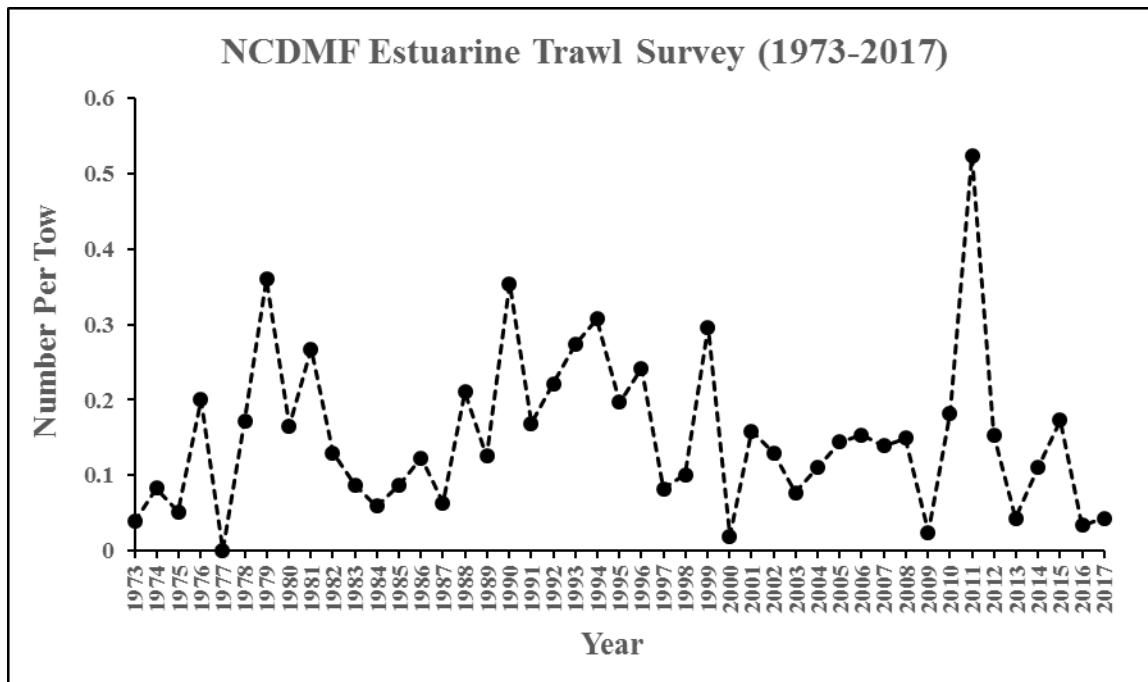


Figure 3. Annual index of relative juvenile (elver) abundance of American eel in the NCDMF Estuarine Trawl Survey, 1973 - 2017.

**FISHERY MANAGEMENT PLAN UPDATE
COBIA
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | February 1983 – SAFMC November 2017 - ASMFC |
| Amendments: | Amendment 1 – September 1985 Amendment 2 – August 1987 Amendment 3 – August 1989 Amendment 5 – August 1990 Amendment 6 – December 1992 Amendment 8 – April 1998 Amendment 11 – December 1999 Amendment 18 – January 2012 Amendment 20b – March 2015 Framework Amendment 4 – September 2017 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | 2020 |

The Gulf of Mexico Fishery Management Council (GMFMC) and the South Atlantic Fishery Management Council (SAFMC) approved and implemented the Fishery Management Plan, Final Environmental Impact Statement, Regulatory Impact Review and Final Regulations for the Coastal Migratory Pelagic Resources (FMP) in 1983 which included all cobia (*Rachycentron canadum*) in the Gulf of Mexico and South Atlantic (GMFMC/SAFMC 1983). This plan managed cobia as one unit stock across the entire jurisdictional area of the GMFMC and SAFMC. The original plan estimated Maximum Sustainable Yield (MSY) of cobia at the time to be 1,057,000 pounds with an estimated domestic harvest of 1,000,000 pounds and set a total allowable level of foreign fishing to zero. The stated management objective for cobia in the plan was to institute management measures necessary to increase yield per recruit and average size and to prevent overfishing. To achieve this, a minimum size limit of 33 inches fork length was established for the fishery conservation zone (FSC), which is analogous to the Exclusive Economic Zone (EEZ) of today which is locally referred to as ‘federal waters’. The FMP was

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first amended in 1985 with the adoption of Amendment 1 which established the fishing year as January 1 through December 31 and clarified that the minimum size limit for cobia is 33 inches fork length or 37 inches total length (GMFMC/SAFMC 1985). This amendment also highlighted the fact that most southeastern states had not yet adopted the recommended minimum size limits for cobia and that populations of cobia in Chesapeake Bay appear to be overfished and that the federal enforcement capability in this case is very limited.

Amendment 2 to the FMP was approved in 1987 and established a permit for charter boats fishing for coastal migratory pelagics (GMFMC/SAFMC 1987a). Amendment 3 (GMFMC/SAFMC 1987b) prohibited drift gill nets as a gear that could be used to harvest coastal pelagic species. Amendment 5 (GMFMC/SAFMC 1990) addressed the issue of average annual catches from 1981-1986 exceeding the established Maximum Sustainable Yield level by 900,000 pounds and defined the overfishing limit for the cobia stock. The stock would be managed using a target level percentage of no less than 20 percent of spawning stock biomass per recruit (SSBR). If the stock was considered overfished then the Science and Statistical Committee (SSC) will develop ranges of Allowable Biological Catch (ABC) that will rebuild the overfished stock. Cobia were added to the annual stock assessment procedures for the councils, and a bag limit of two fish per person per day with a one-day possession limit was established for both commercial and recreational sectors in an effort to control harvest. Amendment 6 (GMFMC/SAFMC 1992) removed the 37-inch total length minimum size specifying that the only minimum size for cobia is 33 inches fork length and changed MSY to 2,200,000 pounds based on results from the mackerel stock assessment panel.

In 1998, Amendment 8 extended the management area for cobia through the Mid-Atlantic Fishery Management Council's (MAFMC) jurisdiction which also extended the two-fish bag limit and 33-inch fork length minimum size limit (GMFMC/SAFMC 1996). Overfishing was defined as a fishing mortality rate greater than a static Spawning Potential Ratio (SPR) threshold of 30 percent and if exceeded, then required that fishing mortality be reduced to rates corresponding to management target levels. Optimum yield (OY) was defined as being equal to MSY. Amendment 11 (SAFMC 1998) redefined OY as the amount of harvest that can be taken by United States fishermen while maintaining the SPR at or above 40 percent of a static SPR. It also redefined the overfishing level as a fishing mortality rate (F) in excess of the F at 30 percent of a static SPR and established a threshold level for all the species in the coastal migratory pelagic unit as 10 percent of the static SPR.

Amendment 18 (GMFMC/SAFMC 2011) separated cobia into two stocks at the jurisdiction boundary between the GSFMC and the SAFMC. The Atlantic stock range was east of the Florida keys through New York. Annual Catch Limits (ACL) were established for both stocks as required under the federal Magnuson-Stevens Act. The ACL for the Atlantic stock was set to 1,571,399 pounds with a 92 percent recreational and eight percent commercial sector allocation. Amendment 20b (GMFMC/SAFMC 2014) modified the stock boundary based on the results of the 2013 stock assessment (SEDAR 28) to the Florida/Georgia line. A new ACL was set at 690,000 pounds for the 2015 fishing season and 670,000 pounds for every year after. Sector allocations were set to 630,000 pounds for the recreational sector for the 2015 season and 620,000 pounds for subsequent years. The commercial allocation was set to 60,000 pounds in 2015 and 50,000 pounds for years following. Accountability Measures (AM) required under the

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federal Magnuson Stevens-Act were established to ensure that ACLs are not exceeded and that stock does not become overfished. Accountability measures require the councils to take action to limit the harvest of the species if an ACL is exceeded. For cobia, the recreational AMs did not allow for in-season closures if the ACL is met or projected to be met rather, measures are to be taken the following season to limit the harvest to keep the three-year running average of landings at or below the ACL. If the total ACL is exceeded, the AMs require that the length of the recreational season the following year be reduced to constrain harvest to the ACL for that year. The commercial AMs require an in-season closure if the commercial ACL is met or projected to be met. If the stock is overfished, and the total ACL is exceeded, then the sector-specific ACL for the following year will be reduced by the appropriate sector-specific overage.

Framework Amendment 4 (SAFMC 2016) to Amendment 20b to the CMP FMP was approved by the council in September of 2016 and the final rule went into effect in September 2017. The amendment increases the recreational minimum size limit of cobia to 36 inches fork length and reduce the bag limit to one fish per person per day and implements a six fish per day vessel limit. The recreational AM were modified to allow for a reduction in vessel limit before a season reduction is implemented. The amendment maintains the existing commercial minimum size limit of 33 inches fork length, and establishes a two fish per person per day or six fish per vessel per day (whichever is more restrictive) commercial trip limit.

The Atlantic States Marine Fisheries Commission (ASMFC) approved the Interstate Fisheries Management Plan for Atlantic Migratory Group Cobia in November of 2017 (ASFMC 2017). The interstate plan compliments Framework Amendment 4 to the Gulf of Mexico and South Atlantic FMP for Cobia and establishes Recreational Harvest Limits (RHL) for the Atlantic states based on the federal recreational and commercial ACLs. The plan provides the states flexibility in management of the species by allowing states to define their own season and vessel limits to constrain harvest to the RHL. At a minimum, states must comply with the size limits and bag limits established in Framework Amendment 4 and not exceed the vessel limits for commercial and recreational vessels. State landings will be evaluated against the RHLs every three years to ensure that management measures are constraining coastwide harvest to the Federal ACLs.

To ensure compliance with interstate requirements, North Carolina also manages this species 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 MAFMC, SAFMC, or the Atlantic States Marine Fisheries Commission 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 (Atlantic States Marine Fisheries Commission plans) are like the goals of the Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

Management Unit

The current management unit for Atlantic cobia is defined in Framework Amendment 4 as all waters north of the Florida/Georgia line through New York from 3 to 200 miles offshore (Figure 1). The interstate plan for cobia extends this management authority into state waters.

Goal and Objectives

The goal of Amendment 20b and Framework Amendment 4 to the FMP is to achieve optimum yield while ensuring regulations are fair and equitable and fishery resources are utilized efficiently. The interstate plan for cobia compliments this goal and further adds the objective of providing a framework of flexibility for states to manage their fisheries under the management measures implemented in Amendment 20b.

STATUS OF THE STOCK

Life History

Cobia is a fast growing and moderately lived (less than 10 years) fish that inhabits nearshore coastal waters from New York to Northern Mexico. They migrate in the spring and fall as water temperatures change from inshore and offshore habitats, as well as up and down the coasts. Spawning occurs in the spring months around inlets and in high salinity estuarine waters. Larval fish settle in the estuaries along the southeast and mid-Atlantic coasts and utilize them as a nursery area. Cobia can grow to as large as 14 inches in their first year of life and move offshore as the water temperatures cool in the fall. Most cobia are mature by age 2 and at 31 inches in length (Smith 1995). Females can spawn multiple times in a season (batch spawners) and can produce millions of eggs in a single year. Cobia can grow as large as 100 pounds but are typically encountered by fisherman in the 25 to 40 pound range (Manooch 1984). Feeding typically occurs on the bottom where they consume fish and crabs, but they have been known to consume prey as large as turtles. Cobia are structure oriented and can be found around channel markers, sea walls and jetties, and larger marine animals such as leatherback sea turtles and rays.

Stock Status

Cobia were last assessed during South East Data, Assessment, and Review (SEDAR) 28 (2013) using data through 2011. Results of the assessment indicate that cobia are not overfished and overfishing is not occurring. However, spawning stock biomass (SSB) was in decline with the terminal year of the assessment approaching the minimum stock size threshold.

Stock Assessment

SEDAR 28 (2013) assessed the Atlantic stock of cobia using data from 1950 - 2011. The data available for cobia included life history information (growth rate, age structure, and age-specific maturity), commercial and recreational landings and discards, commercial and recreational length and age composition, and information on the South Carolina cobia stocking program. Several stock assessment models were considered but the Beaufort Assessment Model (BAM)

was selected by the Assessment Workshop (AW) as the primary assessment model. The BAM uses a statistical catch-at-age formulation which allows for forward-projecting a fish population through time. The base run of the BAM indicated that cobia were not overfished in the terminal year ($SSB_{2001}/MSST = 1.75$; Figure 2) and overfishing was not occurring ($F_{2009-2011}/F_{MSY} = 0.599$; Figure 3). Sensitivity runs of the model confirmed that these values were consistent.

Sources of uncertainty in the assessment included the lack of a fishery-independent index of abundance and the fact that three available indices used in the model were from fishery-dependent sources. Because the fishery operates in such a way that a trip consists of very few fish, the reliability of these indices as a true indicator of the stock is dubious. Also, the spawner-recruit relationship could not be determined and was ultimately fixed at a value agreed upon by the AW. Maximum Sustainable Yield-based management quantities rely heavily on this value so results should be considered with this uncertainty in mind.

The BAM predicted low abundance of cobia in the 1980s followed by high abundance in the 1990s and then another decline in the 2000s (Figure 2). The last strong year class in the model was predicted to have occurred in 2005.

The next benchmark stock assessment for Atlantic Migratory Group cobia (SEDAR 58) was initiated in 2018 with a scheduled completion of 2019. SEDAR 58 began with a stock identification workshop in April 2018 to review spatial, genetic, and life history information the species and make recommendations on stock boundaries for the assessment and management.

STATUS OF THE FISHERY

Current Regulations

Under the Interstate Plan, North Carolina must implement seasons and/or vessel limits that constrain harvest to the 236,313 pound RHL. State landings will be evaluated against the RHL by averaging landings over a three year period. For the 2018 – 2020 fishing years, North Carolina implemented a 36 inch minimum size fork length size limit and a one fish per person per day possession limit with a season from May 1 to December 31. Vessel limits for private vessels are set to two fish per vessel from May 1 – 31 and one fish per vessel from June 1 – December 31. Charter and for-hire vessels may harvest up to four fish per vessel from May 1 – December 31. The commercial fishery is managed under a 33 inch minimum size fork length size limit and two fish per person per day possession limit, not to exceed six fish per vessel. Commercial landings are managed coastwide under the Federal ACL (50,000 pounds).

Commercial Landings

Commercial landings of cobia in North Carolina are available from 1950 to the present. However, monthly landings were not available until 1974. North Carolina instituted mandatory reporting of commercial landings through their Trip Ticket Program, starting in 1994. Landings information collected since 1994 are considered the most reliable. Cobia landings from 1950 - 2017 have ranged from a low of 600 pounds whole weight (1951 and 1955) to a high of 52,684 pounds (2015) with average landings of 16,611 pounds over the 66-year time series. Recently,

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landings have ranged from 19,004 pounds (2007) to 52,684 pounds (2015), averaging 34,858 pounds over the last 10 years (Table 1).

The primary fisheries associated with cobia in North Carolina are the snapper-grouper, coastal pelagic troll, and the large mesh estuarine gill net fisheries. The primary commercial gear used to harvest cobia has changed over time. This is most likely due to changing fisheries and the fact that it is mostly considered a marketable bycatch fishery. From 1950 to the late 1970s, cobia were mostly landed out of the haul seine fishery. Most landings that occurred during the 1980s came from the pelagic troll and handline fishery with modest landings from the haul seine and anchored gill net fishery. From 1994 - 2017, most landings have occurred from the anchored gill net and pelagic troll and handline fishery with gill nets being the top gear during most of those years.

Recreational Landings

Historically, recreational fisherman targeted cobia from a vessel by anchoring and fishing either dead or live bait, or both near inlets and deep water sloughs inshore (Manooch 1984). Fish were also harvested from shore or off piers using dead or live bait, most commonly menhaden. In the early 2000s, fisherman began outfitting their vessels with towers to gain a higher vantage point to spot and target free swimming cobia along tidelines and around bait aggregations. This method of fishing actively targets cobia in the nearshore coastal zone and has become the primary mode of fishing in most parts of the state.

Recreational harvest of cobia in North Carolina from 1983 - 2017 has ranged from a low of zero pounds (1983) to a high of 695,842 pounds (2015) with average landings of 167,826 pounds over the 37-year time series. Recently, landings have ranged from 82,566 pounds (2008) to 695,842 pounds (2015), averaging 300,437 pounds over the last 10-year period (Table 1). Landings during the 1980s and 1990s remained relatively constant from year to year. Landings began to increase and become more variable beginning in the mid-2000s. From 2008 - 2017, recreational cobia landings in North Carolina ranged from 82,566 to 695,842 pounds. Seasonally, cobia are landed mostly in the spring and summer months corresponding with their spring spawning migration (Smith 1995). Peak landings occur during the latter part of May into June and quickly diminish thereafter. However, recreational landings of cobia can occur through the month of October. By fishing mode, most recreational landings of cobia in North Carolina occur from private vessels (73 percent) with charter vessels (14 percent) and shore based modes (13 percent) accounting for the rest (Table 2).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Fishery dependent length-frequency information for the commercial cobia fishery in North Carolina is collected by fish house samplers, specifically through NCDMF programs 438 and 439. Length-frequency information for the recreational cobia fishery is collected through the NCDMF carcass collection program and MRIP. The number of commercial and recreational sampled fish is low and is most likely affected by low possession limits and seasonal nature of

the fishery. Size trends in commercially landed fish appear to correspond with sizes observed in the recreational fishery (Table 2).

Fishery-Independent Monitoring

Currently, the division does not have any fishery-independent sampling programs that target or catch cobia in great numbers.

MANAGEMENT STRATEGY

Cobia is managed under the joint Gulf of Mexico and South Atlantic Fishery Management Council FMP and the ASMFC Interstate Plan requirements. Both plans aim to maintain spawning stock biomass (SSB) above a threshold which allows for surplus recruitment to the stock. To achieve this, a risk adverse approach to management was implemented that attempts to constrain harvest to established Federal ACLs.

RESEARCH NEEDS

Current research needs for cobia can be found in the most recent SEDAR 28 (2013) report and the Interstate Plan (ASMFC 2017). Below is a list of state prioritized research needs based off the recommendations from SEDAR 28, the Interstate Plan, and input from NCDMF lead staff.

- Develop a tagging program and evaluate genetic samples for South Atlantic cobia populations to elucidate the stock boundaries, inshore and offshore migration, and to better identify spawning areas and aggregations of the species.
- Investigate release mortality and fishing mortality within the commercial and recreational fisheries in the U.S. South Atlantic.
- Increase reporting of recreational harvest and better characterize the recreational and for-hire fisheries.
- Develop fishery-independent sampling programs to obtain estimates of cobia abundance.
- Better characterize the life history of cobia including; age sampling of the recreational sector, update age- and length-at-maturity, batch fecundity, spawning seasonality, and spawning frequency information.

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TABLES

Table 1. Recreational harvest (number of fish released and weight) and releases (number of fish; MRIP) and commercial harvest (weight in pounds; N.C. Trip Ticket Program) of cobia from North Carolina, 2008-2017.

| Year | Recreational | | Commercial | | Total Weight Harvested (lb) |
|------|-------------------------|-----------------------|-------------------------|-----------------------|-----------------------------|
| | Number of fish Released | Weight (lb) Harvested | Number of fish Released | Weight (lb) Harvested | |
| 2008 | 8,008 | 2,136 | 22,047 | 82,566 | 104,613 |
| 2009 | 16,527 | 5,754 | 31,898 | 166,195 | 198,093 |
| 2010 | 19,180 | 15,125 | 43,715 | 498,581 | 542,296 |
| 2011 | 12,282 | 4,478 | 19,924 | 145,796 | 165,720 |
| 2012 | 13,917 | 2,050 | 31,972 | 104,106 | 136,078 |
| 2013 | 14,638 | 19,224 | 35,456 | 506,067 | 541,523 |
| 2014 | 10,530 | 9,804 | 41,798 | 247,386 | 289,184 |
| 2015 | 17,409 | 16,166 | 52,684 | 695,842 | 748,526 |
| 2016 | 14,707 | 9,293 | 48,244 | 298,090 | 346,334 |
| 2017 | 51,142 | 7,308 | 20,842 | 259,737 | 280,579 |

Table 2. Mean, minimum, and maximum lengths (total length, mm) of cobia sampled from the recreational (MRIP) and commercial fisheries (NCDMF fish house sampling programs) from North Carolina, 2008-2017.

| Year | Recreational | | | | Commercial | | | |
|------|--------------|-------------|----------------|----------------|-----------------------|----------------|----------------|-----------------------|
| | Mean Length | Mean Length | Minimum Length | Maximum Length | Total Number Measured | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 1,122 | 862 | 128 | 1,460 | 51 | 855 | 1,393 | 5 |
| 2009 | 1,025 | 906 | 322 | 1,116 | 27 | 846 | 1,295 | 8 |
| 2010 | 1,085 | 1,088 | 859 | 1,332 | 40 | 579 | 1,511 | 58 |
| 2011 | 1,017 | 860 | 296 | 1,165 | 24 | 364 | 1,739 | 21 |
| 2012 | 1,236 | 1,095 | 289 | 1,268 | 61 | 832 | 1,564 | 11 |
| 2013 | 978 | 805 | 221 | 1,210 | 37 | 313 | 1,259 | 34 |
| 2014 | 997 | 886 | 290 | 1,350 | 44 | 839 | 1,474 | 41 |
| 2015 | 1,126 | 951 | 390 | 1,223 | 43 | 820 | 1,473 | 63 |
| 2016 | 1,104 | 807 | 291 | 1,305 | 21 | 888 | 1,508 | 48 |
| 2017 | 1,122 | 727 | 178 | 1,170 | 19 | 915 | 1,473 | 24 |

FIGURES

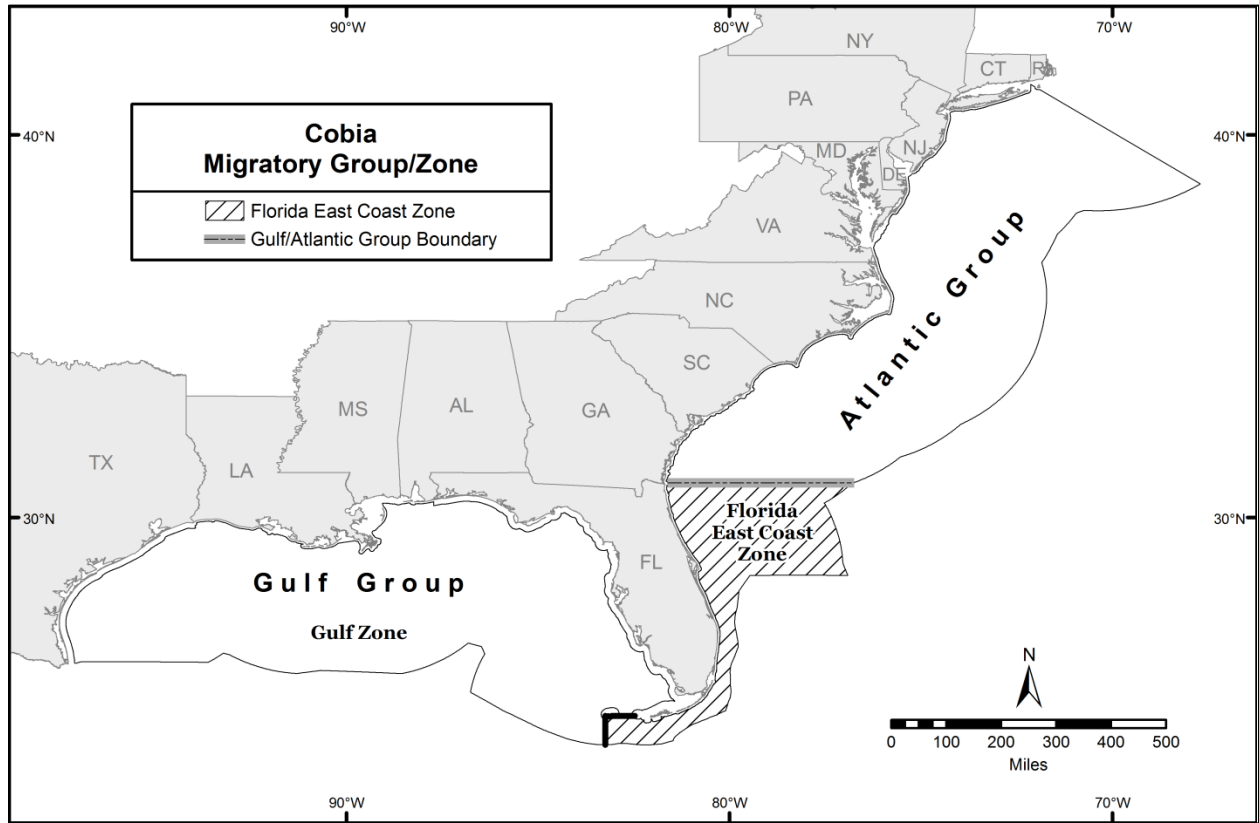


Figure 1. Zone splits for Gulf and Atlantic Migratory Group cobia established in Coastal Migratory Pelagics FMP Amendment 20b (GMFMC/SAFMC 2014).

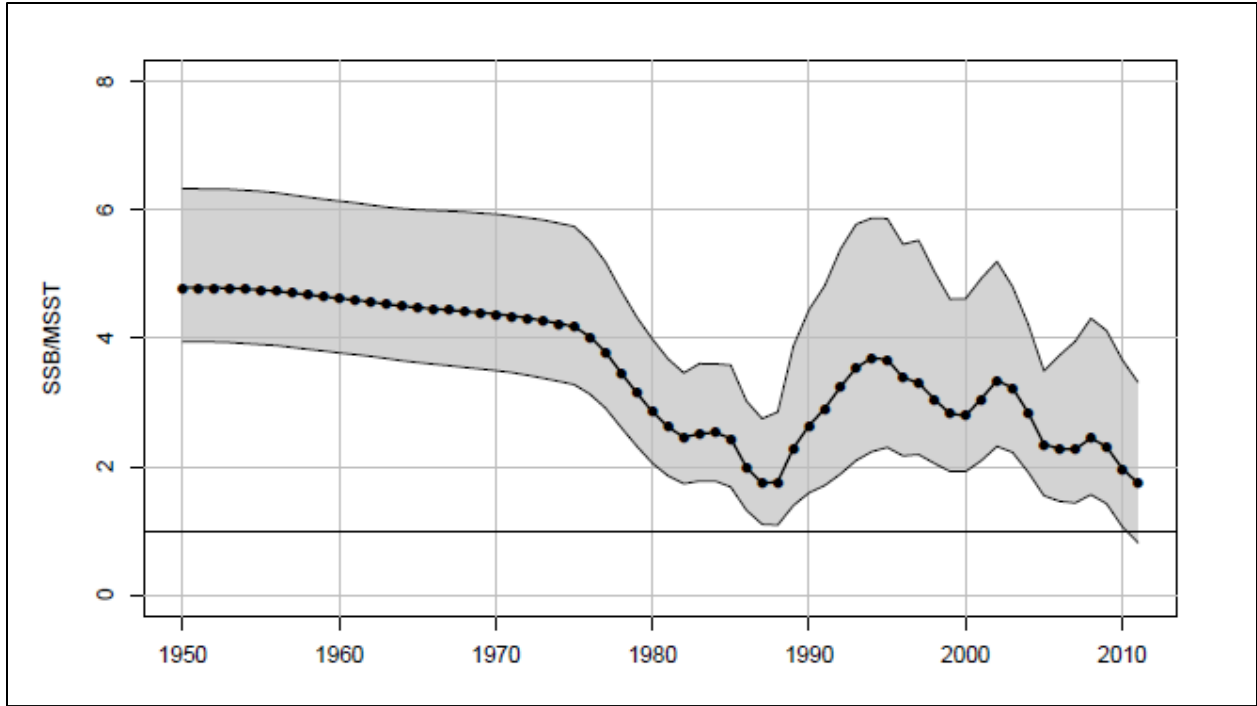


Figure 2. Spawning Stock Biomass (SSB) relative to Minimum Stock Size Threshold (MSST) for cobia from SEDAR 28 (SEDAR 2013).

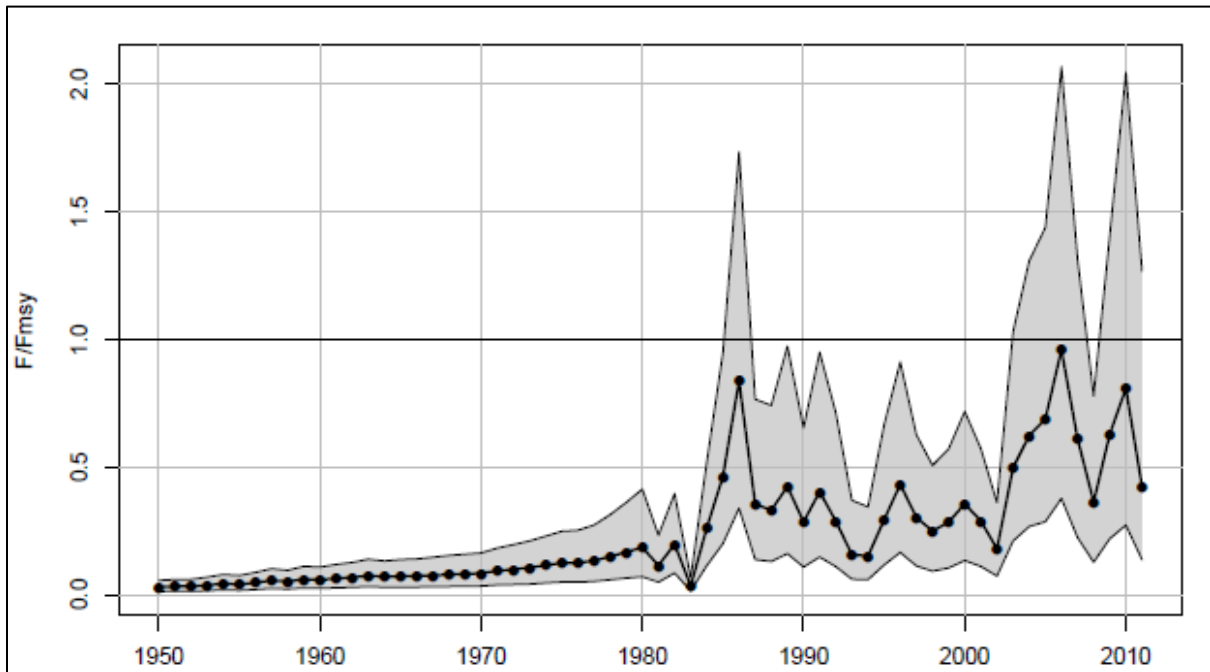


Figure 3. Fishing mortality (F) relative to Fishing mortality at maximum sustainable yield (F_{MSY}) for cobia from SEDAR 28 (SEDAR 2013).

**FISHERY MANAGEMENT PLAN UPDATE
DOLPHIN
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | June 2004 |
| Amendments: | Amendment 1 – July 2010 Amendment 2 – April 2012 Amendment 3 – August 2014 Amendment 5 – July 2014 Amendment 6 – January 2014 Amendment 7 – January 2016 Amendment 8 – February 2016 Regulatory Amendment 1 – March 2017 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | None |

The South Atlantic Fishery Management Council (SAFMC), in cooperation with the Mid-Atlantic and New England Councils, developed a Dolphin/Wahoo Fishery Management Plan (FMP) for the Atlantic in 2004. While dolphin was not overfished, the Council adopted a precautionary and risk-averse approach to management for this fishery. The original FMP established a 20-inch fork length minimum size limit off Georgia and Florida; identified allowable gears in the fishery; and prohibited the use of longline gear to harvest dolphin in areas closed to use of such gear for highly migratory species. Amendment 1 (2010) provided spatial information of Council-designated Essential Fish Habitat and Habitat Areas of Particular Concern relative to the dolphin wahoo fishery. Amendment 2 (SAFMC 2011) established Allowable Biological Catch (ABC), Annual Catch Limits (ACL), Accountability Measures (AM), and modified the allocations for both commercial and recreational sectors; established Annual Catch Targets (ACT) for the recreational sector; prohibited bag limit sales of dolphin from for-hire vessels; and established a minimum size limit of 20 inches fork length for South Carolina. Amendment 3 (SAFMC 2014, 79 F.R. 19490) required federal dealer permits, and changed the method and frequency of reporting harvest. Amendment 4 (in progress) would change the method of reporting commercial harvest of dolphin through the existing logbook program and is included under the Joint Generic Commercial Logbook Reporting Amendment.

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – DOLPHIN

In 2013, Amendment 5 (SAFMC 2013) was approved and adopted by the SAFMC and was the most comprehensive amendment to the Dolphin/Wahoo FMP, in terms of process updates. Amendment 5 updated the ACLs and AM for both sectors, as well as the ABC values and ACT for the recreational fishery as a result of improvements to the recreational catch estimation methods used by the Marine Recreational Information Program. This amendment also set up an abbreviated framework procedure whereby modifications to the ACLs, ACTs, and AMs can be implemented by the National Oceanic and Atmospheric Administration (NOAA) Fisheries without a full FMP amendment. Amendment 7 (SAFMC 2015a) allowed for dolphin and wahoo fillets to enter the U.S. EEZ after lawful harvest in the Bahamas. Amendment 8 (SAFMC 2015b) adjusted sector allocations and increased the commercial ACL to 10 percent of the total ACL. Regulatory Amendment 1 (SAFMC 2016), effective March 2017, establishes a commercial trip limit for vessels with an Atlantic dolphin/wahoo permit of 4,000 pounds for the dolphin commercial sector once 75 percent of the commercial ACL is landed. This regulatory change was pursued after the 2015 commercial ACL was met and commercial harvest was closed in late June of that year.

To ensure compliance with interstate requirements, North Carolina also manages this species 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, SAFMC, or the Atlantic States Marine Fisheries Commission 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 (Atlantic States Marine Fisheries Commission plans) are, like the goals of the Fisheries Reform Act of 1997, to “ensure long-term viability” of these fisheries (NCDMF 2015).

Management Unit

The management unit is the population of dolphin (common dolphin - *Coryphaena hippurus* and pompano dolphin - *Coryphaena equiselis*) from the U.S. South Atlantic, the Mid-Atlantic, and the New England coasts in the 3 to 200-mile Exclusive Economic Zone (EEZ).

Goal and Objectives

The goal of the plan is to maintain the current harvest levels of dolphin and ensure that no new fisheries develop (SAFMC 2003). With the potential for effort shifts in the historical commercial longline fisheries for sharks, tunas, and swordfish, these shifts or expansions into nearshore coastal waters to target dolphin could compromise the historical (1994-1997) and current allocation of the dolphin resource between recreational and commercial fishermen. To achieve these goals, the following management objectives were identified:

1. Address localized reduction in fish abundance. The Councils remain concerned over the potential shift of effort by longline vessels to traditional recreational fishing grounds and the resulting reduction in local availability if commercial harvest intensifies.

2. Minimize market disruption. Commercial markets (mainly local) may be disrupted if large quantities of dolphin are landed from intense commercial harvest or unregulated catch and landing by charter or other components of the recreational sector.
3. Minimize conflict and/or competition between recreational and commercial user groups. If commercial longlining effort increases, either directing on dolphin and wahoo or targeting these species as a significant bycatch, conflict and/or competition may arise if effort shifts to areas traditionally used by recreational fishermen.
4. Optimize the social and economic benefits of the dolphin fishery. Given the significant importance of dolphin to the recreational sector throughout the range of these species and management unit, manage the resources to achieve optimum yield on a continuing basis.
5. Reduce bycatch of the dolphin fishery. Bycatch is a problem in the pelagic longline fishery for highly migratory species. Any increase in overall effort, and more specifically shifts of effort into nearer shore, non-traditional fishing grounds by swordfish and tuna vessels, may result in increased bycatch of non-target species. In addition, National Standard 9 requires that: “Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.” Therefore, bycatch of the directed dolphin fishery must be addressed.
6. Direct research to evaluate the role of dolphin and wahoo as predator and prey in the pelagic ecosystem.
7. Direct research to enhance collection of biological, habitat, social, and economic data on dolphin and wahoo stocks and fisheries.

STATUS OF THE STOCK

Life History

Dolphin, also called mahi-mahi, dorado or common dolphin, are pelagic marine species and can be found worldwide in tropical and subtropical waters. They are sight feeders and usually live in the top 50 feet of the water column. They gather around floating debris and flotsam and prefer water temperatures ranging from 21 – 30 degrees Celsius (70 - 86 degrees Fahrenheit). Adult male and female fish are commonly referred to as ‘bulls’ and ‘cows’ respectively, because of their different shapes and appearance. Mature male dolphin have a high, flat forehead unlike females. The species is short lived (maximum age is 4) and grows rapidly, with some fish reaching lengths of 36 inches by age-1 (Schwenke et al. 2008). The state record for dolphin was caught off Cape Hatteras in 1993 and weighed 79 pounds; however, most fish landed in North Carolina weigh between 5 and 25 pounds. Dolphin can become sexually mature by four months and as small as 14 inches with most fish maturing by 24 inches (Schwenke et al. 2008). They are considered batch spawners, meaning that they will spawn many times throughout the spawning season, maximizing the survival of larval fish. Spawning occurs offshore of North Carolina

around floating grass (brown algae known as Sargassum) and debris during the spring and summer months. In tropical areas, dolphins have been known to spawn year-round.

Stock Status

A surplus production model was fit to abundance indices estimated from long line catches and total landings of the fisheries from years 1985 to 1997. It was concluded that the stock status, as of 1998, was above biomass at maximum sustainable yield (B_{MSY}) and that the species can withstand a relatively high rate of exploitation (Prager 2000).

Stock Assessment

No formal assessment has been conducted on dolphins in the U.S. Atlantic due to uncertainties in the extent of the North Atlantic stock, the life history characteristics of the species, lack of fishery independent indices, and the jurisdictional cooperation necessary to characterize catch across the range of the species. An assessment of dolphins is not expected in the next five years through the Southeast Data, Assessment, and Review (SEDAR) process.

STATUS OF THE FISHERY

Current Regulations

The North Carolina Division of Marine Fisheries (NCDMF) currently complements the management measures of the Dolphin/Wahoo FMP through rule (15A NCAC 03M .0515) and proclamation (15A NCAC 03M 0512). It is unlawful to possess more than 10 dolphins per person per day or more than 60 dolphins per vessel per day. Headboats are excluded from the vessel limit requirement. It is also unlawful to sell a recreational bag limit of dolphins harvested by a person on a vessel while it is operating as a charter vessel or headboat or to sell dolphins without a Federal Commercial Dolphin/Wahoo vessel permit. There is no trip limit for vessels that possess the Federal Commercial Dolphin/Wahoo vessel permit unless 75% of the commercial ACL is reached, at which time a 4,000-pound round weight trip limit is implemented. Commercial vessels that are federally permitted in another fishery are allowed to land up to 200 pounds of dolphins and wahoo combined.

Commercial Landings

Commercial landings of dolphins are reported through the mandatory Trip Ticket reporting program. Landings have fluctuated over the last 10 years with a high of 611,962 pounds in 2009 and a low of 94,210 pounds in 2011 (Table 1 and Figure 1). Over 75 percent of dolphin landings were harvested using surface longlines with the remainder of the harvests coming from the pelagic troll and greenstick fisheries.

Recreational Landings

Recreational landings of dolphins are estimated from the Marine Recreational Information Program (MRIP) through dockside sampling and phone effort surveys. Landings of dolphins have

declined over the last 10 years with a high of 4,960,343 pounds in 2007 and a low of 1,329,353 pounds in 2014 (Table 1 and Figure 2). Directed effort in the fishery and recreational harvest show similar trends and most likely contributes to the variable landings observed in the fishery.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Fishery dependent length-frequency information for the commercial dolphin fishery in North Carolina is collected by fish house samplers, specifically through NCDMF programs 438 and 439. Size trends in landed fish appear to correspond with varying levels of commercial harvest (Table 1 and 2). The average size of dolphin sampled from the commercial fishery decreased for 2017 (634 mm total length) and was below the 10-year average (731.5 mm total length; Table 2). The maximum size of dolphin sampled from the commercial fishery decreased in 2017 (947 mm total length) and was the lowest observed in the 10-year timeseries (Table 2).

Length and weight information for the recreational fishery are collected through the MRIP. The average size of dolphin sampled from the recreational fishery decreased for 2017 (715 mm total length) but was equivalent to the 10-year average (714.7 mm total length; Table 2). The maximum size of dolphin sampled from the recreational fishery decreased in 2017 (1,205 mm total length) and was the lowest observed in the 10-year timeseries (Table 2). The total number of citations awarded through the North Carolina Saltwater Fishing Tournament decreased in 2017 (Table 3).

Fishery-Independent Monitoring

Currently, NCDMF does not have any fishery-independent sampling programs that target or catch dolphin in great numbers.

MANAGEMENT STRATEGY

In North Carolina, dolphin is included in the North Carolina Fishery Management Plan for Interjurisdictional Fisheries, which defers to management under the South Atlantic Fishery Management Council Fishery Management Plan requirements. The South Atlantic Fishery Management Council approved a Fishery Management Plan for dolphin in 2004 and it is currently managed under recent Amendment 8 (SAFMC 2015b) and Regulatory Amendment 1 (SAFMC 2016).

RESEARCH NEEDS

The following (below) are research and management needs as determined by the council and outlined in the FMPs for pelagic *Sargassum* habitat and the dolphin/wahoo fishery (SAFMC 2002; SAFMC 2003).

Essential Fish Habitat research needs for dolphin in order of priority from highest to lowest:

- What is the areal and seasonal abundance of pelagic *Sargassum* off the southeast U.S.?
- Develop methodologies to remotely assess *Sargassum* using aerial or satellite technologies (e.g., Synthetic Aperture Radar)
- What is the relative importance of pelagic *Sargassum* weedlines and oceanic fronts for early life stages of dolphin and wahoo?
- Are there differences in abundance, growth rate, and mortality?
- What is the age structure of all fishes that utilize pelagic *Sargassum* habitat as a nursery and how does it compare to the age structure of recruits to pelagic and benthic habitats?
- Is pelagic *Sargassum* mariculture feasible?
- Determine the species composition and age structure of species associated with pelagic *Sargassum* when it occurs deeper in the water column.
- Additional research on the dependencies of pelagic *Sargassum* productivity on the marine species using it as habitat.
- Quantify the contribution of nutrients to deepwater benthic habitat by pelagic *Sargassum*.
- Studies should be performed on the abundance, seasonality, life cycle, and reproductive strategies of *Sargassum* and the role this species plays in the marine environment, not only as an essential fish habitat, but as a unique pelagic algae.
- Research to determine impacts on the *Sargassum* community, as well as the individual species of this community that are associated with, and/or dependent on, pelagic *Sargassum*. Human induced (tanker oil discharge; trash) and natural threats (storm events) to *Sargassum* need to be researched for the purpose of protecting and conserving this natural resource.
- Develop cooperative research partnerships between the Council, NOAA Fisheries Protected Resources Division, and state agencies since many of the needs to a) research pelagic *Sargassum*, and b) protect and conserve pelagic *Sargassum* habitat, are the same for both managed fish species and listed sea turtles.
- Direct specific research to further address the association between pelagic *Sargassum* habitat and post-hatchling sea turtles

Biological research needs for dolphin in order of priority from highest to lowest:

- In the short-term, effort should be directed at examining all existing seasonality (effort and landings), mean size, and life history data for dolphin from the northern area.
- Additional data are needed to develop and/or improve estimates of growth, fecundity, etc. Research in this area is encouraged.
- There are limited social and economic data available. Additional data need to be obtained and evaluated to better understand the implications of fishery management options.
- Trophic data should be considered in support of an ecosystem management approach.
- Essential fish habitats for dolphin and wahoo need to be identified.
- An overall design should be developed for future tagging work. This could be done by the Working Group. In addition, existing tagging databases should be examined.
- Long-term work should continue and expand on current research investigating genetic variability of dolphin populations in the western central Atlantic.
- Observer programs should place observers on longline trips directed on dolphin. Catch and bycatch characterization, condition released (alive or dead), etc. should be collected. Observers could also be used to collect bioprofile data (size, sex, hard parts for aging, etc.).

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – DOLPHIN

- High levels of uncertainty in inter-annual variation in abundance of dolphin should be investigated through an examination of oceanographic and other environmental factors.
- Release mortality should be investigated as a part of the evaluation of the effectiveness of current minimum size limits in the dolphin fishery.
- Establish a list serve for dolphin and wahoo which would facilitate research and the exchange of information.

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ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – DOLPHIN

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SAFMC (South Atlantic Fishery Management Council). 2014. Joint Generic Dealer Amendment (Amendment 3 to the fishery management plan for the dolphin and wahoo fishery of the Atlantic). South Atlantic Fishery Management Council. Charleston, SC.

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TABLES

Table 1. Recreational harvest (number of fish released and weight in pounds) and releases (number of fish) and commercial harvest (weight in pounds) of dolphin from North Carolina for the period 2008 - 2017.

| Year | Recreational | | Weight (lb) | Commercial | |
|------|----------------|-----------|-------------|----------------|-----------------------------|
| | Number of fish | Harvested | | Harvested (lb) | Total Weight Harvested (lb) |
| 2008 | 2,035 | 357,559 | 3,242,714 | 289,548 | 3,532,262 |
| 2009 | 2,731 | 367,351 | 3,784,128 | 611,962 | 4,396,090 |
| 2010 | 4,604 | 498,626 | 3,291,521 | 239,551 | 3,531,072 |
| 2011 | 8,336 | 472,174 | 3,538,922 | 94,210 | 3,633,132 |
| 2012 | 2,553 | 327,116 | 2,559,382 | 249,020 | 2,808,402 |
| 2013 | 2,986 | 212,388 | 1,562,755 | 178,035 | 1,740,790 |
| 2014 | 3,713 | 185,077 | 1,329,353 | 422,496 | 1,751,849 |
| 2015 | 29,567 | 434,454 | 3,170,590 | 320,961 | 3,491,551 |
| 2016 | 987 | 261,553 | 2,706,002 | 356,053 | 3,062,055 |
| 2017 | 1,936 | 184,928 | 1,486,909 | 197,999 | 1,684,908 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – DOLPHIN

Table 2. Mean, minimum, and maximum lengths (total length, mm) of dolphin collected from the commercial and recreational fisheries for the period 2008-2017.

| Year | Recreational | | | | Commercial | | | |
|------|--------------|----------------|----------------|-----------------------|-------------|----------------|----------------|-----------------------|
| | Mean Length | Minimum Length | Maximum Length | Total Number Measured | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
| 2008 | 744 | 311 | 1,404 | 1,759 | 665 | 413 | 1,135 | 261 |
| 2009 | 800 | 392 | 1,290 | 1,963 | 816 | 140 | 1,295 | 590 |
| 2010 | 657 | 387 | 1,725 | 1,532 | 628 | 345 | 1,115 | 464 |
| 2011 | 689 | 283 | 1,296 | 2,022 | 665 | 410 | 1,120 | 288 |
| 2012 | 722 | 380 | 1,358 | 1,918 | 757 | 430 | 1,245 | 611 |
| 2013 | 686 | 299 | 1,467 | 599 | 700 | 478 | 1,440 | 188 |
| 2014 | 676 | 268 | 1,314 | 891 | 788 | 390 | 1,352 | 344 |
| 2015 | 678 | 286 | 1,323 | 951 | 821 | 497 | 1,360 | 80 |
| 2016 | 780 | 191 | 1,323 | 1,146 | 841 | 463 | 1,035 | 131 |
| 2017 | 715 | 325 | 1,205 | 720 | 634 | 428 | 947 | 166 |

Table 3. Total number of awarded citations for dolphin (>35 lb landed) from the North Carolina Saltwater Fishing Tournament for the time period 2008-2017.

| Year | Total Citations |
|------|-----------------|
| 2008 | 426 |
| 2009 | 209 |
| 2010 | 157 |
| 2011 | 113 |
| 2012 | 147 |
| 2013 | 284 |
| 2014 | 273 |
| 2015 | 171 |
| 2016 | 124 |
| 2017 | 115 |

FIGURES

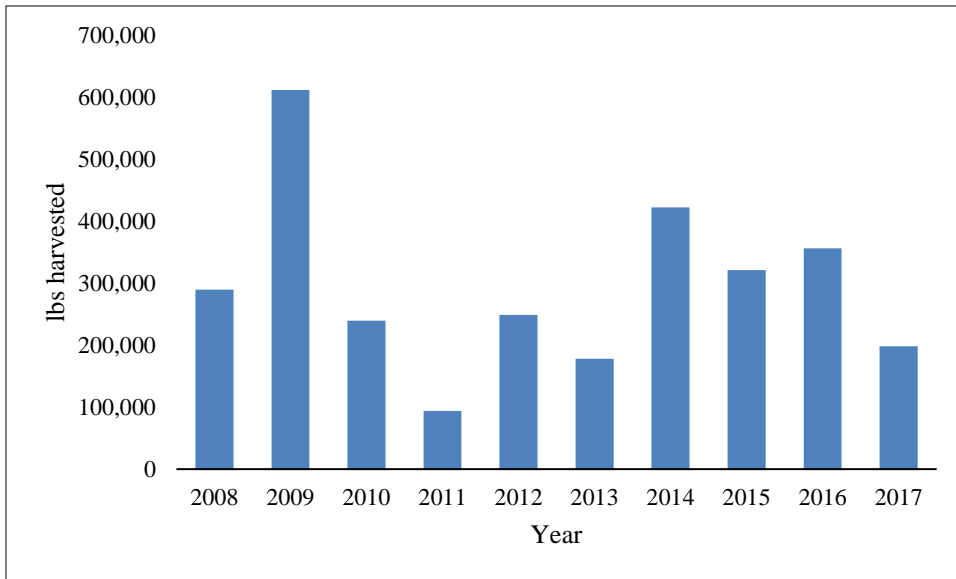


Figure 1. Commercial landings (pounds) of dolphin in North Carolina from 2008 - 2017.

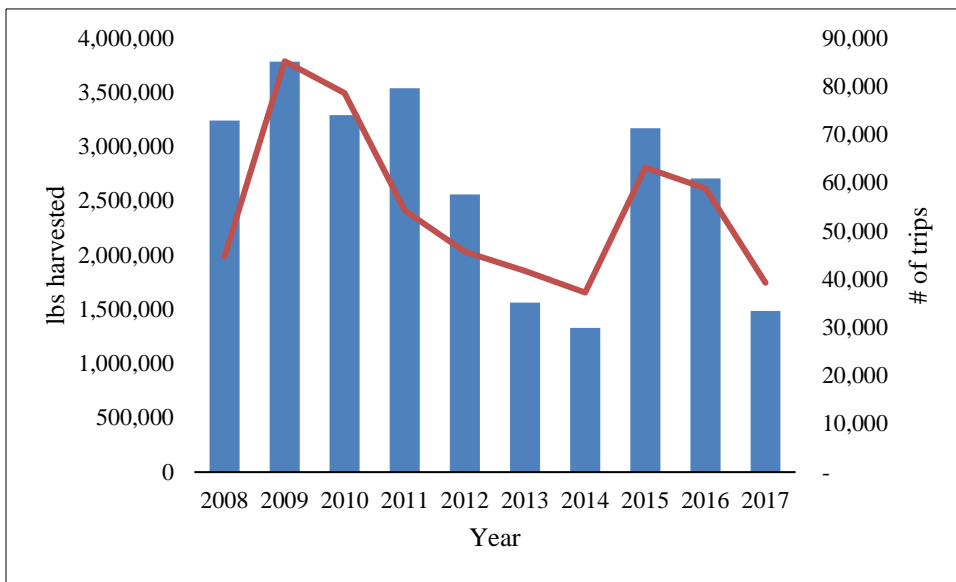


Figure 2. Recreational landings in pounds (bars) and number of directed trips (line) with modes combined (private, headboat, and charter) for dolphin from 2008-2017.

**FISHERY MANAGEMENT PLAN UPDATE
KING MACKEREL
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | February 1983 |
| Amendments: | Amendment 1 – September 1985 Amendment 3 – August 1989 Amendment 5 – August 1990 Amendment 6 – December 1992 Amendment 7 – November 1994 Amendment 8 – March 1998 Amendment 9 – April 2000 Amendment 10 – July 2000 Amendment 11 – December 1999 Amendment 12 – October 2000 Amendment 14 – July 2002 Amendment 15 – August 2005 Amendment 17 – June 2006 Amendment 18 – January 2012 Amendment 19 – July 2010 Amendment 20A – August 2014 Amendment 20B – March 2015 Amendment 22 – January 2014 Amendment 23 – August 2014 Amendment 26 – July 2016 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | The next assessment has not been scheduled. |

The original Gulf and South Atlantic Fishery Management Councils' fishery management plan (FMP) for Coastal Migratory Pelagic Resources (mackerels and cobia) was approved in 1983 (South Atlantic Fishery Management Council (SAFMC) 1983). This plan treated king mackerel as one U.S. stock. Allocations were established for recreational and commercial fisheries, and

the commercial allocation was divided between net and hook-and-line fishermen. The plan also established procedures for the Secretary of Commerce to act by regulatory amendment to resolve possible future conflicts in the fishery, such as establish fishing zones and local quotas to each gear or user group. Numerous amendments have been implemented since the first FMP.

Amendment 1 provided a framework for pre-season adjustment of total allowable catch (TAC), revised king mackerel maximum sustainable yield (MSY) downward, recognized separate Atlantic and Gulf migratory groups of king mackerel, and established fishing permits and bag limits for king mackerel (SAFMC 1985). Commercial allocations among gear users were eliminated.

Amendment 3 prohibited drift gill nets for coastal pelagics and purse seines and run-around gill nets for the overfished groups of mackerels (SAFMC 1998). The habitat section of the FMP was updated and vessel safety considerations were included in the plan. A new objective to minimize waste and bycatch in the fishery was added to the plan.

Amendment 5 extended the management area for the Atlantic groups of mackerels through Mid-Atlantic Fishery Management Council (MAFMC) jurisdiction (SAFMC 1990). The amendment revised problems in the fishery and plan objectives, revised the definition of "overfishing", and provided that the SAFMC will be responsible for pre-season adjustments of TACs and bag limits for the Atlantic migratory groups of mackerels. It redefined recreational bag limits as daily limits; created a provision specifying that the bag limit catch of mackerel may be sold, provided guidelines for corporate commercial vessel permits, established a minimum size of 12 inches (30.5 cm.) fork length or 14 inches total length for king mackerel and included a definition of "conflict" to provide guidance to the Secretary.

Amendment 6 identified additional problems and an objective in the fishery, provided for rebuilding overfished stocks of mackerels within specific periods, provided for biennial assessments and adjustments, provided for more seasonal adjustment actions, including size limits, vessel trip limits, closed seasons or areas, and gear restrictions. It also changed commercial permit requirements to allow qualification in one of three preceding years, discontinued the reversion of the bag limit to zero when the recreational quota is filled, modified the recreational fishing year to the calendar year and changed the minimum size limit for king mackerel to 20 inches fork length (SAFMC 1992).

Amendment 7 equally divided the Gulf commercial allocation in the Eastern Zone at the Dade-Monroe County line in Florida (SAFMC 1994). The sub-allocation for the area from Monroe County through Western Florida was equally divided between commercial hook-and-line and net gear users.

Amendment 8 identified additional problems in the fishery, specified allowable gear, established a moratorium on new commercial king mackerel permits and provided for transferability of permits during the moratorium, and allowed retention of up to five damaged king mackerel on vessels with commercial trip limits (these fish cannot be sold, but do not count against the trip limit) (SAMFC 1998). It also revised the seasonal framework procedures to a) delete a procedure for subdividing the Gulf migratory group of king mackerel, b) request that the stock assessment

panel provide additional information on spawning potential ratios and mixing of king mackerel migratory groups, c) provide for consideration of public comment, d) redefine overfishing and allow for adjustment by framework procedure, f) allow setting zero bag limits, and g) allow gear regulation including prohibition.

Amendment 9 changed the percentage of the commercial allocation of TAC for the Florida east coast (North Area) and Florida west coast (South/West Area) of the Eastern Zone to 46.15 percent North and 53.85 percent South/West (previously, this allocation was split 50 percent to each zone); and allowed possession of cut-off (damaged) king that comply with the minimum size limits and the trip limits in the Gulf, Mid-Atlantic, or South Atlantic exclusive economic zone (EEZ) (sale of such cut-off fish is allowed and is in addition to the existing allowance for possession and retention of a maximum of five cut-off (damaged) king mackerel that are not subject to the size limits or trip limits, but that cannot be sold or purchased, nor counted against the trip limit) (SAMFC 2000).

Amendment 10 designated Essential Fish Habitat (EFH) and EFH-Habitat Areas of Particular Concern for coastal migratory pelagics (SAFMC 1998).

Amendment 11 amended the FMP as required to make definitions of MSY, optimal yield (OY), overfishing and overfished consistent with National Standard Guidelines; identified and defined fishing communities and addressed bycatch management measures (SAFMC 1998).

Amendment 12 extended the commercial king mackerel permit moratorium from October 15, 2000 to October 15, 2005, or until replaced with a license limitation, limited access, and/or individual fishing quota or individual transferable quota system (ITQ), whichever occurs earlier (SAFMC 1999).

Amendment 13 established two marine reserves in the (EEZ) of the Gulf of Mexico near the Dry Tortugas, Florida known as Tortugas North and Tortugas South, in which fishing for coastal migratory pelagic species is prohibited (SAFMC 2002). This action complements previous actions taken under the National Marine Sanctuaries Act.

Amendment 14 established a three-year moratorium on the issuance of for-hire (charter vessel and head boat) permits for coastal migratory pelagic species in the Gulf of Mexico unless sooner replaced by a comprehensive effort limitation system. This resulted in separate for-hire permits for the Gulf and South Atlantic. The control date for eligibility was established as March 29, 2001 (SAFMC 2002). The amendment also includes other provisions for eligibility, application, appeals, and transferability of permits.

Amendment 15 established an indefinite commercial limited access program for king mackerel in the EEZ under the jurisdiction of the Gulf of Mexico, South Atlantic, and Mid-Atlantic fishery management councils (SAMFC 2005). This amendment also changed the fishing year to March 1 through February 28/29 for Atlantic group king and Spanish mackerels.

Amendment 17 (SAFMC 2006) established a permanent limited entry system for Gulf of Mexico coastal migratory pelagics for-hire (charter and headboat) permits, building on the moratorium established under Amendment 14.

Amendment 18 established Annual Catch Limits (ACLs), Annual Catch Targets (ACTs) and accountability measures (AMs) for king mackerel (SAFMC 2011) as required under the 2006 Magnuson-Stevens Reauthorization Act.

Amendment 19 updated existing EFH and HAPC designations for South Atlantic species and prohibited the use of certain gear types within Deepwater Coral Habitat Areas of Particular Concern (SAMFC 2009).

Amendment 20A prohibited the sale of king mackerel caught under the bag limit unless the fish are caught as part of a state-permitted tournament and the proceeds from the sale are donated to charity (SAFMC 2013). In addition, the rule removes the income qualification requirement for king mackerel commercial vessel permits.

Amendment 20B eliminated the 500-pound trip limit that is effective when 75 percent of the respective quotas are landed for king mackerel in the Florida west coast Northern and Southern Subzones; allows transit of commercial vessels with king mackerel through areas closed to king mackerel fishing, if gear is appropriately stowed; and creates Northern and Southern Zones for Atlantic migratory group king mackerel, each with separate quotas (SAFMC 2014). Each zone will close when the respective quota is met or expected to be met. The dividing line between the zones is at the North Carolina and South Carolina state line.

Amendment 22 modified headboat reporting regulations to require weekly electronic reporting of all South Atlantic Council managed species (SAFMC 2013a).

Amendment 23 (SAFMC 2013b) required dealers to possess a federal Gulf and South Atlantic universal dealer permit to purchase king and Spanish mackerel and required weekly electronic dealer reporting. It also required federally-permitted king and Spanish mackerel fishermen to sell only to a federally-permitted dealer.

The 2013 Framework Action (effective 2014) modified commercial king mackerel trip limits in the Florida East Coast subzone to optimize utilization of the resource.

Amendment 26 updates the Atlantic king mackerel annual catch limits and adjusts the mixing zone based on the results of the 2014 stock assessment (SAFMC 2016). The amendment allows limited retention and sale of Atlantic migratory group king mackerel incidentally caught in the small coastal shark gill net fishery.

To ensure compliance with interstate requirements, North Carolina also manages this species 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 MAFMC, SAFMC, or the Atlantic States Marine Fisheries Commission 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 (Atlantic States Marine Fisheries Commission plans) are like the goals of the Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015).

Management Unit

The management unit is defined as king mackerel within U.S. waters of the South Atlantic, Mid-Atlantic and Gulf of Mexico. Current management defines two migratory units: Gulf Migratory Group and Atlantic Migratory Group.

Goal and Objectives

The goal of the FMP for Coastal Migratory Pelagics resources was to institute management measures necessary to prevent exceeding maximum sustainable yield (MSY), establish a mandatory statistical reporting system for monitoring catch, and to minimize gear and user conflicts (SAMFC 1983). Amendment 12 to the Gulf and South Atlantic fishery management councils’ FMP for Coastal Migratory Pelagics lists eight plan objectives:

1. The primary objective of the FMP is to stabilize yield at MSY, allow recovery of overfished populations, and maintain population levels sufficient to ensure adequate recruitment.
2. To provide a flexible management system for the resource which minimizes regulatory delay while retaining substantial Council and public input in management decisions and which can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by areas.
3. To provide necessary information for effective management and establish a mandatory reporting system.
4. To minimize gear and user group conflicts.
5. To distribute the TAC of Atlantic migratory group Spanish mackerel between recreational and commercial user groups based on the catches that occurred during the early to mid-1970s, which is prior to the development of the deep water run-around gill net fishery and when the resource was not overfished.
6. To minimize waste and bycatch in the fishery.
7. To provide appropriate management to address specific migratory groups of king mackerel.
8. To optimize the social and economic benefits of the coastal migratory pelagic fisheries.

STATUS OF THE STOCK

Life History

King mackerel are considered coastal pelagic, meaning they live in open ocean waters near the coast. They are found from North Carolina to southeast Florida, making inshore and offshore migrations that are triggered by water temperature and food supply. King mackerel prefer warm waters and seldom enter waters below 68 degrees Fahrenheit. In the winter, they gather just

inside the Gulf Stream along the edge of the continental shelf. In the summer and fall, they move inshore along the beaches and near the mouths of inlets and rivers. King mackerel spawn from April to November, with males maturing between age 2 and 3 and females between age 3 and 4. King mackerel in North Carolina grow as large as 60 inches, but most recreational catches are between 35 and 45 inches. They feed on menhaden, mullet, thread herring, sardines and squid and may be seen leaping out of the water in pursuit of prey.

Stock Status

In 2014, the Atlantic king mackerel stock was assessed and peer reviewed through the Southeast Data, Assessment and Review (SEDAR 38). The results of the assessment indicated that the stock size and the rate of removals are sustainable and predicts Atlantic king mackerel are not overfished and overfishing is not occurring.

Stock Assessment

An integrated Stock Synthesis approach was used to assess the stock (SEDAR 38) in a benchmark assessment (SEDAR 2014). The assessment model was constructed using fishery independent data from the Southeast Area Monitoring and Assessment Program Trawl Survey for the Atlantic, and fishery dependent information collected from National Oceanic and Atmospheric Administration Fisheries Service Marine Recreational Fisheries Statistics Survey, head boat and logbook surveys, as well as North Carolina Division of Marine Fisheries Trip Ticket landings information. The Stock Synthesis approach was used, which integrated fishery and life history indices into a statistical catch-at-age model to produce observed catch, size and age composition, and Catch Per Unit Effort indices. Overall, stock biomass and spawning stock biomass (SSB) show little depletion until the 1950s, when a slow decline started and then accelerated around 1980, reaching its lowest level in the late 1990s, from which it increased until 2010. Since 2010, there has been a slight decrease in SSB (Figure. 1). Key biological reference points and associated benchmarks (SSB_{MSY} and F_{MSY}) were successfully derived and the consensus derived from sensitivity analysis of the model predict that the Atlantic stock of king mackerel is not overfished and overfishing is not occurring.

STATUS OF THE FISHERY

Current Regulations

The North Carolina Division of Marine Fisheries complements the management measures of the Coastal Migratory Pelagic FMP through rule (15A NCAC 03M .0301) and proclamation authority (15A NCAN 03M .0512). Current regulations include a recreational bag limit of three king mackerel per person per day and 24-inch fork length minimum size (commercial and recreational). Commercial regulations limit trips to 3,500 pounds and require a Federal vessel permit for commercial, charter and head boats. Sale of king mackerel caught under the bag limit are prohibited unless the fish are caught as part of a state-permitted tournament and the proceeds from the sale are donated to charity.

Commercial Landings

In 2017, commercial landings were 629,374 pounds (Figure 1) and 80 percent of the king mackerel harvest was taken by hook and line while the remaining 20 percent was harvested in gill nets. The commercial fishery has declined since 2007, however the 2017 landings were roughly 20 percent higher than the 518,476 pound 10-year average (2008-2017). Peak commercial landings for 2017 came from ocean waters south of Hatteras greater than three miles out, between the months of September and April.

Recreational Landings

Recreational anglers target king mackerel by trolling spoons and live baits both inshore and offshore. Anglers catch most king mackerel between August and October, once the water temperature has begun to cool from the summer heat. Anglers harvested 325,846 pounds of king mackerel in 2017 (Figure 2). Recreational landings of king mackerel are estimated from the Marine Recreational Information Program (MRIP) through dockside sampling and phone effort surveys. For unknown reasons, recreational harvest has declined sharply since 2007. King mackerel in 2017 was 26 percent below the 440,336 pound 10-year average (2008-2017).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Length-frequency information for the commercial king mackerel fishery in North Carolina is collected by port agents through the trip ticket program, specifically programs 438 (Offshore Live Bottom Fishery) and 439 (Coastal Pelagic). Ageing structures, otoliths, are collected from the commercial and recreational fishery as well as king mackerel fishing tournaments statewide and sent to the Southeast Fisheries Science Center in Panama City, Florida for processing and ageing (Table 1). Maximum sizes of king mackerel sampled over the last 10 years have remained steady at ~1,400 millimeters, while mean annual sizes varied from 730 millimeters in 2008 to 990 millimeters in 2013 (Table 2).

Fishery-Independent Monitoring

Currently, the division does not have any fishery-independent sampling programs that target or catch king mackerel in great numbers.

MANAGEMENT STRATEGY

King mackerel is included in the North Carolina Fishery Management Plan for Interjurisdictional Fisheries, which defers, to South Atlantic Fishery Management Council Fishery Management Plan compliance requirements. Current management measures were established under recent Amendments 20A (SAMFC 2014), 20B (SAMFC 2015), and 26 (SAMFC 2016) to the Coastal Migratory Pelagics Fishery Management Plan. Amendment 20A prohibits the sale of all bag-limit-caught king mackerel, except those harvested during a state-permitted tournament. Amendment 20B establishes separate commercial quotas of Atlantic king mackerel for a

Northern Zone (north of North Carolina and South Carolina state line) and Southern Zone (south of North Carolina and South Carolina state line). The South Atlantic Fishery Management Council completed Amendment 26 (2016) to update the Atlantic king mackerel annual catch limits and adjust the mixing zone based on the results of the 2014 stock assessment, and to provide an incidental catch allowance of Atlantic king mackerel in the small coastal shark gillnet fishery. Current management strategies for king mackerel in South Atlantic waters are summarized in Table 3.

RESEARCH NEEDS

From SEDAR 38 report (SEDAR 2014):

- Develop a survey to obtain reliable age and size composition data and relative abundance of adult fish. This could be done using gill nets or handlines. The review panel recommends that the design of a scientific survey be peer reviewed.
- Determine most appropriate methods to deal with changing selectivity in fisheries over time, particularly changing selectivity related to management actions or targeting of specific cohorts. The review panel suggests that historical mark-recapture data be used to compare size composition of recaptures for different fishing gears to evaluate selectivity for historic periods.
- Determine stock mixing rates using otolith microchemistry and/or otolith shape analysis on a routine basis that would allow future stock assessments to capture the dynamic spatial and temporal nature of mixing of the Atlantic and Gulf of Mexico stocks, and consider evaluating stock mixing within integrated modeling approaches.
- More accurately characterize juvenile growth by increasing samples of age-0 and 1 fish. Further investigate two-phase growth models including different breakpoints and different growth models to better model size and age. Consider if there is temporal (annual and seasonal) variability in growth rates. Results of this analysis in terms of the best model will need to be implementable in SS3 to continue with the integrated modeling approach.
- Determine if female spawning periodicity varies by size or age.
- Expand the trawl survey below the Cape Canaveral area and potentially into deeper continental shelf waters.
- Consider conducting an extensive tagging program to: a) better understand migration patterns; b) provide additional and individual growth rate information; c) better understand fishery selectivity; d) provide fishery exploitation rates; and e) provide information about natural mortality rates. Fishery independent recapture information (i.e., use of acoustic and satellite tags) will assist with a). Age at capture information of tagged animals will assist with b). A multi-year tagging program will be required for e). The review panel recommends that a specific workshop be held to consider in detail the design of a tagging program.

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TABLES

Table 1. Mean, minimum, and maximum fork lengths (mm) and total number sampled of king mackerel aged through Comprehensive Life History (Program 930).

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2008 | 872.1 | 595 | 1365 | 450 |
| 2009 | 914.3 | 615 | 1400 | 415 |
| 2010 | 961.7 | 589 | 1452 | 386 |
| 2011 | 948.9 | 595 | 1448 | 429 |
| 2012 | 955.8 | 588 | 1421 | 597 |
| 2013 | 1021.3 | 612 | 1430 | 413 |
| 2014 | 1016.3 | 118 | 1500 | 388 |
| 2015 | 992.6 | 113 | 1383 | 446 |
| 2016 | 893.0 | 337 | 1380 | 482 |
| 2017 | 910.5 | 391 | 1430 | 663 |

Table 2. Mean, minimum, and maximum fork lengths (mm) and total number sampled of king mackerel from fishery dependent sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2008 | 730.8 | 43 | 1365 | 2179 |
| 2009 | 784.4 | 383 | 1405 | 1477 |
| 2010 | 928.2 | 589 | 1452 | 583 |
| 2011 | 884.4 | 595 | 1929 | 1079 |
| 2012 | 933.7 | 588 | 1421 | 1125 |
| 2013 | 990.4 | 144 | 1430 | 506 |
| 2014 | 881.4 | 118 | 1500 | 826 |
| 2015 | 938.8 | 113 | 1383 | 679 |
| 2016 | 794.6 | 312 | 1380 | 538 |
| 2017 | 828.5 | 327 | 1330 | 515 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – KING MACKEREL

Table 3. Management strategies and rules for king mackerel in the South Atlantic.

| Management Strategy | Implementation Status |
|---|--|
| 24 inch minimum size limit | Rule 15A NCAC 03M .0301(b)(1) |
| Three fish creel limit | Rule 15A NCAC 03M .0301(b)(2) |
| Commercial Vessel Permit requirements | Rule 15A NCAC 03M .0301(b)(3)(A) Rule 15A NCAC 03M .0301(b)(3)(B) |
| Unlawful to use gill nets south of Cape Lookout for more than three king mackerel | Rule 15A NCAC 03M .0501(b)(4) |
| Charter vessels or head boats with Commercial Vessel Permit must comply with possession limits when fishing with more than three persons | Rule 15A NCAC 03M .0512 |
| Commercial trip limit of 3,500 pounds of king, Spanish, or aggregate | Rule 15A NCAC 03M .0301(d)) |
| Prohibits Purse Gill Nets when taking king or Spanish mackerel | Rule 15A NCAC 03M .0512 |
| Unlawful for vessels with both a valid Federal Commercial Directed Shark Permit and a valid Federal King Mackerel Permit, when engaged in directed shark fishing with gill nets south of Cape Lookout, to possess and sell more than three king mackerel per crew member. | Proclamation FF-21-2017 |

FIGURES

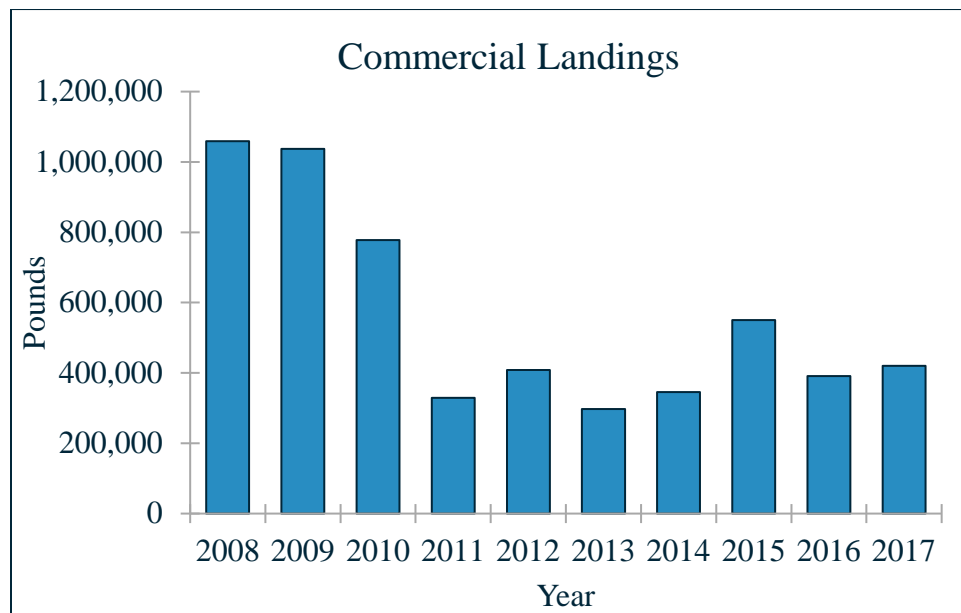


Figure 1. Commercial landings of king mackerel in North Carolina from 2008-2017.

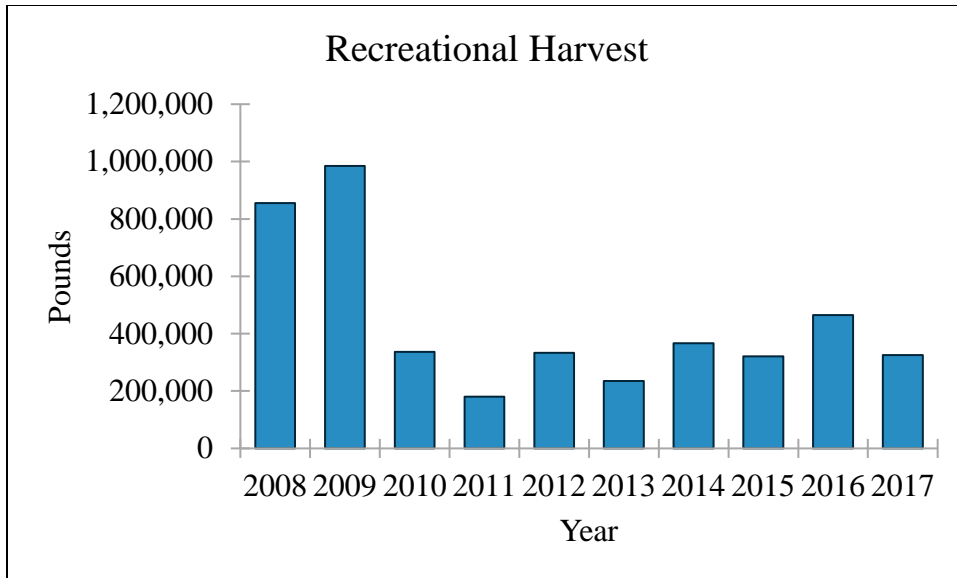


Figure 2. Estimated recreational harvest of king mackerel in North Carolina from 2008-2017.

**FISHERY MANAGEMENT PLAN UPDATE
MONKFISH
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | November 1999 |
| Amendments: | Amendment 1 1999 Framework 1 1999 Framework 2 2004 Amendment 2 2005 Framework 3 2006 Framework 4 2007 Amendment 3 2008 Framework 5 2008 Framework 6 2008 Amendment 4 2018 Amendment 5 2011 Framework 7 2011 Amendment 6 withdrawn 2010 Amendment 7 June 2015 Framework 8 2014 Framework 9 2016 Framework 10 2017 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | None |

Monkfish are jointly managed by the New England Fishery Management Council (NEFMC) and Mid-Atlantic Fishery Management Council (MAFMC) with the NEFMC serving as administrative lead. In the 1990s, monkfish stake holders became concerned about decreased monkfish body size, gear conflicts with other fisheries, and an expansion of the directed trawl fishery prompting management council involvement. Adopted in 1999, the Monkfish Fishery Management Plan (FMP) is designed to stop overfishing and rebuild the stocks through a number of gear and effort restrictions. Based on historic fishery and biological data, the Atlantic monkfish is managed as two stocks. The Northern Fishery Management Area (NMA) includes

the Gulf of Maine and the northern portion of Georges Bank while the Southern Fishery Management Area (SMA) begins from the southern extent of Georges Bank through the Mid-Atlantic Bight to North Carolina/South Carolina border.

In 2006, North Carolina and National Oceanic and Atmospheric Association (NOAA) Fisheries Southeast Regional Office entered into an agreement enabling limited large mesh gill net fisheries for striped bass and monkfish in state waters. By rule the Atlantic Ocean waters in North Carolina are closed to the use of large mesh (> 7 inches stretch mesh) except between December 16-April 14 when a proclamation is issued to allow the use of gill nets with a stretched mesh length of seven inches and greater in the Atlantic Ocean. This gear is specifically for the striped bass and monkfish gill net fisheries. The harvest of monkfish in the large mesh monkfish fishery is opened by proclamation between March 16-April 14 unless opened later or closed sooner by proclamation. The agreement allows the North Carolina Division of Marine Fisheries (NCDMF) to implement Atlantic sturgeon, sea turtle, and marine mammal conservation measures under its proclamation authority as well as effort restrictions on the fishery. All fishery participants must possess a current monkfish permit to land or sell monkfish. Monkfish fishermen are required to report weekly trip information to NCDMF. To ensure compliance with protected species conservation measures before the fishery is allowed to open, NCDMF communicates with the NOAA Northeast Fishery Observer Program (NEFOP) to reserve the necessary days-at-sea observer coverage for monitoring 20% of the fishery. Additionally, fishery participants must report any protected species interactions with fishing gear to the NCDMF. Effort restrictions confine fishing activity for monkfish to a one-mile-wide area (within 2-3 miles offshore) from the Virginia/North Carolina boarder to Wimble shoals (Latitude 35°30'N) and mandates that monkfish gill nets are to be fished at least every 48 hours, weather permitting. The season can be closed by proclamation if reliable sea surface temperature monitoring indicates prolonged water temperatures greater than 11° C or if an interaction occurs between fishing gear and a protected species.

Since the adoption of the monkfish FMP, seven amendments have been considered for the plan and six have been implemented. Amendments 1 and 4 were added to identify, establish, and refine definitions for essential fish habitat for monkfish. Amendments 3, 5, and 7 were included to allow for reporting (at-sea observer coverage) and accurate estimates of bycatch. Amendment 5 also specified annual catch limits and accountability measures to comply with Magnuson-Stevens Fishery Conservation and Management Act. Amendment 6 was proposed management effort that would have allowed for catch shares within the monkfish fishery: however, the consideration was withdrawn and never incorporated into the FMP. Additionally, ten frameworks have been included since 1999 to adjust management strategies for monkfish. The monkfish FMP, associated amendment documents, and framework information can be found at <https://www.nefmc.org/management-plans/monkfish>.

Monkfish fishery monitoring and assessment has been conducted since the implementation of the FMP. Over several years, time series data has been collected to update biological reference points as well as targets and thresholds for standing stock biomass and fishing mortality. The latest stock assessment (NEFSC 2010) and subsequent operational assessments (NEFSC 2013 and NEFSC 2016) has determined both monkfish stocks to be not overfished with no overfishing occurring. However, there continues to be uncertainty related to estimates of commercial

discards, stock structure, and age validation for monkfish. Continued fisheries monitoring, data collection, and identification of research priorities will be conducted by monkfish stakeholders in the future.

To ensure compliance with interstate requirements, NCDMF also manages monkfish 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).

Management Unit

In North Carolina, monkfish regulations reflect those of the NEFMC/MAFMC FMP required for federal waters (3 to 200 miles). Figure 1 illustrates the northern and southern monkfish fishery management areas.

Goal and Objectives

The goals of the monkfish FMP are to: 1) end and prevent overfishing; rebuilding and maintaining a healthy spawning stock; 2) optimize yield and maximize economic benefits to the various fishing sectors; 3) prevent increased fishing on immature fish; 4) allow the traditional incidental catch of monkfish to occur.

STATUS OF THE STOCK

Life History

Despite their importance as a commercial species, little is known about the life history of monkfish (*Lophius americanus*). They are distributed in the Northwestern Atlantic from Gulf of St. Lawrence, Canada to Cape Hatteras, North Carolina (Richards et al. 2008). Generally, monkfish are found in nearshore habitats at a maximum depth of approximately 900 meters (Roundtree et al. 2008). In North Carolina, they occur most abundantly from late February to early April.

Little fine-scale spatial information is known about monkfish in the western Atlantic. Monkfish are hypothesized to exhibit movements between inshore and offshore environments associated with offshore spawning activity (Richards et al. 2008). Very little latitudinal movement is believed to occur and genetic studies have supported this belief and this determination has informed current monkfish stock structure (Armstrong et al. 1992; Hartley 1995).

Similarly, there is a paucity of information on monkfish age and growth. Monkfish are thought to grow to a maximum size of 140 cm and age of 14 years (Richards et al. 2012). Females reach sexual maturity at age 7 and exhibit peak egg development between February and April with evidence of serial spawning within a season (Richards et al. 2008).

There is some information regarding monkfish foraging ecology. Monkfish are a dorsal-ventrally flattened benthic fish that possess a modified first dorsal fin ray that is used to attract and then ambush prey species (Gordoa and Macpherson 1990). Diet studies have indicated monkfish feed primarily on smaller fish but also eat invertebrate prey such as squid and shrimp (Valentim et al. 2008). Cannibalism has been reported for larger monkfish (> 60cm; Johnson et al. 2007) and further research is required to ascertain whether this density dependent effect influences population dynamics.

Stock Status

The most recent stock (NESFSC 2010) and operational assessments (NESFSC 2016) have determined that both the North and South monkfish stocks are not considered overfished with no overfishing occurring.

Stock Assessment

All of the biological reference points used in the 2010 monkfish FMP were based on results of a statistical catch at age model. While the results of this assessment indicated that both stocks were not overfished with no overfishing occurring, ageing monkfish is arduous. Due to the uncertainty in ageing data and the potential influence on model results, several subsequent assessment updates have been conducted for monkfish. The 2013 Monkfish Operational Assessment (NEFSC 2013) updated the 2010 FMP biological reference points for fishing mortality and stock biomass and were deemed applicable during the 2016 operational assessment (NEFSC 2016):

Northern Stock (based on 2013 Monkfish Operational Assessment)

- $F_{\max} = 0.44$
- $B_{\text{threshold}} = 0.5 * B_{\max}$ Projected = 23,037 metric tons
- $B_{\text{target}} = B_{\max}$ Projected = 46,074 metric tons
- $B_{\text{msy}} = F_{\max}$ Projected = 9,383 metric tons

Southern Stock (based on 2013 Monkfish Operational Assessment)

- $F_{\max} = 0.37$
- $B_{\text{threshold}} = 0.5 * B_{\max}$ Projected = 35,834 metric tons
- $B_{\text{target}} = B_{\max}$ Projected = 71,667 metric tons
- $B_{\text{msy}} = F_{\max}$ Projected = 14,328 metric tons

STATUS OF THE FISHERY

Current Regulations

In addition to seasonal, effort, and reporting regulations there are size limits established for monkfish harvest. Minimum size length for monkfish is 17inch total length or 11inch tail length for both commercial and recreational anglers. North Carolina does not set trip or possession limits for monkfish.

Commercial Landings

In general, North Carolina commercial landings for monkfish have not been substantial for the past decade. Monkfish landings predominately occur as marketable by-catch from the summer flounder trawl fishery with diminutive landings being reported from estuarine gears (Table 1). From 2013-2017, the Atlantic Ocean large mesh gill net fishery had no reported trips and potential participation in the fishery has been declining (2017: n=7 permits issued). Probable causes for observed declines in the commercial monkfish fishery include seasonal closures due to warm water temperatures, effort restrictions, and fisherman behavior (e.g. participation in more lucrative fisheries).

Recreational Landings

Not available due to no observed catch.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

North Carolina does not have a directed fishery dependent monitoring program for monkfish as individual lengths are difficult to attain. Monkfish are often encountered as bycatch from the flounder trawl fishery, processed at sea, and arrive at the dock dressed (i.e. tails).

Fishery-Independent Monitoring

North Carolina does not have a fishery independent monitoring program for monkfish.

MANAGEMENT STRATEGY

The monkfish fishery is managed in federal and North Carolina state waters primarily with effort, gear, and harvestable size restrictions. Operational assessments are conducted every three years to monitor and potentially update biological reference points. The MAFMC and NEFMC are authorized to enact management changes via FMP amendments or framework adjustments as deemed appropriate. Additionally, the Monkfish Monitoring Committee (MC) meets six months prior to the opening of the fishing season to review available fisheries data. The MC reviews and develops target Total Allowable Catch recommendations and management options necessary to achieve the FMP goals and objectives.

RESEARCH NEEDS

- Continued collection of biological information needed to better estimates age, growth, and natural mortality estimates
- Obtain better estimates of commercial discards.
- Development of sex-based modeling.
- Continue microsatellite research to determine stock structure.
- Identification of movements between stock management areas.

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ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – MONKFISH

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TABLES

Table 1. Commercial landings (lbs.) as reported by the N.C. Trip Ticket Program for monkfish in ocean and estuarine waters by gear for 2008-2017.

| Ocean landings | | | | | | | | | | |
|----------------|---------|--------|--------|--------|--------|--------|--------|---------|--------|--------|
| Gear | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Gill Nets | 54,443 | 70,286 | 15,225 | 8,879 | 9,239 | 2,272 | 1,952 | 556 | 2,692 | 826 |
| Trawls | 51,099 | 26,967 | 23,960 | 29,371 | 11,662 | 8,009 | 71,418 | 110,270 | 47,324 | 64,354 |
| Other | 2,330 | 1,448 | 7,293 | 236 | 322 | 11 | 1,054 | 554 | 98 | 110 |
| Total | 107,872 | 98,701 | 46,478 | 38,486 | 21,223 | 10,292 | 74,424 | 111,380 | 50,114 | 65,290 |

| Estuarine landings | | | | | | | | | | |
|--------------------|------|------|------|------|------|------|------|------|------|------|
| Gear | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Gill Nets | 180 | 340 | 92 | 48 | 71 | 149 | 51 | 60 | 196 | 16 |
| Trawls | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Other | 5 | 0 | 0 | 0 | 22 | 0 | 0 | 0 | 0 | 20 |
| Total | 185 | 345 | 92 | 48 | 93 | 149 | 51 | 60 | 196 | 36 |

FIGURES

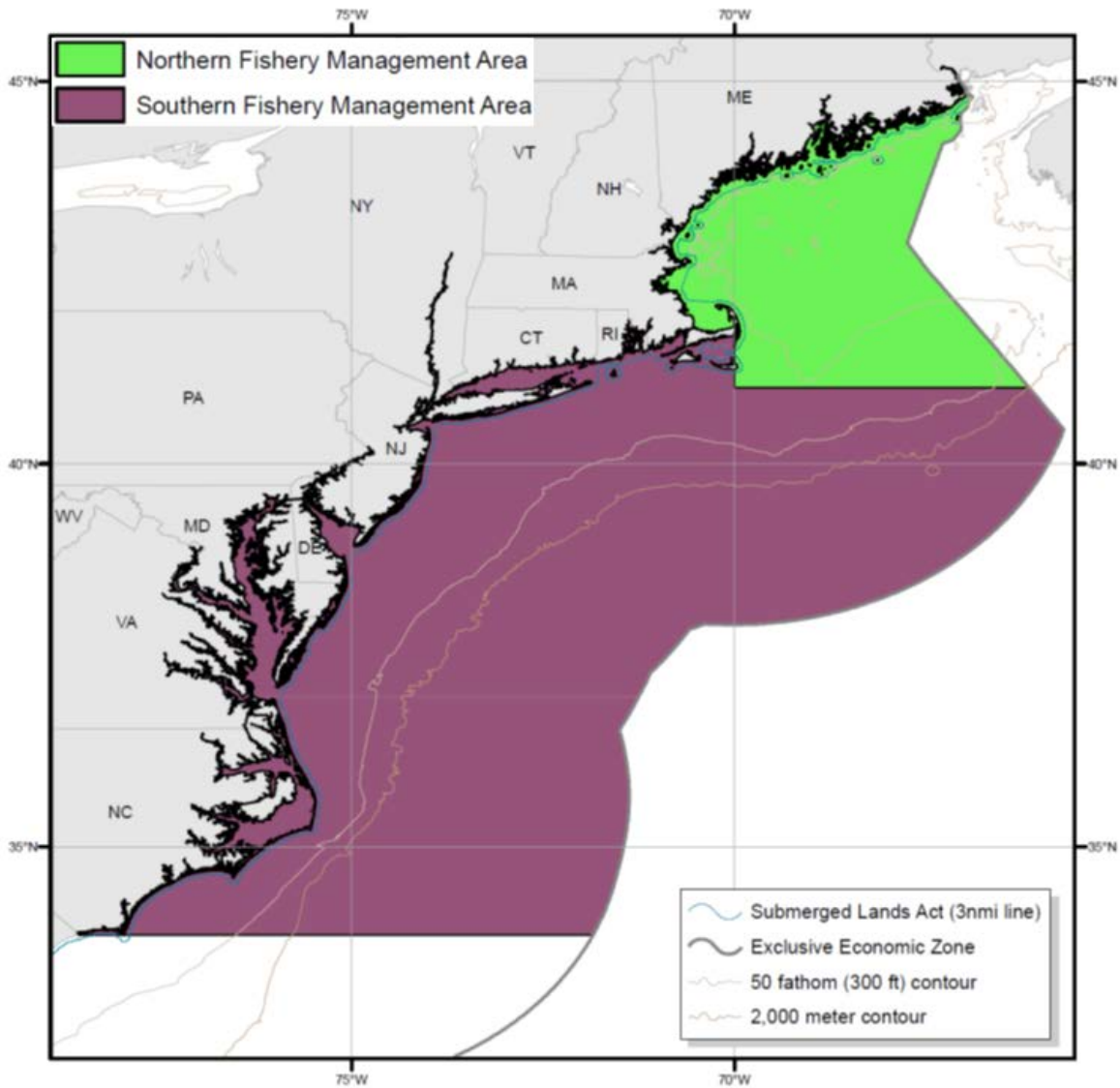


Figure 1. A map illustrating the Atlantic Monkfish fishery management areas (NOAA Fisheries Greater Atlantic Region). Monkfish management areas are divided between a northern (green) and southern area (purple).

**FISHERY MANAGEMENT PLAN UPDATE
SCUP NORTH OF CAPE HATTERAS
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption: Incorporated into the Summer Flounder FMP through Amendment 8 in 1996

Amendments:

- Amendment 8 in 1996
- Regulatory Amendment in 1996
- Amendment 10 in 1997
- Amendment 11 in 1998
- Amendment 12 in 1999
 - Framework 1 in 2001
 - Addendum III in 2001
 - Addendum IV in 2001
 - Addendum V in 2002
 - Addendum VII in 2002
 - Framework 3 in 2003
 - Framework 4 in 2003
 - Addendum IX in 2003
 - Addendum X in 2003
- Amendment 13 in 2003
 - Framework 5 in 2004
 - Addendum XI in 2004
 - Addendum XIII in 2004
 - Addendum XVI in 2005
 - Framework 7 in 2007
 - Addendum XIX in 2007
- Amendment 14 in 2007
- Amendment 16 in 2007
 - Addendum XX in 2009
- Amendment 15 in 2011
- Amendment 19 (Recreational Accountability Amendment) in 2013
- Amendment 17 in 2015
- Amendment 18 in 2015
 - Framework 9 in 2016
- Amendment 20 in 2017
 - Addendum XXIX in 2017
 - Framework 10 in 2017
 - Framework 11 in 2018

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SCUP

Framework 12 in 2018

| | |
|------------------------|---|
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | A benchmark stock assessment was completed in 2015 and a stock assessment update has been scheduled for mid-2019. |

Because of their presence in, and movement between, state waters (0-3 miles) and federal waters (3-200 miles), the Mid-Atlantic Fisheries Management Council (MAFMC) manages scup (*Stenotomus chrysops*) north of Cape Hatteras cooperatively with the Atlantic States Marine Fisheries Commission (ASMFC). The two management entities work in conjunction with the National Marine Fisheries Service (NMFS) as the federal implementation and enforcement entity. The Summer Flounder, Scup and Black Sea Bass Fishery Management Plan (FMP) and amendments use output controls (catch and landings limits) as the primary management tool, with landings divided between the commercial (78 percent) and recreational (22 percent) fisheries. The FMP also includes minimum fish sizes, bag limits, seasons, gear restrictions, permit requirements, and other provisions to prevent overfishing and ensure sustainability of the fisheries. Recreational bag and size limits and seasons are determined on a state-by-state basis using conservation equivalency in state waters and coastwide measures in federal waters. The commercial quota is coastwide.

Specific details for each Amendment include:

Amendment 8 - incorporated scup into the Summer Flounder FMP; established scup management measures, including commercial quotas, recreational harvest limits, size limits, gear restrictions, permits, and reporting requirements.

Regulatory Amendment – established seasonal quota periods of the commercial scup fishery.

Amendment 10 – modified commercial minimum mesh requirements; continued commercial vessel moratorium; prohibited transfer of summer flounder at sea; established a special permit for the summer flounder party/charter sector.

Amendment 11 - modified certain provisions related to vessel replacement and upgrading, permit history transfer, splitting, and permit renewal regulations.

Amendment 12 - revised the Summer Flounder, Scup, and Black Sea Bass FMP to comply with the Sustainable Fisheries Act and established a framework adjustment process; established quota set-aside for research for summer flounder, scup and black sea bass; established state-specific

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conservation equivalency measures; allowed the rollover of the winter scup quota; revised the start date for the scup summer quota period; established a system to transfer scup at sea. Framework 1 – established quota set-aside for research for summer flounder, scup and black sea bass.

Addendum III – established recreational fishing specifications for 2001 for summer flounder and scup.

Addendum IV – provided that upon the recommendation of the relevant monitoring committee and joint consideration with the Mid-Atlantic Fishery Management Council, the Mid-Atlantic Fishery Management Board will decide the state regulations rather than forward a recommendation to the National Marine Fisheries Science center; made states responsible for implementing the Mid-Atlantic Fishery Management Boards decisions on regulations.

Addendum V – created state-specific shares of the summer period quota that will remain in place until the Atlantic States Marine Fisheries Commission Management Board takes direct action to modify them.

Addendum VII – established recreational fishing specifications for scup for 2002.

Framework 3 – allowed the rollover of winter scup quota; revised the start date for the summer quota period for the scup fishery.

Framework 4 – established a system to transfer scup at sea.

Addendum IX – established recreational specifications for scup in 2003.

Addendum X – established quota rollover and quota period specifications for the commercial scup fishery.

Amendment 13 - revised black sea bass commercial quota system; addressed other black sea bass management measures; established multi-year specification setting of quota for summer flounder, scup and black sea bass; established region-specific conservation equivalency measures for summer flounder; built flexibility into process to define and update status determination criteria for each plan species. Amendment 13 also removed the necessity for fishermen who have both a Northeast Region (NER) black sea bass permit and a Southeast Region (SER) snapper/grouper permit to relinquish their permits for a six-month period prior to fishing south of Cape Hatteras during the northern closure.

Framework 5 – established multi-year specification setting of quota for summer flounder, scup, and black sea bass.

Addendum XI – proposed that the recreational scup fishery be constrained to the coastwide recreational harvest limit, allow states to customize scup recreational management measures to deal with burden issues associated with the implementation of coastwide measures, minimize the administrative burden when implementing conservation equivalency.

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Addendum XIII – modified the Summer Flounder, Scup, and Black Sea Bass FMP so that Total Allowable Landings for summer flounder, scup, and/or black sea bass can be specified for up to three years.

Addendum XVI – established guidelines for delayed implementation of management strategies.

Framework 7 – built flexibility into process to define and update status determination criteria for summer flounder, scup and black sea bass.

Addendum XIX – continued the state-by-state black sea bass commercial management measures, without a sunset clause; broadened the descriptions of stock status determination criteria contained within the Summer Flounder, Scup, and Black Sea Bass FMP to allow greater flexibility in those definitions, while maintaining objective and measurable status determination criteria for identifying when stocks or stock complexes covered by the fishery management plan are overfished.

Amendment 14 - established a rebuilding schedule for scup; scup gear restricted areas made modifiable through framework adjustment process.

Amendment 16 - standardized bycatch reporting methodology.

Addendum XX – set policies to reconcile commercial quota overages to address minor inadvertent quota overages; streamlined the quota transfers process and established clear policies and administrative protocols to guide the allocation of transfers from states with underages to states with overages; allowed for commercial quota transfers to reconcile quota overages after a years end.

Amendment 15 - established annual catch limits and accountability measures.

Amendment 19 – (Recreational Accountability Amendment) – modified the accountability measures for the MAFMC recreational fisheries.

Amendment 17 – implemented standardized bycatch reporting methodology.

Amendment 18 – eliminated the requirement for vessel owners to submit “did not fish” reports for the months or weeks when their vessel was not fishing; removed some of the restrictions for upgrading vessels listed on federal fishing permits.

Framework 9 – modified the southern and eastern boundaries of the southern scup gear restricted area (in effect January 1-March 15).

Amendment 20 - implemented management measures to prevent the development of new, and the expansion of existing, commercial fisheries on certain forage species in the Mid-Atlantic.

Addendum XXIX – established new start and end dates for the scup commercial quota periods, moved first half of May to Winter I and October to Winter II.

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SCUP

Framework 10 - implemented a requirement for vessels that hold party/charter permits for Council-managed species to submit vessel trip reports electronically (eVTRs) while on a trip carrying passengers for hire.

Framework 11 - established a process for setting constant multi-year Acceptable Biological Catch (ABC) limits for Council-managed fisheries, clarified that the Atlantic Bluefish, Tilefish, and Atlantic Mackerel, Squid, and Butterfish FMPs will now automatically incorporate the best available scientific information in calculating ABCs (as all other Mid-Atlantic management plans do) rather than requiring a separate management action to adopt them, clarified the process for setting ABCs for each of the four types of ABC control rules.

Framework 12 – modified the dates of the commercial scup quota periods, moving the month of October from the Summer Period to the Winter II period.

Specific details for each Amendment under development include: None

To ensure compliance with interstate requirements, North Carolina also manages this species 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 MAFMC, 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).

Management Unit

U.S. waters in the western Atlantic Ocean from Cape Hatteras northward to the U.S.-Canadian border.

Goal and Objectives

The objectives of the Summer Flounder, Scup, and Black Sea Bass FMP are to:

1. Reduce fishing mortality in the summer flounder, scup and black sea bass fisheries to assure that overfishing does not occur;
2. Reduce fishing mortality on immature summer flounder, scup and black sea bass to increase spawning stock biomass;
3. Improve the yield from these fisheries;
4. Promote compatible management regulations between state and federal jurisdictions;

5. Promote uniform and effective enforcement of regulations;
6. Minimize regulations to achieve the management objectives stated above.

The 2011 Omnibus Amendment contains Amendment 15 to the Summer Flounder, Scup and Black Sea Bass FMP. The amendment is intended to formalize the process of addressing scientific and management uncertainty when setting catch limits for the upcoming fishing year(s) and to establish a comprehensive system of accountability for catch (including both landings and discards) relative to those limits, for each of the managed resources subject to this requirement. Specifically: (1) Establish allowable biological catch control rules, (2) Establish a MAFMC risk policy, which is one variable needed for the allowable biological catch control rules, (3) Establish annual catch limits, (4) Establish a system of comprehensive accountability, which addresses all components of the catch, (5) Describe the process by which the performance of the annual catch limit and comprehensive accountability system will be reviewed, (6) Describe the process to modify the measures above in 1-5 in the future.

STATUS OF THE STOCK

Life History

Scup are a migratory, schooling species found primarily along the Atlantic coast from Cape Cod, Massachusetts to Cape Hatteras North Carolina. However, a smaller southern stock is believed to occur in North Carolina south of Cape Hatteras. Scup, north of Cape Hatteras, typically reach sexual maturity at age 2 to 3 or when they reach 7 inches fork length. Spawning for the northern stock typically occurs in estuaries and coastal waters during the months of May to August. They move offshore during the fall and winter. Extensive seasonal migration related to spawning is common for scup (north of Cape Hatteras). Scup have a maximum age of 14 years. Scup are bottom (benthic) feeders and prey on small crustaceans, mollusks, squid, sand dollars and fish (Steimle et al. 1999).

Stock Status

The 2015 scup benchmark stock assessment included data through 2014 and indicated that the stock was not overfished and overfishing was not occurring in 2014. A stock assessment update has been scheduled for mid-2019.

Stock Assessment

The 2015 scup benchmark stock assessment estimated fishing mortality and stock sizes using a statistical catch at age model calculated by using the Age Structured Assessment Program. This indicated that the fishing mortality rate was below the threshold reference point and the spawning stock biomass was above the target reference point so the stock was not overfished and overfishing was not occurring as outlined by the biological reference points.

STATUS OF THE FISHERY

Current Regulations

Commercial: 9-inch fork length minimum size limit in Atlantic Ocean and internal coastal waters. Daily trip limits for the different harvest periods (Winter I, Summer, Winter II) are set by proclamation. Winter I and Winter II trip limits follow the coastwide measures, while the summer trip limit is designed to prevent exceeding North Carolina's summer quota allocation (see most recent North Carolina Division of Marine Fisheries (NCDMF) proclamation).

Recreational: 8-inch fork length minimum size, 50-fish creel limit in state Atlantic Ocean and internal coastal waters north of Cape Hatteras; 9-inch fork length minimum size, 50-fish creel limit in federal Atlantic Ocean waters north of Cape Hatteras. Season is year-round.

Commercial Landings

All scup landings are reported through the North Carolina Trip Ticket Program. Most scup landings from north of Cape Hatteras were from trawls. Annual landings were variable from 2008 to 2017 with very low landings during 2012-2013 (Figure 1). The low landings in 2012-2013 were partly due to the closure of Oregon Inlet to large vessels (such as trawlers) and the consequent transfer of most of North Carolina's quota allocation to Virginia and other states. In 2014 and 2015, more winter trawl vessels returned to North Carolina to land catches rather than transferring quota to Virginia and other states. Trends in commercial trips have generally followed landings trends (Figure 1). Trips include the number of trip ticket records with landings of scup reported. Trips may represent more than one day of fishing, especially for trawling.

Recreational Landings

All scup harvest is reported through the NCDMF Marine Recreational Information Program. Recreational harvest of scup north of Cape Hatteras only occurred in 2011, 2012 and 2015 (Table 1).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Two NCDMF sampling programs collect biological data on commercial and recreational fisheries that catch scup north of Cape Hatteras. Program 433 (Winter Trawl Fishery) is the primary program that collects harvest length data. Other commercial sampling programs focusing on fisheries that do not target scup rarely collect biological data. NCDMF sampling of the recreational fishery through the marine recreational information program collects harvest length data. There were no clear trends in commercial trawl length data in 2008-2017 (Table 2). Annual mean lengths were fairly consistent for the time-series and 2017 was typical.

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SCUP

Recreational harvest length data were only collected in 2011, 2012 and 2015 for scup north of Cape Hatteras (Table 3). Only one fish was measured in 2015. Very few scup are encountered in this fishery.

Age data have not been collected by NCDMF for scup north of Cape Hatteras.

Fishery-Independent Monitoring

NCDMF currently does not have independent sampling programs in Atlantic Ocean and internal coastal waters north of Cape Hatteras.

MANAGEMENT STRATEGY

Scup stock assessments are completed by the NMFS Northeast Fisheries Science Center (NEFSC). Results from the 2015 benchmark stock assessment are used to guide management. Data are analyzed from the previous year based on decisions made for the previous benchmark assessment. Projections based on stock assessments are used to set the coastwide quota level each year. Amendments to the FMP are undertaken as issues arise that require action.

RESEARCH NEEDS

The following research needs were reviewed (existing needs) or developed (new) during the 2015 Stock Assessment Workshop by the Southern Demersal Working Group and the MAFMC Scientific and Statistical Committee. Text in parentheses indicates known progress made to address needs.

- Evaluation of indicators of potential changes in stock status that could provide signs to management of potential reductions of stock productivity in the future would be helpful (some progress has been made but more development work is needed).
- A management strategy evaluation of alternative approaches to setting quotas would be helpful (progress unknown).
- Current research trawl surveys are likely adequate to index the abundance of scup at ages 0 to 2. However, the implementation of new standardized research surveys that focus on accurately indexing the abundance of older scup (ages 3 and older) would likely improve the accuracy of the stock assessment (Rhode Island has conducted research but funding was halted which has prohibited further research).
- Continuation of at least the current levels of at-sea and port sampling of the commercial and recreational fisheries in which scup are landed and discarded is critical to adequately characterize the quantity, length and age composition of the fishery catches (adequate sampling is ongoing).
- Quantification of the biases in the catch and discards, including non-compliance, would help confirm the weightings used in the model. Additional studies would be required to address this issue (progress unknown).
- The commercial discard mortality rate was assumed to be 100 percent in this assessment. Experimental work to better characterize the discard mortality rate of scup captured by

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SCUP

different commercial gear types should be conducted to more accurately quantify the magnitude of scup discard mortality (progress unknown).

- Improve estimates of discards and discard mortality for commercial and recreational fisheries (some progress has been made on discard estimates and have been included in the latest assessment but progress is unknown for discard mortality estimates).
- Evaluate indices of stock abundance from new surveys (some progress has been made from the Northeast Area Monitoring and Assessment Program, Rhode Island Department of Fish and Wildlife, and New York State Department of Environmental Conservation and has been included in the latest assessment).
- Quantify the pattern of predation on scup (NEFSC has done some research but more data is needed).
- Conduct biological studies to investigate maturity schedules and factors affecting annual availability of scup to research surveys (NEFSC has made some progress with this research),
- Explore the utility of incorporating ecological relationships, predation, and oceanic events that influence scup population size on the continental shelf and its availability to resource surveys into the stock assessment mode (NEFSC has made some progress).
- Evaluate alternate forms of survey selectivity in the assessment to inform indices of abundance at higher ages (some progress has been made and was included in the latest assessment).
- A standardized fishery dependent catch per unit effort of scup targeted tows, from either Northeast Fisheries Observer Program observer samples or the commercial study fleet, might be considered as an additional index of abundance to complement survey indices in future benchmark assessments (progress unknown).
- Explore additional sources of length and age data from fisheries and surveys in the early parts of the time series to provide additional context for model results (progress unknown).
- Explore experiments to estimate the catchability of scup in NEFSC and other research trawl surveys (side-by-side, camera, gear mensuration, acoustics, etc.) (progress unknown).
- Refine and update the Manderson et al. availability analysis when/if a new ocean model is available (need additional support). Explore alternative niche model parameterizations including laboratory experiments on thermal preference and tolerance (progress unknown).
- Explore study fleet data in general for information that could provide additional context and/or input for the assessment (progress unknown).
- A scientifically designed survey to sample larger and older scup would likely prove useful in improving knowledge of the relative abundance of these large fish (progress unknown).

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Steimle, Frank, Christine Zetlin, Peter Berrien, Donna Johnson, and Sukwoo Chang. 1999. Scup, *Stenotomus chrysops*, Life History and Habitat Characteristics. National Oceanic And Atmospheric Administration. 48 pp.

TABLES

Table 1. Recreational hook and line harvest of scup in numbers of fish north of Cape Hatteras from Marine Recreational Information Program data 2008-2017.

| Year | Harvest (numbers) |
|------|-------------------|
| 2008 | 0 |
| 2009 | 0 |
| 2010 | 0 |
| 2011 | 27 |
| 2012 | 148 |
| 2013 | 0 |
| 2014 | 0 |
| 2015 | 596 |
| 2016 | 0 |
| 2017 | 0 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SCUP

Table 2. Summary of scup length (fork length, mm) data from NCDMF commercial fishery sampling Program 433 (winter trawl fishery) north of Cape Hatteras.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 281 | 183 | 415 | 3,493 |
| 2009 | 281 | 153 | 403 | 1,740 |
| 2010 | 276 | 200 | 386 | 1,450 |
| 2011 | 267 | 198 | 407 | 1,076 |
| 2012 | 327 | 287 | 401 | 7 |
| 2013 | 253 | 192 | 389 | 261 |
| 2014 | 281 | 193 | 441 | 2,725 |
| 2015 | 283 | 127 | 429 | 2,998 |
| 2016 | 273 | 165 | 388 | 1,175 |
| 2017 | 281 | 194 | 405 | 2,879 |

Table 3. Summary of scup length (fork length, mm) data from NCDMF Marine Recreational Information Program north of Cape Hatteras.

| Year | Mean Length | Minimum Length | Maximum Length | Total Measured |
|------|-------------|----------------|----------------|----------------|
| 2008 | 0 | 0 | 0 | 0 |
| 2009 | 0 | 0 | 0 | 0 |
| 2010 | 0 | 0 | 0 | 0 |
| 2011 | 181 | 181 | 181 | 1 |
| 2012 | 290 | 290 | 290 | 1 |
| 2013 | 0 | 0 | 0 | 0 |
| 2014 | 0 | 0 | 0 | 0 |
| 2015 | 110 | 110 | 110 | 1 |
| 2016 | 0 | 0 | 0 | 0 |
| 2017 | 0 | 0 | 0 | 0 |

FIGURES

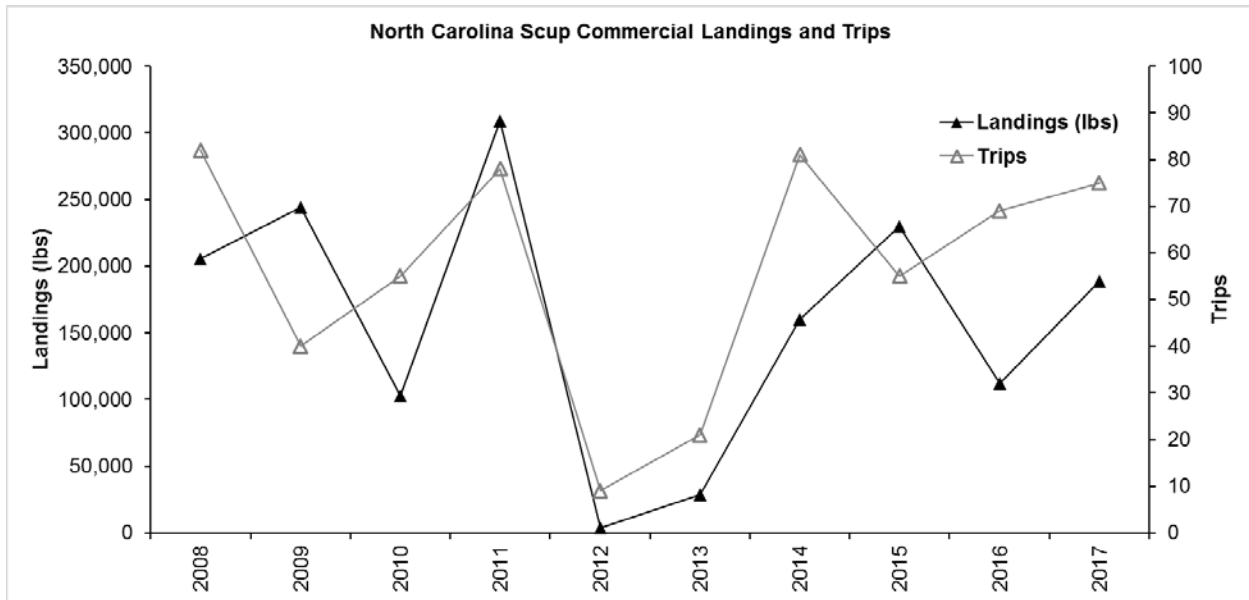


Figure 1. North Carolina commercial landings (total pounds, lb) and trips for scup north of Cape Hatteras 2008-2017.

**FISHERY MANAGEMENT PLAN UPDATE
SHARKS
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|--|
| Original FMP Adoption: | August 2008 Addendum I – September 2009 Addendum II – May 2013 Addendum III – October 2013 Addendum IV – August 2016 |
| Amendments: | None |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | None |

The Atlantic States Marine Fisheries Commission (ASMFC) adopted a fishery management plan (FMP) for coastal sharks in 2008 (ASMFC 2008) to complement federal management actions and increase protection of pregnant females and juveniles in inshore nursery areas. The FMP regulates 40 different species of coastal sharks found on the Atlantic coast. The ASMFC does not actively set quotas for any shark species and follows NOAA Fisheries (National Oceanic and Atmospheric Administration) openings and closures for all shark management groups. Species in the prohibited category may not be possessed or taken. Sandbar sharks (*Carcharhinus plumbeus*) may only be taken with an Atlantic Highly Migratory Species (HMS) Shark Research Fishery Permit. All species must be landed with their fins attached to the carcass by natural means through offloading, with the exception of smooth dogfish (*Mustelus canis*).

Addendum I (ASMFC 2009) modified the FMP to allow limited smooth dogfish processing at sea (removal of fins from the carcass), removed smooth dogfish recreational possession limits, and removed gill net check requirements for smooth dogfish fishermen. The goal of Addendum I was to remove restrictive management intended for large coastal sharks (LCS) from the smooth dogfish fishery and to allow fishermen to continue their operations while upholding the conservation measures of the FMP.

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In 2012, NOAA Fisheries created the smoothhound complex for the management of both the Florida smoothhound and smooth dogfish. Addendum II (ASMFC 2013a) modified the FMP to allow year-round smooth dogfish processing at sea and allocated state-shares of the smooth dogfish federal quota. The goal of Addendum II was to implement an accurate fin-to-carcass ratio and prevent the quota of the smoothhound shark complex from being harvested by one state.

Addendum III (ASMFC 2013b) modified the species groups for hammerhead and blacknose sharks to ensure consistency with NOAA Fisheries. The addendum also increased the recreational size limit for all hammerhead shark species to 78 inches fork length (FL) and for blacknose and finetooth sharks to 54 inches FL.

Addendum IV (ASMFC 2016) allows smooth dogfish carcasses to be landed with corresponding fins removed from the carcass if the total retained catch, by weight, is composed of at least 25 percent smooth dogfish, consistent with federal management measures.

To ensure compliance with interstate requirements, North Carolina also manages the coastal shark complex 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).

Management Unit

The management unit includes the entire coastwide distribution of the resource from the estuaries eastward to the inshore boundary of the exclusive economic zone (EEZ). The management unit is split between the Atlantic and Gulf of Mexico regions for aggregated LCS, hammerhead, non-blacknose small coastal sharks (SCS), and blacknose sharks. No regional quotas are in place for pelagic shark species.

Goal and Objectives

The Interstate FMP for Coastal Sharks (ASMFC 2008) established the following goal and objectives.

The goal of the Interstate FMP for Coastal Sharks is to promote stock rebuilding and management of the coastal shark fishery in a manner that is biologically, economically, socially, and ecologically sound.

In support of this goal, the following objectives are in place for the Interstate Shark FMP:

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1. Reduce fishing mortality to rebuild stock biomass, prevent stock collapse, and support a sustainable fishery.
2. Protect essential habitat areas such as nurseries and pupping grounds to protect sharks during particularly vulnerable stages in their life cycle.
3. Coordinate management activities between state and federal waters to promote complementary regulations throughout the species' range.
4. Obtain biological and improved fishery related data to increase understanding of state water shark fisheries.
5. Minimize endangered species bycatch in shark fisheries.

STATUS OF THE STOCK

Life History

Sharks belong to the class Chondrichthyes (cartilaginous fish) that also includes rays and skates. Relative to other marine fish, sharks produce few young in their lifetime. The low reproductive rate is due to slow growth, late sexual maturity of females, one to two-year reproductive cycles, and small litter size (Musick 1999). These biological factors leave many species of sharks vulnerable to overfishing (Stevens et al. 2000).

Sharks exhibit a number of different reproductive strategies ranging from giving birth to live pups (young) to egg laying (Dulvy and Reynolds 1997). Generally, female sharks produce a small number (2 to 25) large-body pups (Simpfendorfer 1992). For some species, an increased gestation period allows for larger pups which is thought to increase juvenile survivorship (Stevens and McLoughlin 1991). Adults usually gather in specific areas to mate although little is known about shark mating behavior for most species. Sharks also exhibit a wide variety of life history traits across species. Some pelagic species such as shortfin mako (*Isurus oxyrinchus*) or Atlantic thresher (*Alopias vulpinus*), generally remain in offshore ocean environments their whole lives (Casey and Kohler 1992; Smith et al. 2008). Other shark species have an estuarine-dependent component to their life cycle. For example, mature female Atlantic sharpnose sharks (*Rhizoprionodon terraenovae*) and sandbars (*Charcarhinus plumbeus*) travel from near-shore coastal areas into estuarine habitats to pup (Grubbs et al. 2007; Carlson et al. 2008). Coastal shark nursery areas, such as bays and estuaries, are discrete, productive, and highly structured habitats that provide juveniles ample nutrients and refuge from predators (Heupel et al. 2007). Once mature, these shark species will emigrate into coastal ocean environments to continue their life cycle. The variability of life history traits (growth rate, age-at-maturity, reproduction rate, etc.) and highly mobile nature of sharks makes fisheries management across multiple species difficult (Cortés 2002).

Stock Status

Stock status is assessed by species complex for most coastal sharks and by species group for those with enough data for an individual assessment (Table 1). NOAA Fisheries produces an

annual Stock Assessment and Fisheries Evaluation (SAFE) Report that reviews the status of Atlantic HMS fish stocks (tunas, swordfish, billfish, and sharks). These reports are required under the Magnuson-Stevens Fishery Conservation and Management Act and provide the public with information on the latest developments in Atlantic HMS management. The 2016 SAFE Report included information on the stock assessment update for dusky sharks and the continued shark nursery ground research and essential fish habitat studies (NOAA Fisheries 2016).

Stock Assessment

Stock status varies between species and species group (Table 1). The Southeast Data Assessment and Review (SEDAR) completed a benchmark stock assessment on the smoothhound shark complex (*Mustelus spp.*) in the Gulf of Mexico and Atlantic smooth dogfish in the Atlantic through SEDAR 39. The assessment found that neither stock was overfished or experiencing overfishing (SEDAR 2015). The SEDAR 21 (2011) benchmark assessment of dusky (*Carcharhinus obscurus*), sandbar, and blacknose (*Carcharhinus acronotus*) sharks indicated that both sandbar and dusky sharks were overfished with overfishing occurring for dusky sharks. Blacknose sharks, part of the SCS complex, were also overfished with overfishing occurring. The Coast Shark Management Board of ASMFC approved the blacknose shark assessment for management use in February 2012 and NOAA Fisheries' Highly Migratory Species Division (HMS) incorporated the results of the assessment as part of Amendment 5a to its FMP (HMS 2013). The dusky shark stock assessment updated in 2016, resulted in a determination of the population being overfished with overfishing occurring. ASMFC has yet to finalize measures for dusky shark management based on this most recent stock determination.

Porbeagle sharks (*Lamna nasus*) were assessed by the International Commission for the Conservation of Atlantic Tunas (ICCAT) Standing Committee on Research and Statistics in 2009 (ICCAT 2010). The assessment found that while the Northwest Atlantic stock was increasing in biomass, the stock was considered to be overfished with overfishing not occurring. The 2007 SEDAR 13 assessed the SCS complex, finetooth (*Carcharhinus isodon*), Atlantic sharpnose (*Rhizoprionodon terraenovae*), and bonnethead (*Sphyrna tiburo*) sharks (SEDAR 2013). The SEDAR 13 peer reviewers considered the data to be the 'best available at the time' and determined the status of the SCS complex to be adequate. Finetooth, Atlantic sharpnose and bonnethead were all considered to be not overfished and not experiencing overfishing. Atlantic sharpnose and bonnethead were more recently assessed by SEDAR 34, and are still considered not overfished or undergoing overfishing (SEDAR 2013).

SEDAR 11 (2006) assessed the LCS complex and blacktip sharks (*Carcharhinus limbatus*). The LCS assessment suggested that it was inappropriate to assess the LCS complex as a whole due to the variation in life history parameters, different intrinsic rates of increase, and different catch and abundance data for all species included in the LCS complex. Based on these results, NOAA Fisheries changed the status of the LCS complex from overfished to unknown. As part of SEDAR 11, blacktip sharks were assessed for the first time as two separate populations: Gulf of Mexico and Atlantic. The results indicated that the Gulf of Mexico stock was not overfished and overfishing was not occurring, while the status of blacktip sharks in the Atlantic region was unknown.

In 2017, ICCAT updated a 2012 stock assessment for shortfin mako sharks (*Isurus oxyrinchus*). This assessment used another modeling approach which incorporated more abundance indices, sex-specific life history data, and tagging information. Based on model results, the population was considered overfished with overfishing occurring. In March of 2018, NOAA HMS implemented emergency rules for both commercial and recreational fisheries to achieve the 75% reduction in landings stipulated by ICCAT. For the pelagic longline commercial sector, shortfin makos can only be landed if the individual is dead on haul back and the vessel has on-board NOAA observer or video monitoring. Shortfin makos cannot be retained using non-pelagic longline gear. For recreational fisherman, the minimum size limit was raised to 83 inches (210 cm) fork length. Due to the paucity of captures of shortfin makos in state waters, the ASMFC Coastal Shark Technical Committee reached a consensus that complimentary measures were not warranted immediately.

STATUS OF THE FISHERY

Current Regulations

Commercial

All non-prohibited coastal shark complexes opened in North Carolina on January 1, 2017 (Table 2) reflecting NOAA Fisheries openings for these complexes. NOAA Fisheries closes the shark complexes when 80 percent of their quota is reached. When the fishery closes in federal waters, the Interstate FMP dictates that the fishery also closes in state waters. No harvest or size restrictions are in place except for LCS, and it is unlawful to possess more than 36 LCS per trip. It is unlawful to possess any shark (with the exception of smooth dogfish) without tail and fins naturally attached to the carcass through offloading. Commercial fishermen may completely remove the fins of smooth dogfish, if the total retained catch, by weight, is composed of at least 25 percent smooth dogfish. If fins are removed, the total wet weight of the shark fins may not exceed 12 percent of the total dressed weight of smooth dogfish carcasses landed or found onboard a vessel. It is unlawful for a vessel to retain, transship, land, store or sell scalloped hammerhead, great hammerhead, or smooth hammerhead sharks with pelagic longline gear onboard. It is unlawful for a vessel to retain sandbar sharks unless the vessel is selected to participate in the shark research fishery, subject to retention limits established by NOAA Fisheries and only when a NOAA Fisheries approved observer is onboard. It is unlawful to use gears other than rod and reel, handlines, large and small mesh gill nets, shortlines (maximum of two shortlines, 500 yards each with 50 hooks or less, hooks shall not be corrosion resistant and must be designated by the manufacturer as circle hooks), pound nets/fish traps, and trawl nets. It is unlawful to use a large mesh (stretched mesh size greater than or equal to five inch) gill net more than 2,734 yards in length to capture sharks. It is unlawful to sell shark to anyone who is not a federally-permitted shark dealer.

NOAA Fisheries sets quotas for coastal sharks through their 2006 Consolidated Highly Migratory Species Fishery Management Plan (HMS FMP) (NOAA Fisheries 2006). As indicated above, the states follow NOAA Fisheries openings and closings, which are based on those quotas (Table 2).

Recreational

All non-prohibited coastal shark complexes opened on January 1, 2017. These openings followed NOAA Fisheries openings of the species complexes. It is unlawful for a recreational angler to possess more than one Atlantic sharpnose, and one bonnethead and one additional shark from the recreationally permitted species list per person per calendar day (Table 3). If fishing from a vessel, it is unlawful to have more than one additional shark from the recreationally permitted species list aboard a vessel, per calendar day, regardless of the number of people on board the vessel. It is unlawful to possess silky sharks (*Carcharhinus falciformis*) and sandbar sharks for recreational purposes. It is unlawful to possess great hammerhead, smooth hammerhead and scalloped hammerhead sharks less than 78 inches fork length (Table 4). It is unlawful to possess the rest of the LCS, blacknose, finetooth, and pelagic shark species less than 54 inches fork length (Table 4). Smooth dogfish and SCS have no minimum size, except for blacknose sharks. It is unlawful for recreational fishermen to possess any shark without head, tail, and fins intact with the carcass through the point of landing. Anglers may still gut and bleed the carcass as long as the tail is not removed. Filleting sharks at sea is prohibited. It is unlawful to fail to return all sharks not meeting harvest requirements (including prohibited species) to the water in a manner that ensures the highest likelihood of survival. It is unlawful for recreational fishermen to catch sharks by any method other than rod and reel or handlines. Handlines are defined as a mainline with no more than two gangions or hooks attached that are retrieved by hand only. It is unlawful to possess a great hammerhead, scalloped hammerhead, smooth hammerhead, or oceanic whitetip shark while in possession of tunas, billfish or, swordfish.

Commercial Landings

Table 2 summarized commercial landings data from 2017 by shark management group. Atlantic commercial landings of LCS totaled 288,383 pounds dressed weight (dw) in 2017 a decrease of 68,020 pounds from 2016. Total commercial landings of hammerhead sharks was 20,590 pounds dw in 2017 a decrease from 30,900 pounds dw reported in 2016. Commercial landings of non-blacknose SCS shark species in 2017 totaled 273,978 pounds dw, which was an increase from the 180,942 pounds dw observed in 2016. The commercial landings total of blacknose sharks south of 34° N latitude (Kure Beach, North Carolina) in 2017 was 17,241 pounds dw. Commercial retention of blacknose sharks is prohibited north of 34° N latitude. In 2017, the total commercial landings of pelagic shark species was 246,687 pounds dw. This is an increase of 15,847 pounds dw from 2016. Commercial landings of smoothhound sharks in 2017 were 832,480 pounds dw an increase of 145,623 pounds dw from 2016. In North Carolina, commercial landings have been variable for the past ten years (Table 5).

Recreational Landings

Recreational harvest for SCS has fluctuated from a peak harvest number of 5,989 in 2010 to a low of 550 in 2016, and averaged 2,717 sharks from 2008 to 2017. Recreational landings ranged from 2,709 pounds whole weight (ww) to 36,544 pounds ww and averaged 17,726 pounds ww from 2008 to 2017 (Table 6).

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Recreational harvest for LCS has been on a much smaller magnitude relative to SCS. Annual harvest numbers have ranged from 0 to 388 and averaged 164 sharks from 2008 to 2017 (Table 7).

Recreational harvest of pelagic sharks is similar to LCS. Harvest numbers for pelagic sharks ranged from 28 to 576 and averaged 132 sharks from 2008 to 2017 (Table 8).

Recreational harvest of smooth dogfish contributes to the highest release number. Harvest numbers for smooth dogfish ranged from 0 to 3,337 and averaged 1,452 sharks from 2008 to 2017 (Table 9).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

North Carolina does not collect individual lengths for sharks other than spiny dogfish, due to the fish arriving at the dock dressed (i.e. gutted with head and tail removed).

Fishery-Independent Monitoring

The North Carolina Division of Marine Fisheries (NCDMF) established a fisheries-independent adult red drum longline survey in 2007. Since this survey is conducted using longline gear, Atlantic coastal shark species are susceptible to capture. In 2017, three coastal shark species were encountered in the survey. Six blacktip and two bull sharks were tagged with a Northeast Fisheries Science Center's Apex Predators Program tag and released (Table 10).

NCDMF has conducted a fisheries-independent gill net survey which has been conducted in Pamlico Sound since 2001. The objective of this project is to provide annual indices of abundance for key estuarine species in North Carolina that can be incorporated into stock assessments. Data from this survey are used to improve bycatch estimates, evaluate management measures, and evaluate habitat usage. Results from this project are used by the NCDMF and other Atlantic coast fishery management agencies to evaluate the effectiveness of current management measures and to identify additional measures that may be necessary to conserve marine and estuarine stocks. Developing fishery independent indices of abundance for target species allows the NCDMF to assess the status of these stocks without relying solely on commercial and recreational fishery dependent data. Sampling is a stratified random sampling design in Pamlico Sound, utilizing multiple mesh gill nets (3.0-6.5 inch in one-half inch increments). In 2017, a total of 83 individual coastal sharks were captured in the gill net survey (Table 11). This result was similar to the number of sharks encountered in 2017 (n=84).

MANAGEMENT STRATEGY

Most Atlantic shark species are highly mobile and the NOAA Fisheries' HMS Management Division is responsible for managing them under the Magnuson-Stevens Fishery Conservation and Management Act. In cooperation with an advisory panel, the division develops and

implements FMPs for these species considering various domestic and international requirements. The ASMFC adopts NOAA Fisheries regulations in state waters.

RESEARCH NEEDS

The 2015 review of the ASMFC FMP (ASMFC 2016) for coastal sharks lists the following research needs:

Species-Specific Priorities

- Investigate the appropriateness of using vertebrae for ageing adult sandbar sharks. If appropriate, implement a systematic sampling program that gathers vertebral samples from entire size range for annual ageing to allow tracking the age distribution of the catch as well as updating of age-length keys.
- Develop and conduct tagging studies on dusky and blacknose stock structure with increased international collaboration (e.g., Mexico) to ensure wider distribution and returns of tags. Expand research efforts directed towards tagging of individuals in south Florida and Texas/Mexico border to get better data discerning potential stock mixing.

General Priorities

- Update age and growth and reproductive studies for all species currently assessed
- Determine gear-specific post-release mortality estimates for all species currently assessed.
- Determine life history information for data-poor species that are currently not assessed.
- Examine female sharks during the pupping periods to determine the proportion of reproductive females. Efforts should be made to develop non-lethal methods of determining pregnancy status.
- Expand or develop monitoring programs to collect appropriate length and age samples from the catches in the commercial sector by gear type, from catches in the recreational sector, and from catches taken in research surveys to provide reliable length and age compositions for stock assessment.
- Continue investigations into stock structure of coastal sharks using genetic, conventional and electronic tags to determine appropriate management units.
- Evaluate to what extent the different CPUE indices track population abundance (e.g., through power analysis).
- Explore modeling approaches that do not require an assumption that the population is at virgin level at some point in time.
- Increase funding to allow hiring of additional HMS stock assessment scientists. There are currently inadequate staff to conduct stock assessments on more than one or two stocks/species per year.

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TABLES

Table 1. Atlantic States Marine Fisheries Commissions 2018 stock status designations for coastal sharks species groups.

| Species or Complex Name | Stock overfished? | Stock undergoing overfishing? | Stock assessment year and comments |
|--|--------------------------|--------------------------------------|---|
| <i>Pelagic</i> | | | |
| Porbeagle | Yes | No | 2009: Rebuilding ends 2018 |
| Blue | No | No | 2015 |
| Shortfin Mako | Yes | Yes | 2017 |
| All other pelagic species | Unknown | Unknown | |
| <i>Large Coastal Sharks</i> | | | |
| Blacktip | Unknown | Unknown | 2006 |
| Aggregated Large Coastal Sharks-Atlantic Region | Unknown | Unknown | 2006: Difficult to assess as a species complex due to various life history characteristics/lack of available data |
| <i>Non-blacknose Small Coastal Sharks</i> | | | |
| Atlantic Sharpnose | No | No | 2013 |
| Bonnethead | No | No | 2013 |
| Finetooth | No | No | 2007 |
| <i>Hammerhead</i> | | | |
| Scalloped | Yes | Yes | 2009 |
| <i>Blacknose</i> | | | |
| Blacknose | Yes | Yes | 2010: Rebuilding ends in 2043 |
| <i>Smoothhound</i> | | | |
| Smooth Dogfish | No | No | 2015 |
| <i>Research</i> | | | |
| Sandbar | Yes | No | 2010 |
| <i>Prohibited</i> | | | |
| Dusky | Yes | Yes | 2010 |
| All other prohibited species | Unknown | Unknown | |

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Table 2. Summary of the 2017 coastwide Atlantic coastal shark commercial fishery landings and annual quota in pounds by dressed weight (lb dw) (NOAA Fisheries 2018).

| Management Group | Region | 2017 Annual Adjusted Quota (lb dw) | Season Opening Date | Season Closing Date | 2017 Landings (lb dw) |
|--|--------------------|------------------------------------|---------------------|---------------------|-----------------------|
| Aggregated Large Coastal Sharks | Atlantic | 372,552 | 1/1/2017 | 12/31/2017 | 288,383 |
| Hammerhead Sharks | | 59,736 | | | 20,590 |
| Non-Blacknose Small Coastal Sharks | | 582,333 | 1/1/2017 | 12/31/2017 | 273,978 |
| Blacknose Sharks (South of 34° N. latitude only) | | 37,921 | | 12/31/2017 | 17,241 |
| Blue Sharks | 601,856 | 12/31/2017 | | < 2,000 | |
| Porbeagle Sharks | 3,748 | 12/31/2017 | | < 1,000 | |
| Pelagic Sharks Other Than Porbeagle or Blue | No Regional Quotas | 1,075,856 | | 12/31/2017 | 246,687 |
| Smoothhound | | 3,973,902 | | | 832,480 |

Table 3. Recreationally permitted species list.

| SPECIES AUTHORIZED FOR RECREATIONAL HARVEST | | | |
|--|--|--|------------------------------------|
| Large Coastal Sharks (LCS) (non-ridgeback* LCS & tiger) | Small Coastal Sharks (SCS) | Pelagic Sharks | Other |
| Blacktip Bull Hammerhead, great** Hammerhead, scalloped** Hammerhead, smooth** Lemon Nurse Spinner Tiger | Atlantic Sharpnose Blacknose Bonnethead Finetooth | Blue Oceanic whitetip** Porbeagle Shortfinmako Thresher | Smoothhound Shark (Smooth Dogfish) |

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Table 4. Recreational size and bag limits.

| RECREATIONAL SIZE / BAG LIMITS and SEASONS | | | |
|---|--|---|------------------|
| Species | Minimum Size (Fork Length) in Inches (") | Trip Bag Limit/Calendar Day | Season |
| Atlantic sharpnose | None | 1 per person of each species | Jan. 1 – Dec. 31 |
| Bonnethead | None | | |
| Hammerheads (Great, Smooth and Scalloped) | 78" | 1 per vessel <u>OR</u> 1 per person for shore-anglers | |
| Non-Hammerhead LCS, Tiger, Pelagic, Blacknose, and Finetooth Sharks | 54" | | |
| Small Coastal Sharks (SCS) | None | | |

Table 5. Summary of North Carolina landings (lbs.) for large coastal sharks (LCS), small coastal sharks (SCS), blacknose, hammerheads, smoothhound, pelagics, and sandbars from 2008-2017.

| Year | LCS | SCS (non-blacknose) | Blacknose | Hammerhead | Smoothhound | Pelagics | Sandbar |
|------|---------|---------------------|-----------|------------|-------------|----------|---------|
| 2008 | 43,068 | 70,800 | 0 | 0 | 826,274 | 178,754 | 0 |
| 2009 | 42,586 | 182,314 | 0 | 0 | 1,221,150 | 166,556 | 0 |
| 2010 | 96,462 | 132,572 | 0 | 0 | 1,614,844 | 295,163 | 58,746 |
| 2011 | 88,742 | 133,586 | 2,338 | 0 | 1,241,252 | 245,186 | 61,166 |
| 2012 | 101,882 | 276,048 | 3,394 | 44 | 980,333 | 243,121 | 19,792 |
| 2013 | 134,872 | 133,744 | 7,054 | 12,114 | 783,053 | 220,872 | 22,468 |
| 2014 | 269,436 | 200,887 | 3,685 | 28,264 | 498,904 | 424,851 | 71,272 |
| 2015 | 150,394 | 371,069 | 3,957 | 41,768 | 268,429 | 176,882 | 47,554 |
| 2016 | 230,797 | 369,948 | 1,192 | 62,135 | 178,694 | 224,746 | 57,226 |
| 2017 | 173,758 | 359,486 | 0 | 40,743 | 154,440 | 240,250 | 42,384 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SHARKS

Table 6. North Carolina small coastal sharks recreational harvest, discards, and percent standard error (PSE) (including blacknose) 2008-2017.

| Year | Harvest | | Weight (lb) | | Number Released | |
|------|---------|------|-------------|------|-----------------|------|
| | Number | PSE | | PSE | | PSE |
| 2008 | 3,268 | 66.4 | 18,610 | 66.4 | 0 | |
| 2009 | 3,402 | 38.7 | 29,148 | 44.6 | 1,260 | 65.3 |
| 2010 | 5,989 | 31.9 | 36,544 | 34.1 | 12,358 | 59.6 |
| 2011 | 2,127 | 42.8 | 15,414 | 44.0 | 11,049 | 29.9 |
| 2012 | 1,449 | 51.6 | 9,839 | 51.6 | 3,319 | 46.5 |
| 2013 | 1,325 | 37.6 | 8,038 | 39.4 | 5,736 | 43.6 |
| 2014 | 2,796 | 32.0 | 15,657 | 31.1 | 1,662 | 45.1 |
| 2015 | 3,983 | 32.7 | 24,150 | 32.1 | 5,132 | 50.1 |
| 2016 | 550 | 60.2 | 2,709 | 57.8 | 18,011 | 40.6 |
| 2017 | 2,282 | 75.2 | 17,150 | 73.7 | 11,315 | 66.8 |

*PSE higher than 50 indicates a very imprecise estimate.

Table 7. North Carolina large coastal sharks recreational harvest, discards, and percent standard error (PSE) 2008-2017.

| Year | Harvest | | Weight (lb) | | Number Released | |
|------|---------|-------|-------------|-------|-----------------|------|
| | Number | PSE | | PSE | | PSE |
| 2008 | 61 | 104.8 | 798 | 104.8 | 0 | |
| 2009 | | | | | 582 | 89.1 |
| 2010 | 388 | 94.0 | 685 | 94.0 | 10589 | 57.2 |
| 2011 | 305 | 99.9 | 471 | 99.9 | 3,342 | 77.9 |
| 2012 | 243 | 76.7 | 22,634 | 64.1 | 3,898 | 59.7 |
| 2013 | 59 | 113.4 | 11,128 | 113.4 | 2,776 | 35.1 |
| 2014 | 242 | 79.0 | 4,464 | 80.2 | 7,993 | 54.6 |
| 2015 | 10 | 99.9 | 0 | | 25,511 | 50.9 |
| 2016 | 14 | 102.2 | 1,212 | 102.2 | 4,520 | 39.9 |
| 2017 | 155 | 90.8 | 17,004 | 94.5 | 9,993 | 67.8 |

*PSE higher than 50 indicates a very imprecise estimate.

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SHARKS

Table 8. North Carolina pelagic sharks recreational harvest, discards, and percent standard error (PSE) 2008-2017.

| Year | Harvest | | Weight (lb) | | Number Released | |
|------|---------|-------|-------------|-------|-----------------|-------|
| | Number | PSE | | PSE | | PSE |
| 2008 | 30 | 79.8 | 2,693 | 79.8 | | |
| 2009 | 102 | 55.6 | 9,009 | 55.1 | | |
| 2010 | 87 | 78.2 | 13,559 | 84.4 | 116 | 98.9 |
| 2011 | 88 | 77.0 | 5,356 | 68.6 | 25 | 63.8 |
| 2012 | 172 | 63.2 | 11,697 | 61.1 | 13 | 98.0 |
| 2013 | 28 | 100.8 | 1,219 | 100.8 | 374 | 96.4 |
| 2014 | 37 | 56.0 | 2,981 | 53.4 | 62 | 110.8 |
| 2015 | 576 | 78.0 | 63,862 | 84.1 | 467 | 93.9 |
| 2016 | | | | | 891 | 71.4 |
| 2017 | 72 | 63.5 | 5,174 | 62.6 | 34 | 85 |

*PSE higher than 50 indicates a very imprecise estimate.

Table 9. North Carolina recreational harvest, discards, and percent standard error (PSE) of smooth dogfish 2008-2017.

| Year | Harvest | | Weight (lb) | | Number Released | |
|------|---------|-------|-------------|-------|-----------------|------|
| | Number | PSE | | PSE | | PSE |
| 2008 | 3,337 | 69.6 | 2,433 | 68.0 | 41,265 | 41.2 |
| 2009 | 929 | 82.4 | 16,251 | 98.9 | 19,972 | 74.3 |
| 2010 | 1,540 | 63.4 | 3,035 | 62.8 | 55,306 | 26.5 |
| 2011 | 3,087 | 54.8 | 3,792 | 54.1 | 95,873 | 28.0 |
| 2012 | 176 | 71.5 | 743 | 80.7 | 3,951 | 35.9 |
| 2013 | 1,581 | 100.0 | 4,009 | 100.0 | 12,777 | 46.3 |
| 2014 | | | | | 20,142 | 31.8 |
| 2015 | 961 | 81.4 | 1,799 | 85.3 | 21,315 | 45.6 |
| 2016 | 1,459 | 89.1 | 2,602 | 90.7 | 14,587 | 44.1 |
| 2017 | 0 | | 0 | | 16,140 | 34.6 |

*PSE higher than 50 indicates a very imprecise estimate.

Table 10. Shark species captured in the NCDMF 2017 independent red drum longline project in the Pamlico Sound.

| Species | Number Measured | Min of TL (mm) | Max of TL (mm) | Average of TL (mm) |
|--------------------|-----------------|----------------|----------------|--------------------|
| Bull | 2 | 890 | 1,520 | 1,205 |
| Blacktip | 18 | 472 | 1,760 | 1,051 |
| Atlantic Sharpnose | 1 | 495 | 495 | 495 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SHARKS

Table 11. Shark species captured in the NCDMF 2017 Pamlico Sound Independent Gill Net Survey. Asterisk indicates a single individual was captured of represented species.

| Species | Number Measured | Min of TL (mm) | Max of TL (mm) | Average of TL (mm) |
|-----------------------|-----------------|----------------|----------------|--------------------|
| Blacknose* | 1 | 1,227 | 1,227 | 1,227 |
| Bull Shark | 23 | 611 | 1,100 | 797 |
| Blacktip* | 1 | 1,680 | 1,680 | 1,680 |
| Sandbar | 17 | 697 | 974 | 807 |
| Smooth Dogfish | 10 | 617 | 964 | 710 |
| Atlantic Sharpnose | 10 | 436 | 901 | 534 |
| Scalloped hammerhead* | 1 | 536 | 536 | 536 |
| Bonnethead | 20 | 575 | 958 | 704 |

**FISHERY MANAGEMENT PLAN UPDATE
SNAPPER GROUPE COMPLEX
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

Original FMP Adoption: August 1983 (SAFMC 1983a, b; 48 FR 39463)

Amendments:

- Regulatory Amendment 1 - March 1987
- Regulatory Amendment 2 - March 1989
- Amendment 1 - January 1989
- Regulatory Amendment 3 - November 1990
- Amendment 2 - December 1990
- Amendment 3 - January 1991
- Amendment 4 - January 1992
- Amendment 5 - April 1992
- Regulatory Amendment 4 - July 1993
- Regulatory Amendment 5 - July 1993
- Amendment 6 - July 1994
- Amendment 7 - January 1995
- Regulatory Amendment 6 - May 1995
- Amendment 8 - December 1998
- Regulatory Amendment 7 - January 1999
- Amendment 9 - February 1999/October 2000
- Amendment 10 - July 2000
- Amendment 11 - December 1999
- Regulatory Amendment 8 - November 2000
- Amendment 12 - September 2000
- Amendment 13a - April 2004
- Amendment 13c - October 2006
- Amendment 14 - February 2009
- Amendment 15a - March 2008
- Amendment 15b - February 2010
- Amendment 16 - July 2009
- Amendment 19 - July 2010
- Amendment 17a - March 2011
- Amendment 17b - January 2011
- Regulatory Amendment 10 - May 2011
- Regulatory Amendment 9 - July 2011
- Regulatory Amendment 11 - May 2012
- Amendment 25 - April 2012
- Amendment 24 - July 2012
- Amendment 23 - January 2012

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPEL

| | |
|-------------------------|--|
| Amendments (continued): | Amendment 18a - July 2012/January 2013 Amendment 20a - October 2012 Regulatory Amendment 12 - October 2012 Amendment 18b - May 2013 Regulatory Amendment 13 - July 2013 Regulatory Amendment 14 - December 2014 Regulatory Amendment 15 - September 2013 Amendment 27 - January 2014 Amendment 31 - January 2014 Amendment 28 - August 2013 Regulatory Amendment 18 - September 2013 Regulatory Amendment 19 - October 2013 Regulatory Amendment 21 - November 2014 Amendment 32 - March 2015 Amendment 29 - July 2015 Regulatory Amendment 22 - August/September 2015 Regulatory Amendment 20 - August 2015 Amendment 33 - January 2016 Amendment 34 - February 2016 Amendment 35 - June 2016 Regulatory Amendment 25 - August 2016 Regulatory Amendment 16 - December 2016/March 2017 Amendment 36 - July 2017 Amendment 37 - August 2017 Amendment 41 - February 2018 |
| Revisions: | N/A |
| Supplements: | N/A |
| Information Updates: | N/A |
| Schedule Changes: | N/A |
| Next Benchmark Review: | N/A |

Of the 75-species managed by the South Atlantic Fishery Management Council (SAFMC), 55 of these are included in the Snapper-Grouper management complex. Because of its mixed species nature, this fishery offers the greatest challenge for SAFMC to manage. Initially, Fishery Management Plan (FMP) regulations consisted of minimum sizes, gear restrictions, and a provision for the designation of Special Management Zones (SMZs). Early attempts to develop more effective management measures were thwarted by lack of data on both the resource and the fishery. The condition of many of the species within the snapper grouper complex is unknown. Improved data collection (in terms of quantity and quality) during the 1980s and 90s has provided more management information on some of the more commercially and recreationally

valuable species, but lack of basic management data on many of the species remains the major obstacle to successful management.

Management of the snapper-grouper fishery is also difficult because many of these species are slow growing, late maturing, hermaphroditic, and long lived; thus, rebuilding efforts for some species will take years to full recovery. Strict management measures, including prohibition of harvest in some cases, have been implemented to rebuild overfished species in the snapper-grouper complex. Such harvest restrictions are beneficial, not only in rebuilding species, but also in helping to prevent species from undergoing overfishing in the future.

Regulatory Amendment 1 (48 FR 9864) prohibited fishing in SMZs, except with hand-held hook-and-line and spearfishing gear; prohibited harvest of goliath grouper in SMZs; and implemented SMZs off South Carolina and Georgia.

Regulatory Amendment 2 (54 FR 8342) established two artificial reefs off Fort Pierce, Florida as SMZs.

Amendment 1 (SAFMC 1988; 54 FR 1720) prohibited use of trawl gear to harvest fish in the snapper-grouper fishery south of Cape Hatteras, North Carolina and north of Cape Canaveral, Florida; defined directed snapper-grouper fishery as a vessel with trawl gear and greater than or equal to 200-pounds of snapper grouper species onboard; and established the rebuttable assumption that vessels with snapper grouper species onboard harvested these fish in the U.S. Exclusive Economic Zone (EEZ).

Regulatory Amendment 3 (55 FR 40394) established an artificial reef at Key Biscayne, Florida as an SMZ in Dade County, Florida; prohibited fish trapping, bottom longlining, spearfishing and harvesting of Goliath grouper in SMZs.

Amendment 2 (SAFMC 1990a; 55 FR 46213) prohibited harvest or possession of Goliath grouper in or from the EEZ in the South Atlantic and defined overfishing for snapper-grouper species according to NMFS 602 guidelines.

Amendment 3 (SAFMC 1990b; 56 FR 2443) established a management program for the wreckfish fishery which: added wreckfish to the snapper grouper management unit; defined Optimum Yield (OY) and overfishing; required an annual permit to fish for, land or sell wreckfish; established a control date of March 28, 1990 for the area bounded by 33° and 30° N latitude; established a fishing year beginning April 16; established a process whereby annual quotas would be specified; implemented a 10,000 pound trip limit and a January 15 – April 15 spawning season closure.

Amendment 4 (SAFMC 1991a; 56 FR 56016) prohibited the use of various gear, including fish traps, the use of bottom longlines for wreckfish, and powerheads in SMZ off South Carolina; established bag limits and minimum size limits for several species; established income requirements to qualify for permits; and required that all snapper-grouper species possessed in South Atlantic federal waters must have heads and fins intact through landing.

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPEL

Amendment 5 (SAFMC 1991b; 57 FR 7886) established an Individual Transferable Quota (ITQ) management program for the wreckfish fishery.

Regulatory Amendment 4 (SAFMC 1992a; 58 FR 36155) modified the definition of black sea bass pots; allowed for multi-gear trips and the retention of incidentally caught fish.

Regulatory Amendment 5 (SAFMC 1992b; 58 FR 35895) established eight additional SMZs off the coast of South Carolina.

Amendment 6 (SAFMC 1993; 59 FR 27242) established commercial quotas for snowy grouper, golden tilefish; established commercial trip limits for snowy grouper, golden tilefish, speckled hind, and Warsaw grouper; included golden tilefish in grouper recreational aggregate bag limits; prohibited sale of Warsaw grouper and speckled hind; created the Oculina Experimental Closed Area; and specified data collection needs for evaluation of possible future Individual Fishing Quota (IFQ) system.

Amendment 7 (SAFMC 1994a; 59 FR 66270) established size limits and bag limits for hogfish and mutton snapper; specified allowable gear; prohibited the use of explosive charges, including powerheads, off South Carolina; and required dealer, charter, and headboat federal permits.

Regulatory Amendment 6 (SAFMC 1994b; 60 FR 19683) includes provisions to rebuild and protect hogfish by implementing a recreational bag limit of five fish per person off Florida; protect cubera snapper by implementing a recreational bag limit of two per person for fish 30-inches total length or larger off Florida; and protect gray triggerfish by implementing a minimum size limit of 12-inches total length (TL) off Florida.

Amendment 8 (SAFMC 1997; 63 FR 38298) established a limited entry system for the snapper-grouper fishery.

Regulatory Amendment 7 (63 FR 71793) established ten SMZs at artificial reefs off South Carolina.

Amendment 9 (SAFMC 1998a; 64 FR 3624; 65 FR 55203) increased the minimum size limits on red porgy, black sea bass, vermillion snapper (recreational only), gag, and black grouper; changed bag limits for red porgy, black sea bass, greater amberjack, gag, and black grouper; established an aggregate recreational bag limit of 20 fish per person per day inclusive of all snapper grouper species currently not under a bag limit, excluding tomtate and blue runners; and specified that vessels with bottom longline gear aboard may only possess snowy grouper, Warsaw grouper, yellowedge grouper, misty grouper, golden tilefish, blueline tilefish, and sand tilefish.

Amendment 10 (SAFMC 1998b; 65 FR 37292) identified Essential Fish Habitat (EFH) and EFH - Habitat Areas of Particular Concern (HAPCs) for species in the snapper-grouper management unit.

Amendment 11 (SAFMC 1998c; 64 FR 59126) amended the FMP as required to make definitions of Maximum Sustainable Yield (MSY), OY, overfishing and overfished consistent with "National Standard Guidelines"; identified and defined fishing communities; and addressed bycatch management measures.

Regulatory Amendment 8 (65 FR 61114) established 12 SMZs at artificial reefs off Georgia; revised boundaries of seven existing SMZs off Georgia to meet Coast Guard permit specifications; restricted fishing in new and revised SMZs.

Amendment 12 (SAFMC 2000; 65 FR 51248) set regulatory limits for red porgy including a recreational bag limit, a commercial incidental catch limit, and a recreational and commercial size limit. It also permitted the transfer of the 225-pound trip limited commercial permit to another vessel (not another person) regardless of vessel size.

Amendment 13A (SAFMC 2003; 69 FR 15731) extended regulations within the Oculina Experimental Closed Area off the east coast of Florida that prohibit fishing for and retention of snapper grouper species for an indefinite period with a 10-year re-evaluation by the Council. The Council will review the configuration and size of the area within three years of publication of the Final Rule (March 26, 2004).

Amendment 13C (SAFMC 2006; 71 FR 55096) addressed overfishing for snowy grouper, golden tilefish, black sea bass and vermilion snapper. The amendment also allowed for a moderate increase in the harvest of red porgy as stock continues to rebuild.

Amendment 14 (SAFMC 2007a; 74 FR 1621) established a series of deepwater marine protected areas in the South Atlantic EEZ.

Amendment 15A (SAFMC 2008a; 73 FR 14942) updated management reference points for snowy grouper, black sea bass, and red porgy; modified rebuilding schedules for snowy grouper and black sea bass; defined rebuilding strategies for snowy grouper, black sea bass, and red porgy; and redefined the minimum stock size threshold for the snowy grouper stock.

Amendment 15B (SAFMC 2008b; 74 FR 58902) prohibited sale the sale of bag-limit caught snapper grouper species; reduced the effects of incidental hooking on sea turtles and smalltooth sawfish; changed the commercial permit renewal period and transferability requirements; implemented a plan to monitor and address bycatch; and established management reference points for golden tilefish. Amendment 15B also established allocations between recreational and commercial fishermen for snowy grouper and red porgy.

Amendment 16 (SAFMC 2009a; 74 FR 30964) included measures to end overfishing for gag grouper and vermilion snapper; established commercial and recreational allocations for both species; established a January through April spawning season closure for gag, black grouper, red grouper, scamp, red hind, rock hind, yellowmouth grouper, tiger grouper, yellowfin grouper, graysby, and coney; reduced the aggregate grouper bag limit from five fish to three fish, and within that, reduced the gag bag limit from two fish to one gag or black grouper, combined; reduced the vermilion snapper bag limit from 10 fish to five fish; established a recreational

closed season for vermilion snapper of November through March; excluded captain and crew on for-hire vessels from retaining a bag limit of groupers; and required the use of dehooking tools to reduce bycatch mortality.

Amendment 19 (SAFMC 2009b; 75 FR 35330) was included under the Comprehensive Ecosystem-Based Amendment 1 (CE-BA 1) and included measures to provide presentation of spatial information for EFH and EFH-HAPC designations under the Snapper-Grouper FMP; and designation of deepwater coral HAPCs.

Amendment 17A (SAFMC 2010a; 75 FR 76874) addressed management measures to end overfishing of red snapper and rebuild the stock, including Annual Catch Limits (ACLs) and Accountability Measures (AMs). It extended the prohibition of red snapper in federal waters throughout the South Atlantic EEZ effective immediately. Amendment 17A also included a regulation requiring the use of non-stainless circle hooks north of 28 degrees N latitude effective March 3, 2011.

Amendment 17B (SAFMC 2010b; 75 FR 82280) established ACLs and AMs and addressed overfishing for nine species in the snapper grouper management complex: golden tilefish, snowy grouper, speckled hind, Warsaw grouper, black grouper, black sea bass, gag, red grouper, and vermilion snapper. Measures in Amendment 17B included a deepwater closure (240 feet seaward) for deepwater species to help protect Warsaw grouper and speckled hind. Additional measures in the amendment included a reduction in the snowy grouper bag limit; establishment of a combined ACL for gag, black grouper, and red grouper; an allocation of 97% commercial and 3% recreational for the golden tilefish fishery based on landings history; and establishment of AMs as necessary.

Regulatory Amendment 10 (SAFMC 2011a; 76 FR 23728) eliminated the large area closure in Amendment 17A for all snapper grouper species off the coasts of southern Georgia and north/central Florida. The regulatory amendment modified measures implemented in Amendment 17A to end overfishing for red snapper.

Regulatory Amendment 9 (SAFMC 2011b; 76 FR 34892) reduced the bag limit for black sea bass from 15 fish per person to five fish per person, established trip limits on vermilion snapper and gag, and increased the trip limit for greater amberjack.

Regulatory Amendment 11 (SAFMC 2011c; 77 FR 27374) eliminated a restriction on the possession or harvest of some deepwater snapper-grouper species in waters greater than 240 feet deep.

Amendment 25 (Comprehensive Annual Catch Limit Amendment) (SAFMC 2011d; 77 FR 15916) met the 2011 deadline mandated by the Magnuson-Stevens Act to establish ACLs and AMs for species managed by the Council that are not undergoing overfishing.

Amendment 24 (SAFMC 2011e; 77 FR 34254) proposed measures to end overfishing and establish a rebuilding plan for red grouper. The amendment also implemented or revised

parameters such as Maximum Sustainable Yield (MSY), Minimum Stock Size Threshold (MSST), ACLs, AMs, and specified allocations for the commercial and recreational sectors.

Amendment 23 (Comprehensive Ecosystem-Based Amendment 2) (SAFMC 2011f; 76 FR 82183) included measures to designate the Deepwater MPAs as EFH-HAPCs; limited harvest of snapper-grouper species in South Carolina SMZs to the bag limit; and modified sea turtle release gear.

Amendment 18A (SAFMC 2012a; 77 FR 32408; 77 FR 72991) established management actions to limit participation and effort in the black sea bass fishery. Measures included establishment of an endorsement program and other modifications to the commercial black sea bass pot fishery; establishment of a commercial trip limit (all gear-types) for black sea bass; and increased minimum size limits for both commercial and recreational black sea bass fisheries.

Amendment 20A (SAFMC 2012b; 77 FR 59129) defined and reverted inactive shares within the wreckfish ITQ program; redistributed reverted shares to active shareholders; established a share cap; and implemented an appeals process.

Regulatory Amendment 12 (77 FR 61295) adjusted the ACL and OY for golden tilefish; specified a commercial Annual Catch Target (ACT); and revised recreational AMs for golden tilefish.

Amendment 18B (SAFMC 2012c; 78 FR 23858) addressed management of golden tilefish. Actions included in the amendment are: An endorsement program for the longline sector of the golden tilefish component of the snapper-grouper fishery; establishment of landings criteria to determine who will receive endorsements; an appeals process for the golden tilefish endorsement program; establishment of a procedure to allow transferability of golden tilefish endorsements; allocation of 75% of the commercial ACL to the longline sector and 25% to the hook-and-line sector; and modification of the golden tilefish trip limit.

Regulatory Amendment 13 (SAFMC 2012d; 78 FR 36113) revised the acceptable biological catch estimates, ACLs (including sector ACLs), and recreational annual catch targets for 37 un-assessed snapper-grouper species. The revisions incorporated updates to the recreational data for these species, as per the new Marine Recreational Information Program, as well as revisions to commercial and for-hire landings. Regulatory Amendment 13 was necessary to avoid triggering AMs for these snapper-grouper species based on ACLs that were established by the Comprehensive Annual Catch Limit Amendment in April 2012, using recreational data under the Marine Recreational Fisheries Statistics Survey system.

Regulatory Amendment 14 (SAFMC 2013a; 79 FR 66316) modified the fishing year for greater amberjack; revised the minimum size limit measurement for gray triggerfish; increased the minimum size limit for hogfish; modified the commercial and recreational fishing year for black sea bass; adjusted the commercial fishing season for vermilion snapper; modified the aggregate grouper bag limit; and revised the AMs for gag and vermilion snapper.

Regulatory Amendment 15 (SAFMC 2013b; 78 FR 49183) modified the existing specification of OY and ACLs for yellowtail snapper in the South Atlantic; modified existing regulations for yellowtail snapper in the South Atlantic; and modified the existing gag commercial ACL and AM for gag that requires a closure of all other shallow water groupers (black grouper, red grouper, scamp, red hind, rock hind, graysby, coney, yellowmouth grouper, and yellowfin grouper) in the South Atlantic when the gag commercial ACL is met or projected to be met.

Amendment 27 (SAFMC 2013c; 78 FR 78770) assumed management of Nassau grouper in the Gulf of Mexico; modified the crew size restriction for dual-permitted vessels (those with a Snapper Grouper Unlimited or 225-Pound Permit and a Charter/Headboat Permit for Snapper-Grouper); modified the bag limit retention restriction for captain and crew of for-hire vessels; changed the existing snapper grouper framework procedure to allow for more timely adjustments to ACLs; and removed blue runner from the fishery management unit.

Amendment 31 (Joint South Atlantic and Gulf of Mexico Generic Headboat Reporting Amendment) (SAFMC 2013d; 78 FR 78779) modified logbook reporting for headboats to require fishing records to be reported electronically for snapper-grouper species on a weekly basis.

Amendment 28 (SAFMC 2013e; 78 FR 44461) established a process to determine if a red snapper fishing season will occur each year, including specification of the allowable harvest for both sectors and season length for the recreational sector; an equation to determine the ACL for red snapper for each sector; and management measures if fishing for red snapper is allowed.

Regulatory Amendment 18 (SAFMC 2013f; 78 FR 47574) adjusted the ACL (and sector ACLs) for vermilion snapper and red pogy based on the stock assessment updates for those two species and removed the annual recreational closure for vermilion snapper.

Regulatory Amendment 19 (SAFMC 2013g; 78 FR 58249) adjusted the black sea bass ACLs based on the results of the 2013 assessment. Because the increase to the ACL was substantial, there was concern that this could extend fishing with pots into the calving season for right whales and create a risk of entanglement for large migratory whales during the fall months. To minimize this risk, the amendment also established a closure to black sea bass pot gear from November 1 to April 30.

Regulatory Amendment 21 (SAFMC 2014a; 79 FR 60379) prevents snapper-grouper species with low natural mortality rates (red snapper, blueline tilefish, gag, black grouper, yellowtail snapper, vermilion snapper, red pogy, and greater amberjack) from being unnecessarily classified as overfished. For these species, even small fluctuations in biomass due to natural conditions rather than fishing mortality may cause a stock to be classified as overfished. Modifying the minimum stock size threshold definition (used in determining whether a species is overfished) prevents these species from being classified as overfished unnecessarily.

Amendment 32 (SAFMC 2014b; 80 FR 16583) addressed the determination that blueline tilefish are overfished and undergoing overfishing. The amendment removed blueline tilefish from the deep-water complex; established blueline tilefish commercial and recreational sector ACLs and

AMs; revised the deep-water complex ACLs and AMs; established a blueline tilefish commercial trip limit; and revised the blueline tilefish recreational bag limit and harvest season.

Amendment 29 (SAFMC 2014c; 80 FR 30947) revised ACLs and recreational annual catch targets (ACTs) for four unassessed snapper grouper species (bar jack, Atlantic spadefish, scamp, and gray triggerfish) and three snapper grouper species complexes (snappers, grunts, and shallow water groupers) based on an update to the Acceptable Biological Catch (ABC) control rule and revised ABCs for 14 snapper-grouper stocks (bar jack, margate, red hind, cubera snapper, yellowedge grouper, silk snapper, Atlantic spadefish, gray snapper, lane snapper, rock hind, tomtate, white grunt, scamp, and gray triggerfish). Additionally, this final rule revises management measures for gray triggerfish in federal waters in the South Atlantic region, including modifying minimum size limits, establishing a split commercial season, and establishing a commercial trip limit.

Regulatory Amendment 22 (SAFMC 2015a; 80 FR 48277) adjusted the ACLs and OY for gag and wreckfish. Changes to the gag recreational bag limit were proposed, but status quo was maintained.

Regulatory Amendment 20 (SAFMC 2014d; 80 FR 43033) increased the recreational and commercial ACLs for snowy grouper, increased the commercial trip limit, and modified the recreational fishing season. This amendment also adjusted the re-building strategy for snowy grouper.

Amendment 33 (SAFMC 2015b; 80 FR 80686) updated regulations that allow snapper-grouper fillets to be brought into the U.S. EEZ from the Bahamas. Snapper-grouper fillets from the Bahamas must have the skin intact, two fillets (regardless of size) will count as one fish towards the bag limit, and fishermen must abide by both U.S. and Bahamian bag/possession limits (whichever is more restrictive). All boats must have the proper permits, and fishermen must carry passports which are required to be stamped and dated to prove vessel passengers were in the Bahamas. All fishing gear must be appropriately stowed while in transit.

Amendment 34 (SAFMC 2015c; 81 FR 3731) revised the AMs for several snapper grouper species (black grouper, mutton snapper, yellowtail snapper, greater amberjack, red pogy, gag, golden tilefish, red grouper, snowy grouper, gray triggerfish, hogfish, scamp, Atlantic spadefish, bar jack, snappers complex, jacks complex, shallow water grouper complex, porgies complex, and wreckfish (recreational)).

Amendment 35 (SAFMC 2015d; 81 FR 32249) clarified regulations governing the use of golden tilefish longline endorsements to align them with the SAFMC's intent when the program was originally implemented. Four species will also be removed from the FMP (black snapper, mahogany snapper, dog snapper, and schoolmaster).

Regulatory Amendment 25 (SAFMC 2016b; 81 FR 45245) revised the commercial and recreational ACLs, the commercial trip limit, and recreational bag limit for blueline tilefish. This amendment also revised the black seabass recreational bag limit and the commercial and recreational fishing years for yellowtail snapper.

Regulatory Amendment 16 (SAFMC 2016a; 81 FR 95893) revised the current seasonal prohibition on the use of black sea bass pot gear in the South Atlantic and added an additional gear marking requirement for black sea bass pot gear.

Amendment 36 (SAFMC 2016c; 82 FR 29772) establish spawning special management zones (Spawning SMZs) to enhance protection for snapper-grouper species in spawning condition, including speckled hind and Warsaw grouper.

Amendment 37 (SAFMC 2016d; 82 FR 34584) modified the hogfish fishery management unit and specified fishing levels for the two South Atlantic hogfish stocks. It established/revised management measures for both hogfish stocks in the South Atlantic Region, such as size limits, recreational bag limits, and commercial trip limits. Additionally, this amendment established a rebuilding plan for the Florida Keys/East Florida stock.

Amendment 41 (SAFMC 2017o; 83 FR 1305) updated the acceptable biological catch, annual catch limit, maximum sustainable yield, minimum stock size threshold, optimum yield (OY), and revised management measures for mutton snapper.

There are several other amendments either in development or under secretarial review (Table 1).

To ensure compliance with interstate requirements, North Carolina also manages this species complex 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, SAFMC, or the Atlantic States Marine Fisheries Commission 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 (Atlantic States Marine Fisheries Commission plans) are like the goals of the Fisheries Reform Act of 1997 to “ensure long-term viability” of these fisheries (NCDMF 2015a).

Management Unit

The original SAFMC plan stated the management unit of the snapper-grouper fishery is the stocks within the EEZ from North Carolina/Virginia border through the east coast of Florida. In the case of black sea bass, the unit is limited to south of Cape Hatteras, North Carolina. Since the inception of the FMP, there has been the addition of four species: wreckfish, spadefish, banded rudderfish, and lesser amberjack. In recent years, 14 species have been removed; 13 in 2012 (tiger grouper, sheepshead, queen triggerfish, puddingwife, black margate, yellow jack, Crevalle jack, porkfish, grass pogy, small mouth grunt, French grunt, Spanish grunt, and blue striped grunt) and one in 2014 (blue runner). In June 2016, Amendment 35 removed four additional species from the complex (black snapper, mahogany snapper, dog snapper, and schoolmaster).

Objectives

The following are the fishery management plan objectives for the snapper grouper fishery as specified by the Council. These were last updated in Snapper-Grouper FMP Amendment 8 in July 1997 (SAFMC 1997).

1. Prevent overfishing.
2. Collect necessary data.
3. Promote orderly utilization of the resource.
4. Provide for a flexible management system.
5. Minimize habitat damage.
6. Promote public compliance and enforcement.
7. Mechanism to vest participants.
8. Promote stability and facilitate long-run planning.
9. Create market-driven harvest pace and increase product continuity.
10. Minimize gear and area conflicts among fishermen.
11. Decrease incentives for overcapitalization.
12. Prevent continual dissipation of returns from fishing through open access.
13. Evaluate and minimize localized depletion.

STATUS OF THE STOCK

Life History

Fifty-five species make up the snapper grouper complex, which is managed by the South Atlantic Fishery Management Council. Included in the complex are three sea bass species, 17 grouper species, 10 snapper species, seven porgy species, five grunt species, five jack species, three tilefish species, two triggerfish species, hogfish, spadefish and wreckfish. The majority of these species are long lived, slow growing, late maturing and hermaphroditic (can change sexes). Most of these species are considered reef fish and are associated with hard bottom (live bottom) offshore habitats, but can be found in waters 1,000 feet deep or shallower. Some are migratory, exhibiting seasonal and/or ontogenic (occurring during a certain life stage) east to west migratory behavior (black sea bass), as well as some species making north to south migrations (gag

grouper). The full list of the species in the complex is available online at [Snapper Grouper Management Complex](#).

Stock Status

Of the 55 species in the South Atlantic Fishery Management Council (SAFMC) management unit, several species are either overfished or experiencing some degree of overfishing. The overfished stocks include red grouper, red porgy, red snapper, hogfish (east Florida) and snowy grouper. Stocks experiencing overfishing are red grouper, red snapper, blueline and golden tilefish, speckled hind, Warsaw grouper, and hogfish (east Florida).

Stock Assessment

The status of several species within the snapper grouper complex is unknown. However, for some of the species, assessments are available through various federal entities; the snapper grouper complex is regionally (North Carolina south to eastern Florida) managed, and none of the assessments have been conducted by NCDMF (Table 2).

Since 2002, stock assessments have been conducted through the SouthEast Data, Assessment, and Review (SEDAR) which is the cooperative process by which stock assessment projects are conducted in NOAA Fisheries' Southeast Region. Currently, stock assessments are available for 16 of the complex species. Assessments scheduled for completion in 2018 include vermilion snapper (SEDAR 55), black seabass (SEDAR 56) and greater amberjack (SEADAR 59). An assessment for red porgy (SEDAR60) is scheduled for completion in 2019.

Some of the other species have status updates provided by National Oceanic and Atmospheric Administration (NOAA) Fisheries. These updates are based on landings data to determine whether the stock is overfished or undergoing overfishing. This information is updated quarterly by NOAA Fisheries and available on their website (<https://www.fisheries.noaa.gov/national/population-assessments/fishery-stock-status-updates>).

STATUS OF THE FISHERY

Current Regulations

The following species have state and federal regulations for minimum lengths:

- Greater amberjack: 28-inch FL (recreational); 36-inch FL (commercial)
- Black and gag groupers: 24-inch TL
- Red, scamp, yellowfin, and yellowmouth groupers: 20-inch TL
- Black sea bass: 13-inch TL (recreational); 11-inch (commercial)
- Red porgy: 14-inch TL
- Vermilion, gray, cubera, queen, silk, yellowtail and blackfin snappers: 12-inch TL
- Hogfish (not pigfish): 17-inch FL
- Mutton snapper: 18-inch TL
- Gray triggerfish: 12-inch FL
- Lane snapper: 8-inch TL

All species have sector ACLs and recreational bag limits. See the SAFMC or NCDMF websites for the most current information.

The fisheries are open year-round, with the exception of:

- Goliath grouper, Nassau grouper, Warsaw grouper, and speckled hind, unlawful to possess/harvest (commercial and recreational)
- Red snapper, unlawful to possess/harvest (commercial and recreational); limited season may occur based on previous years' data
- January-April shallow water grouper spawning closure (commercial and recreational); Commercial also has same closure for red porgy
- Wreckfish have commercial spawning closure January 15-April 15; recreational fishery open July 1-August 31 annually
- April commercial closure for greater amberjack
- Snowy grouper and blueline tilefish recreational fishery open May 1- August 31

Temporary closures may result for a species if the ACL is met. NOAA fisheries monitors the landings for the species managed by SAFMC, and this information is available online for both the commercial and recreational sectors

(http://sero.nmfs.noaa.gov/sustainable_fisheries/acl_monitoring/index.html). See also the SAFMC or NCDMF websites for more details, and the most current information.

Commercial Landings

Commercial gear used in the snapper grouper fishery includes bandit reels, electromate reels, manual hook-and-line, long lines, fish pots, spear, and trolling. Bandit reels, followed by electromate rods and reels are the two most prevalent gear types used, especially south of Cape Hatteras (NCDMF 2015b). Spear fishing seems to be limited to south of Cape Hatteras, while longlines are primarily fished north of Cape Hatteras (NCDMF 2015b); their use is limited to six deepwater species and depths greater than 50 fathoms. Fish pots are used primarily to target black sea bass. Trip lengths vary dependent on the area fished and the gear used, but tended to average between two to three days in length over the past five years; trips ranged from one day to 12 days for the entire commercial snapper grouper fleet (NCDMF 2015b).

The average landings for commercially caught snapper grouper from 2008-2017 was 1,945,710 pounds with a dockside value of \$4,432,916.¹ The highest landings from the past 10 years were in 2008 and 2009, after which landings dropped; landings have been under two million pounds for the last five years (Table 3). The decline in landings over the past five years is most likely due to the removal of species from the complex, as well as the changes to annual catch limits and trip limits and implementation of a seasonal spawning closure by the SAFMC (i.e., gag grouper).

¹ These averages do not include sheepshead, as well as a number of other species, as they were removed from the complex in 2012. See Amendment 25 for list of species removed from complex.

Over the last five years, landings have been dominated by six main aggregates, sea bass, grouper, snapper, triggerfish, jacks and tilefish though the dominant group varies by year (Table 4). The top ten dominant species are: black sea bass, vermillion snapper, blueline tilefish, gag, triggerfish, red grouper, red porgy, amberjack, scamp, and grunts (NCDMF 2015b).

Recreational Landings

Recreational fishing uses many of the same gear types as the commercial fishery, with the exception of fish pots and longlines. The average recreational catch of snapper grouper species was 1,189,828 pounds for 2008-2017. Since 2008, the total amount of fish landed declined steadily until 2016 (Table 5). The number of fish harvested increased roughly 5% from 2016 to 2017; however, harvest weight declined 14%. Recreational landings (by weight) have dropped over 80% since 2008. As with the commercial fishery this is most likely due to the removal of species from the complex, as well as the changes to ACLs and the seasonal spawning closure by the SAFMC. For the last five years, the number of releases has been above 80% of the total fish caught (driven by the 13-inch (TL) size limit for black sea bass implemented in 2013, which has resulted in an increase of sublegal fish being discarded).

For 2017, the dominant species (by pounds) landed were black sea bass, jacks, triggerfish, snappers, spadefish, and groupers. This pattern mainly holds true for the last five years; however, other species are occasionally more dominant (Table 6).

MONITORING PROGRAM DATA

Most of the data (dependent and independent) collected by NCDMF is provided to NOAA Fisheries. The division received a grant, which ended in 2014, to look at the age structure and release mortality of the commercial snapper grouper fishery in general and at the south of Hatteras black sea bass stock age structure specifically. Data collected for this grant is summarized in the final Marine Fisheries Initiative (MARFIN) reports (NCDMF 2015b, c).

Fishery-Dependent Monitoring

Commercial fisheries are monitored by port agents (state and federal) who collect information on trips, as well as biological information. Information is collected through the Trip Information Program (TIP), seafood dealer reporting, and logbooks (SAMFC 2014e). Recreational fisheries are monitored by creel clerks through the Southeast Region Headboat Survey program and the Marine Recreation Information Program (MRIP) (SAFMC 2014e). North Carolina contributes to this data through the collection of trip and biological information for both fisheries.

Fishery-Independent Monitoring

The Southeast Reef Fish Survey (SERFS) maintains the fisheries independent data for the snapper grouper complex. SERFS is a collective program for gathering fisheries independent data within the South Atlantic federal waters. There are three primary programs that contribute to the data:

- Marine Resources Monitoring, Assessment, and Prediction (MARMAP) survey
- Southeast Fisheries-Independent Survey (SEFIS), and
- Southeast Area Monitoring and Assessment Program (SEAMAP) - South Atlantic. (SAFMC 2015e).

North Carolina has contributed to the data collected through programs such as the gag ingress and tagging work done in partnership with SEAMAP and MARFIN.

MANAGEMENT STRATEGY

The snapper grouper complex is managed under the various amendments of the SAFMC fisheries management plan. The fishery is a regional fishery, and the Council has authority within the federal 200-mile limit of the Atlantic Ocean off the coasts of North Carolina, South Carolina, Georgia, and east Florida to Key West with the exception of black sea bass north of Cape Hatteras, North Carolina. In state waters, North Carolina defers to the Council and the same regulations are followed. Thresholds and targets for the species are determined by the SAFMC and are species dependent.

RESEARCH NEEDS

The reauthorization of the Magnuson-Stevens Fishery Conservation and Management Act in 2006 directed that all regional management councils develop a prioritized research plan for annual submission to the Secretary of Commerce. The following (below) are research and management needs as determined by the council in 2007 (SAFMC 2007b). All needs are ongoing; however, the emphasis changes annually based on the SAFMC Science and Statistical Committee review of these needs. The reviewed list and priorities for the year are then approved for submission to the NOAA Fisheries Southeast Fisheries Science Center. The council has a series of research and monitoring needs for the period of 2012-2016 (SAFMC 2012e), and has developed another set of needs for 2015-2019 (SAFMC 2015f, 2017a). Research needs include:

- Continue monitoring of catches
- Collect otoliths and spines for ageing
- Estimate mortality rates
- Determine if stock structure exists for many of the species
- Note seasonal and spawning migrations
- Identify and map essential/critical fish habitat
- Determine spawning locations and seasons
- Continue life history studies
- Estimate reproductive parameters including fecundity, age and size of maturity, age and size of sexual transition, and sex ratio
- Determine reliability of historical landings
- Expand diet studies
- Develop juvenile and adult indexes

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TABLES

Table 1. Amendments under consideration/review by the SAFMC. Summaries of the issues the amendment addresses are included; documentation is provided as available.

| Amendment | Issue addressed | Where in process | Documentation |
|--|---|---|----------------------|
| Regulatory Amendment 32 | Changes to Yellowtail Accountability Measures (AM); this amendment would consider changing AMs to remove in-season closures for either sector until the total ACL is met/projected to be met | Under development by the Council | SAFMC 2017b |
| Regulatory Amendment 30 | Red Grouper Rebuilding Plan | Under development by the Council | SAFMC 2017c |
| Regulatory Amendment 29 | Address Best Fishing Practices & remove powerhead restrictions in SMZs off South Carolina | Potential options awaiting Council review | SAFMC 2017d |
| Amendment 42 | Options for new sea turtle release gears. This amendment would also consider modifications to the snapper grouper framework so that Council may more quickly modify protected resources release gear and handling requirements in the future. | Approved by the Council for scoping | SAFMC 2017e |
| Regulatory Amendment 28 | Golden Tilefish ACL revisions. Also, considers changing the fishing year start date for the commercial hook & line sector | Under development by the Council | SAFMC 2017f |
| Amendment 38 | BlueLine Tilefish management measures | Potential options awaiting Council review | SAFMC 2017g |
| Amendment 46 | Private recreational reporting and permitting | Under development by the Council | SAFMC 2017h |
| Amendment 47 | Limited entry of for-hire permits for the snapper grouper fishery | Under development by the Council | SAFMC 2017i |
| Red Grouper Abbreviated Framework Action | Red Grouper management measures | Approved by Council for Formal Review | SAFMC 2017j |
| Amendment 44 | Long-term management of yellowtail snapper | Amendment on hold | SAFMC 2017k |
| Amendment 43 | Red snapper ACL determination revisions | Approved the by Council for Formal Review | SAFMC 2017l |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPEL

| | | | |
|--|--|---|-------------|
| Vision Blueprint Recreational Regulatory Amendment 26 | Recreational management measures: aggregate structure, bag limits, gray triggerfish size limits, and red grouper season | Approved by the Council for public hearings | SAFMC 2017m |
| Vision Blueprint Commercial Regulatory Amendment 27 | Commercial split seasons and trip limits for the snapper grouper fishery | Approved by the Council for public hearings | SAFMC 2017n |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPER

Table 2. Stock status of the 55 species within the snapper grouper complex. Documentation is provided for the assessment associated with each species. No assessments have been conducted by NCDMF due to the nature of the fishery.

| Family (species aggregate) | Species | Overfishing? | Overfished? | Approaching overfished condition? | Documentation |
|---|--|------------------------|-------------|-----------------------------------|---|
| Serranidae (Sea basses and Groupers) | Gag (<i>Mycteroperca microlepis</i>) | No** | No | No | SEDAR 10 Update (SEDAR 2014); NMFS 2017 |
| | Red grouper (<i>Epinephelus morio</i>) | Yes | Yes | No | SEDAR 53 (SEDAR 2017a); NMFS 2017 |
| | Scamp (<i>Mycteroperca phenax</i>) | No | Unknown | Unknown | NMFS 2016 |
| | Black grouper (<i>Mycteroperca bonaci</i>) | No | No | No | SEDAR 19 (SEDAR 2010); NMFS 2017 |
| | Rock hind (<i>Epinephelus adscensionis</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Red hind (<i>Epinephelus guttatus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Graysby (<i>Cephalopholis cruentata</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Yellowfin grouper (<i>Mycteroperca venenosa</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Coney (<i>Cephalopholis fulva</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Yellowmouth grouper (<i>Mycteroperca interstitialis</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Goliath grouper (<i>Epinephelus itajara</i>) | No (Permanent closure) | Unknown | Unknown | SEDAR 47 (SEDAR 2016d); NMFS 2017 |
| | Nassau grouper (<i>Epinephelus striatus</i>) | No (Permanent closure) | Unknown | Unknown | NMFS 2017 |
| | Snowy grouper (<i>Epinephelus niveatus</i>) | No | Yes | No | SEDAR 36 (SEDAR 2013a); NMFS 2017 |
| | Yellowedge grouper (<i>Epinephelus flavolimbatus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |

* Indicates ecosystem component species which do not have management measures in place and are not assessed.

**Based on NMFS stock assessment

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPER

Table 2 (continued).

| Family (species aggregate) | Species | Overfishing? | Overfished? | Approaching overfished condition? | Documentation |
|--------------------------------------|---|-------------------------|-------------|-----------------------------------|---|
| Serranidae (Sea basses and Groupers) | Warsaw grouper (<i>Epinephelus nigritus</i>) | Yes (Permanent closure) | Unknown | Unknown | SG Amendment 17b (SAFMC 2010b); NMFS 2016 |
| | Speckled hind (<i>Epinephelus drummondhayi</i>) | Yes (Permanent closure) | Unknown | Unknown | SG Amendment 17b (SAFMC 2010b); NMFS 2017 |
| | Misty grouper (<i>Epinephelus mystacinus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Black sea bass (<i>Centropristis striata</i>) | No | No | No | SEDAR 56 (SEDAR 2018b); NMFS 2017 |
| | Bank sea bass (<i>Centropristis ocyurus</i>)* | N/A | N/A | N/A | |
| | Rock sea bass (<i>Centropristis philadelphica</i>)* | N/A | N/A | N/A | |
| Polyprionidae (Wreckfish) | Wreckfish (<i>Polyprion americanus</i>) | No | No | No | Rademeyer and Butterworth 2014; NMFS 2017 |
| Lutjanidae (Snappers) | Queen snapper (<i>Etelis oculatus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Yellowtail snapper (<i>Ocyurus chrysurus</i>) | No | No | No | SEDAR 27A (SEDAR 2012b); NMFS 2017 |
| | Gray snapper (<i>Lutjanus griseus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Mutton snapper (<i>Lutjanus analis</i>) | No | No | No | SEDAR 15A Update (SEDAR 2015); NMFS 2017 |
| | Lane snapper (<i>Lutjanus synagris</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Cubera snapper (<i>Lutjanus cyanopterus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |

* Indicates ecosystem component species which do not have management measures in place and are not assessed.

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPER

Table 2 (continued).

| Family (species aggregate) | Species | Overfishing? | Overfished? | Approaching overfished condition? | Documentation |
|----------------------------|--|--------------|-------------|-----------------------------------|--|
| Lutjanidae (Snappers) | Vermilion snapper (<i>Rhomboplites aurorubens</i>) | No | No | No | SEDAR 55 (SEDAR 2018a); NMFS 2017 |
| | Red snapper (<i>Lutjanus campechanus</i>) | Yes | Yes | No | SEDAR Assessment 41 (SEDAR 2016a); NMFS 2017 |
| | Silk snapper (<i>Lutjanus vivanus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Blackfin snapper (<i>Lutjanus buccanella</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| Sparidae (Porgies) | Red Porgy (<i>Pagrus pagrus</i>) | No | Yes | No | SEDAR 1 Update (SEDAR 2012a); NMFS 2017 |
| | Knobbed porgy (<i>Calamus nodosus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Jolthead porgy (<i>Calamus bajonado</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Scup (<i>Stenotomus chrysops</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Whitebone porgy (<i>Calamus leucosteus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Saucereye porgy (<i>Calamus calamus</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Longspine porgy (<i>Stenotomus caprinus</i>)* | N/A | N/A | N/A | |
| Haemulidae (Grunts) | White grunt (<i>Haemulon plumieri</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Margate (<i>Haemulon album</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Tomtate (<i>Haemulon aurolineatum</i>) | Unknown | Unknown | Unknown | NMFS 2017 |

* Indicates ecosystem component species which do not have management measures in place and are not assessed.

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPER

Table 2 (continued).

| Family (species aggregate) | Species | Overfishing? | Overfished? | Approaching overfished condition? | Documentation |
|-------------------------------|---|------------------------------------|------------------------------------|-----------------------------------|--|
| Haemulidae (Grunts) | Sailor's choice (<i>Haemulon parra</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Cottonwick (<i>Haemulon melanurum</i>)* | N/A | N/A | N/A | |
| Carangidae (Jacks) | Greater Amberjack (<i>Seriola dumerili</i>) | No | No | No | SEDAR 15 (SEDAR 2008); NMFS 2017 |
| | Almaco jack (<i>Seriola rivoliana</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Banded rudderfish (<i>Seriola zonanta</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Bar jack (<i>Caranx ruber</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| | Lesser Amberjack (<i>Seriola fasciata</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| Malacanthidae (Tilefishes) | Golden tilefish (<i>Lopholatilus chamaeleonticeps</i>) | Yes | No | No | SEDAR 25 Update (SEDAR 2016b); NMFS 2017 |
| | Blueline (or gray) tilefish (<i>Caulolatilus microps</i>) | Yes** | No | No | SEDAR 50 (SEDAR 2017b); NMFS 2017 |
| | Sand tilefish (<i>Malacanthus plumier</i>) | Unknown | Unknown | Unknown | NMFS 2017 |
| Balistidae (Triggerfishes) | Gray triggerfish (<i>Balistes capriscus</i>) | No | Unknown | Unknown | SEDAR Assessment 41 (SEDAR 2016c); NMFS 2017 |
| | Ocean triggerfish (<i>Canthidermis sufflamen</i>)* | N/A | N/A | N/A | |
| Labridae (Wrasses) | Hogfish (<i>Lachnolaimus maximus</i>) | Unknown (Carolinas); Yes (Florida) | Unknown (Carolinas); Yes (Florida) | No (Carolinas and Florida) | SEDAR 37 (SEDAR 2013b); NFMS 2017 |
| Eppiphidae (Spadefishes) | Atlantic spadefish (<i>Chaetodipterus faber</i>) | Unknown | Unknown | Unknown | NMFS 2017 |

* Indicates ecosystem component species which do not have management measures in place and are not assessed.

**Based on NMFS stock assessment

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPER

Table 3. Landings of all snapper grouper species for the commercial fishery for 2008-2017. Sheepshead were removed from the fishery in 2012 and therefore not included past 2011.

| Year | Weight of harvested fish (pounds) | Value of Landings (U.S. dollars) |
|-------------|--|---|
| 2008 | 2,996,691 | 6,221,744 |
| 2009 | 2,913,935 | 5,442,271 |
| 2010 | 2,424,148 | 4,980,908 |
| 2011 | 1,948,428 | 4,088,660 |
| 2012 | 1,705,871 | 4,237,923 |
| 2013 | 1,514,279 | 3,987,056 |
| 2014 | 1,628,296 | 4,017,758 |
| 2015 | 1,438,358 | 3,525,689 |
| 2016 | 1,389,648 | 3,831,969 |
| 2017 | 1,497,444 | 3,995,178 |

Table 4. Landings (in pounds) of snapper grouper, by aggregate groups, for the commercial fishery from 2008-2017. Aggregate groups are those used by the SAFMC and are done by family (as in Table 2). Sheepshead were removed from the fishery in 2012 and therefore not included past 2011; these are included in the porgy aggregate. Only black sea bass from south of Cape Hatteras are included, as the northern populations are managed by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fisheries Management Council (MAFMC). Wreckfish landings are confidential after 2011.

| Species | Year | | | | | | | | | |
|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Black sea bass | 275,754 | 437,951 | 292,879 | 173,681 | 194,778 | 241,363 | 316,420 | 226,337 | 197,264 | 242,511 |
| Grouper | 785,555 | 637,447 | 561,926 | 408,507 | 382,085 | 308,891 | 300,002 | 261,124 | 257,717 | 223,458 |
| Wreckfish | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Snapper | 602,838 | 374,081 | 320,260 | 326,371 | 279,367 | 276,533 | 251,062 | 232,030 | 275,427 | 280,841 |
| Porgies | 114,457 | 98,771 | 84,781 | 90,792 | 83,918 | 72,664 | 82,779 | 54,386 | 45,918 | 64,951 |
| Grunts | 91,292 | 74,054 | 47,219 | 33,443 | 49,734 | 44,702 | 39,312 | 32,684 | 39,843 | 42,192 |
| Jacks | 164,259 | 157,990 | 131,050 | 73,865 | 140,525 | 104,672 | 202,207 | 154,144 | 142,300 | 133,067 |
| Tilefish | 404,295 | 469,293 | 430,394 | 133,824 | 361,094 | 217,079 | 91,074 | 45,354 | 111,788 | 88,689 |
| Triggerfish | 198,724 | 215,759 | 225,682 | 220,204 | 143,114 | 160,861 | 116,782 | 131,536 | 131,626 | 148,166 |
| Hogfish | 13,035 | 10,839 | 13,046 | 10,793 | 8,256 | 7,847 | 9,767 | 8,238 | 9,195 | 15,776 |
| Spadefish | 11,694 | 20,636 | 18,827 | 21,535 | 24,238 | 20,369 | 22,761 | 15,997 | 15,231 | 18,833 |
| Unclassified | 20,025 | 18,165 | 17,763 | 7,692 | 12,038 | 14,914 | 22,052 | 23,341 | 29,705 | 24,966 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SNAPPER GROUPER

Table 5. Landings of all snapper grouper species for the recreational fishery for 2008-2017. Sheepshead were removed from the fishery in 2012 and therefore not included past 2011.

| Year | Number Harvested | Weight of harvested fish (pounds) | Number Released | Percent Released |
|-------------|-------------------------|--|------------------------|-------------------------|
| 2008 | 739,664 | 3,094,722 | 1,482,895 | 67% |
| 2009 | 634,427 | 2,589,581 | 1,190,644 | 65% |
| 2010 | 560,011 | 1,825,184 | 1,360,216 | 71% |
| 2011 | 264,744 | 758,711 | 1,211,170 | 82% |
| 2012 | 320,282 | 926,553 | 2,203,059 | 87% |
| 2013 | 192,482 | 535,802 | 1,509,176 | 89% |
| 2014 | 176,737 | 458,516 | 1,446,165 | 89% |
| 2015 | 175,380 | 526,169 | 1,633,305 | 90% |
| 2016 | 236,149 | 635,547 | 2,211,527 | 90% |
| 2017 | 247,015 | 547,499 | 1,793,671 | 88% |

Table 6. Recreational landings (in pounds), by aggregate groups, for 2008-2017. Aggregate groups are those used by the SAFMC and are done by family (as in Table 2). Sheepshead were removed from the fishery in 2012 and therefore not included past 2011; these are included in the porgy aggregate. Only black sea bass from south of Cape Hatteras are included, as the northern population is managed by ASMFC and MAFMC.

| Species | Year | | | | | | | | | |
|----------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| Black sea bass | 61,615 | 113,998 | 170,538 | 95,924 | 120,468 | 58,233 | 131,171 | 96,260 | 86,347 | 94,194 |
| Groupers | 1,392,577 | 1,153,064 | 328,824 | 151,382 | 212,334 | 76,133 | 29,102 | 32,764 | 58,653 | 21,119 |
| Snappers | 66,429 | 54,948 | 35,041 | 25,167 | 60,164 | 14,013 | 15,016 | 15,147 | 49,828 | 17,363 |
| Porgies | 467,687 | 292,941 | 460,919 | 191,262 | 26,249 | 16,720 | 15,658 | 9,420 | 7,120 | 17,376 |
| Grunts | 175,864 | 117,684 | 56,802 | 44,213 | 95,724 | 26,769 | 39,266 | 32,119 | 30,861 | 13,807 |
| Jacks | 426,588 | 517,542 | 440,846 | 138,703 | 175,197 | 197,482 | 88,427 | 272,051 | 193,280 | 147,779 |
| Tilefish | 316,174 | 120,173 | 43,211 | 27,163 | 43,681 | 33,525 | 36,760 | 4,821 | 159,953 | 0 |
| Triggerfish | 175,409 | 178,157 | 160,737 | 77,371 | 148,982 | 96,262 | 68,138 | 55,208 | 45,813 | 196,194 |
| Hogfish | 1,587 | 1,731 | 1,398 | 1,539 | 14,961 | 3,619 | 0 | 0 | 349 | 7,032 |
| Spadefish | 7,090 | 35,277 | 125,088 | 2,711 | 25,905 | 12,459 | 34,789 | 7,804 | 2,768 | 32,345 |
| Wreckfish | 0 | 0 | 0 | 0 | 525 | 0 | 0 | 0 | 0 | 0 |

**FISHERY MANAGEMENT PLAN UPDATE
SPANISH MACKEREL
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|------------------------|---|
| Original FMP Adoption: | February 1983 |
| Amendments: | Amendment 2 – July 1987 Amendment 3 – August 1989 Amendment 4 – October 1989 Amendment 5 – August 1990 Amendment 6 – December 1992 Amendment 8 – March 1998 Amendment 9 – April 2000 Amendment 10 – July 2000 Amendment 11 – December 1999 Amendment 14 – August 2005 Amendment 15 – February 2004 Amendment 18 – January 2012 Amendment 19 – July 2010 Amendment 20A – August 2014 Framework Action 2013 – December 2014 Amendment 20B – March 2015 Framework Amendment 1 – December 2014 Amendment 22 – January 2014 Amendment 23 – January 2014 Framework Amendment 5 – August 2017 Omnibus Amendment – August 2011 Addendum I to Omnibus Amendment – August 2013 |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | The next assessment has not been scheduled. |

Spanish mackerel is managed under the Atlantic States Marine Fisheries Commission's (ASMFC) Fishery Management Plan (FMP) for Spanish Mackerel and the South Atlantic

Fishery Management Council's (SAFMC) Coastal Migratory Pelagics FMP (ASMFC 2011; SAFMC 1982). The original Gulf and South Atlantic fishery management councils' fishery management plan (FMP) for Coastal Migratory Pelagic Resources (mackerels) was approved in 1982 (SAMFC 1982) and went into effect in 1983. This plan treated Spanish mackerel as one U.S. stock. Allocations were established for recreational and commercial fisheries, and the commercial allocation was divided between net and hook and line fishermen. The plan also established procedures for the Secretary of Commerce to act by regulatory amendment to resolve possible future conflicts in the fishery, such as establish fishing zones and local quotas to each gear or user group. Numerous amendments have been implemented since the first FMP.

Amendment 2 revised Spanish mackerel maximum sustainable yield (MSY) downward, recognized two migratory groups, and set commercial quotas and bag limits (SAFMC 1987). Charter boat permits were required, and it was clarified that total allowable catch (TAC) for overfished stocks must be set below the upper range of acceptable biological catch (ABC). The use of purse seines on overfished stocks was prohibited.

Amendment 3 prohibited drift gill nets for coastal pelagics and purse seines and run-around gill nets for the overfished groups of mackerels (SAMFC 1989a). The habitat section of the FMP was updated and vessel safety considerations were included in the plan. A new objective to minimize waste and bycatch in the fishery was added to the plan.

Amendment 4 reallocated Spanish mackerel equally between recreational and commercial fishermen on the Atlantic group with an increase in TAC (SAFMC 1989b).

Amendment 5 extended the management area for the Atlantic groups of mackerels through Mid-Atlantic Fishery Management Council (MAFMC) jurisdiction (SAMFC 1990). It revised problems in the fishery and plan objectives, revised the definition of "overfishing", provided that the SAFMC will be responsible for pre-season adjustments of TACs and bag limits for the Atlantic migratory groups of mackerels, redefined recreational bag limits as daily limits, created a provision specifying that the bag limit catch of mackerel may be sold, provided guidelines for corporate commercial vessel permits, and included a definition of "conflict" to provide guidance to the Secretary.

Amendment 6 identified additional problems and an objective in the fishery, provided for rebuilding overfished stocks of mackerels within specific periods, provided for biennial assessments and adjustments, provided for more seasonal adjustment actions, including size limits, vessel trip limits, closed seasons or areas, and gear restrictions, provided for commercial Atlantic Spanish mackerel possession limits, changed commercial permit requirements to allow qualification in one of three preceding years, discontinued the reversion of the bag limit to zero when the recreational quota is filled, modified the recreational fishing year to the calendar year, and changed all size limit measures to fork length only (SAMFC 1992).

Amendment 8 identified additional problems in the fishery, specified allowable gear, revised qualifications for a commercial permit, revised the seasonal framework procedures to: provide for consideration of public comment, redefine overfishing and allow for adjustment by

framework procedure, allow changes in allocation ratio of Atlantic Spanish mackerel, allow setting zero bag limits, and allow gear regulation including prohibition (SAMFC 1996).

Amendment 9 allowed possession of cut-off (damaged) Spanish mackerel that comply with the minimum size limits and the trip limits in the Gulf, Mid-Atlantic, or South Atlantic exclusive economic zone (EEZ) (sale of such cut-off fish is allowed as long as such fish are within the existing allowance for possession) (SAFMC 2000).

Amendment 10 designated Essential Fish Habitat (EFH) and EFH-Habitat Areas of Particular Concern (HAPC) for coastal migratory pelagics (SAFMC 1998a).

Amendment 11 amended the FMP as required to make definitions of MSY, optimal yield (OY), overfishing and overfished consistent with National Standard Guidelines; identified and defined fishing communities and addressed bycatch management measures (SAFMC 1998).

Amendment 14 established a three-year moratorium on the issuance of for-hire (charter vessel and head boat) permits for coastal migratory pelagic species in the Gulf of Mexico unless sooner replaced by a comprehensive effort limitation system. This resulted in separate for-hire permits for the Gulf and South Atlantic. The control date for eligibility was established as March 29, 2001 (SAFMC 2002b). The amendment also includes other provisions for eligibility, application, appeals, and transferability of permits.

Amendment 15 changed the fishing year to March 1 through February 28/29 for Atlantic group king and Spanish mackerels (SAFMC 2004).

Amendment 17 (SAFMC 2006) established a permanent limited entry system for Gulf of Mexico coastal migratory pelagics for-hire (charter and headboat) permits, building on the moratorium established under Amendment 14.

Amendment 18 established Annual Catch Limits (ACLs), Annual Catch Targets (ACTs) and accountability measures (AMs) for Spanish mackerel (SAFMC 2011) as required under the 2006 Magnuson Stevens Reauthorization Act.

Amendment 19 updated existing EFH and HAPC designations for South Atlantic species and prohibited the use of certain gear types within Deepwater Coral Habitat Areas of Particular Concern (SAFMC 2009).

Amendment 20A prohibits the sale of Spanish mackerel caught under the bag limit unless the fish are caught as part of a state-permitted tournament and the proceeds from the sale are donated to charity (SAFMC 2014).

Framework Action 2013 established provisions to allow for the transfer at sea of Spanish mackerel caught in gill nets when one set exceeds the trip limit and modified the trip limit for the Florida East Coast subzone by moving the potential step-up to 75 fish/day in the last month of the season and if less than 70 percent of the subzone's ACL has been met.

Amendment 20B creates Northern and Southern Zones for Atlantic migratory group Spanish mackerel. National Oceanic and Atmospheric Administration Fisheries will close each zone when the respective quota is met or expected to be met (SAMFC 2015). The dividing line between the zones is at the North Carolina/South Carolina state line.

Framework Amendment 1 (SAFMC 2014) updated the ACLs and ACTs for Gulf and Atlantic migratory groups of Spanish mackerel based on the results of the 2012 stock assessment.

Amendment 22b. modified headboat reporting regulations to require weekly electronic reporting of all SAFMC managed species (SAFMC 2013).

Amendment 23 (SAFMC 2013) required dealers to possess a federal Gulf and South Atlantic universal dealer permit to purchase king and Spanish mackerel and required weekly electronic dealer reporting. It also required federally-permitted king and Spanish mackerel fishermen to sell only to a federally-permitted dealer.

Framework Amendment 5 (SAFMC 2016) modifies the regulations that prohibit fishing for and retaining the bag limit of king and Spanish mackerel on recreational trips on vessels with federal commercial king mackerel and Spanish mackerel permits, when there is a commercial quota closure.

The ASMFC approved the Omnibus Amendment in 2011 (ASMFC 2011). The management goal for the Omnibus Amendment is to bring the Fishery Management Plan for Spanish Mackerel under authority of the Atlantic Coastal Fisheries Cooperative Management Act, providing for more efficient and effective management and changes to management in the future.

Addendum I to the Omnibus Amendment (ASMFC 2013) established a pilot program that would allow states to reduce the Spanish mackerel minimum size limit for the commercial pound net fishery to 11.5 inches during the summer months of July through September for the 2013 and 2014 fishing years only. In August 2015, the South Atlantic Board formally extended the provisions of Addendum I for the 2015, 2016 and 2017 fishing seasons. Reports by North Carolina, the only state to reduce their minimum size, are reviewed annually.

To ensure compliance with interstate requirements, North Carolina also manages this species 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 MAFMC, SAFMC, 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).

Management Unit

The management unit is defined for South Atlantic Spanish mackerel within U.S. waters north of Miami-Dade/Monroe County line, Florida in the Atlantic Ocean.

Goal and Objectives

The goal of the FMP for Coastal Migratory Pelagics resources was to institute management measures necessary to prevent exceeding maximum sustainable yield (MSY), establish a mandatory statistical reporting system for monitoring catch, and to minimize gear and user conflicts (SAMFC 1982). Amendment 12 to the Gulf and South Atlantic fishery management councils' FMP for Coastal Migratory Pelagics lists eight plan objectives:

1. The primary objective of the FMP is to stabilize yield at MSY, allow recovery of overfished populations, and maintain population levels sufficient to ensure adequate recruitment.
2. To provide a flexible management system for the resource which minimizes regulatory delay while retaining substantial Council and public input in management decisions and which can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by areas.
3. To provide necessary information for effective management and establish a mandatory reporting system.
4. To minimize gear and user group conflicts.
5. To distribute the TAC of Atlantic migratory group Spanish mackerel between recreational and commercial user groups based on the catches that occurred during the early to mid-1970s, which is prior to the development of the deep water run-around gill net fishery and when the resource was not overfished.
6. To minimize waste and bycatch in the fishery.
7. To provide appropriate management to address specific migratory groups of king mackerel.
8. To optimize the social and economic benefits of the coastal migratory pelagic fisheries.

The primary goal of the ASMFC Omnibus Amendment is to bring the FMPs for Spanish mackerel, spot, and spotted seatrout under the authority of the Act, providing for more efficient and effective management and changes to management for the future (ASMFC 2011). Omnibus amendment 1 objectives include:

1. Manage the Spanish mackerel fishery by restricting fishing mortality to rates below the threshold fishing mortality rates to provide adequate spawning potential to sustain long-term abundance of the Spanish mackerel populations.
2. Manage the Spanish mackerel stock to maintain the spawning stock biomass above the target biomass levels.
3. Minimize endangered species bycatch in the Spanish mackerel fishery.
4. Provide a flexible management system that coordinates management activities between state and federal waters to promote complementary regulations throughout Spanish mackerel's range which minimizes regulatory delay while retaining substantial ASMFC, Council, and public input into management decisions; and which can adapt to changes in resource

abundance, new scientific information and changes in fishing patterns among user groups or by area.

5. Develop research priorities that will further refine the Spanish mackerel management program to maximize the biological, social, and economic benefits derived from the Spanish mackerel population.

STATUS OF THE STOCK

Life History

Spanish mackerel are considered coastal pelagic, meaning they live in the open waters near the coast. They make northern and southern migrations depending on water temperature and seldom enter waters below 68 degrees Fahrenheit. In North Carolina's waters, Spanish mackerel can be found from April to November. They migrate south to the Florida coast in the late fall. In the summer months, they may be found as far inland as the sounds and coastal river mouths. Spanish mackerel spawn from May to September, are fast growing, and may live to be 8 years old. Spanish mackerel in North Carolina grow as large as 30 inches, but most recreational catches are between 12 and 15 inches. Both sexes are capable of reproduction by age 2. Spanish mackerel feed primarily on small, schooling pelagic fish such as anchovies and herring.

Stock Status

In 2012, the Atlantic Spanish mackerel stock was assessed and peer reviewed through the Southeast Data, Assessment and Review (SEDAR 2014). The results of the assessment (SEDAR 28) indicate Atlantic Spanish mackerel are not overfished and overfishing is not occurring. The next assessment has not been scheduled.

Stock Assessment

There is a lack of available fishery independent indices of abundance for this species. Many of the indices of abundance that were made available were rejected due to concerns about the way the fishers targeted Spanish mackerel. The schooling behavior of Spanish mackerel makes a random survey of their population particularly difficult. The one fishery independent index used (Southeast Area Monitoring and Assessment Program Trawl Survey young of the year) was highly variable, as would be expected for a recruitment index. The base run of the age-structured assessment model indicated that the stock is not overfished and that overfishing is not occurring. The sensitivity analyses yielded similar results and there was no retrospective pattern of concern. Conclusions about stock status during the analysis were most sensitive to different combinations of input data and variance around fixed parameters (steepness, recreational discard mortality, historical recreational landings, and natural mortality). A statistical catch-age model was used to assess the population of Atlantic Spanish mackerel. The age-structured assessment indicated that the stock was not overfished and that overfishing was not occurring.

STATUS OF THE FISHERY

Current Regulations

The North Carolina Division of Marine Fisheries currently complements the management measures of the Coastal Migratory Pelagic FMP through rules (15A NCAC 03M .0301 and proclamation authority (15A NCAC 03M .0512). Current regulations include a recreational bag limit of 15 Spanish mackerel per person per day and 12-inch fork length minimum size. Commercial regulations also include a 12-inch fork length minimum size and a trip limit of 3,500 pounds. Federal vessel permits are required for commercial, charter and head boats fishing in the EEZ. Sale of Spanish mackerel caught under the bag limit are prohibited unless the fish are caught as part of a state-permitted tournament and the proceeds from the sale are donated to charity.

Commercial Landings

Predominant commercial fisheries for Spanish mackerel include gill nets and estuarine pound nets. In 2017, commercial landings were 815,972 pounds (Figure 1) and 80 percent of the Spanish mackerel harvest was taken in gill nets. 2017 landings are above the 10-year average of 735,046 pounds, with most landings falling between May and October in inshore waters. The North Carolina commercial fishery is responsible for landing approximately 20 percent of the South Atlantic landings annually.

Recreational Landings

Spanish mackerel are a favorite of many anglers due to their exciting behavior when hooked and their delicious taste when cooked. Recreational anglers target Spanish mackerel by trolling spoons and plugs inshore. Anglers catch most Spanish mackerel between May and September, once the water temperature has warmed up to 70°F. Anglers harvested 459,982 pounds of Spanish mackerel in 2017 (Figure 2). Recreational landings of Spanish mackerel are estimated from the Marine Recreational Information Program (MRIP) through dockside sampling and phone effort surveys. Recreational harvest has been relatively steady between 400,000 and 600,000 pounds since an initial sharp decline from 968,108 pounds in 2008.

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Length-frequency information for the commercial Spanish mackerel fishery in North Carolina is collected by port agents through the trip ticket program and fish house sampling, specifically the Sciaenid Pound Net Fishery, Ocean Gill Net Fishery, Long Haul Seine Fishery, and Estuarine Gill Nets and Seine Sampling programs (431, 434, 437, and 461). Maximum sizes of Spanish mackerel sampled over the last 10 years have fluctuated from less than 700 mm to over 1,000 mm but, average lengths of harvested fish have remained steady at about 400 mm (Table 1). Ageing structures, otoliths, are collected from fishery-dependent sampling programs and are sent to the Southeast Fisheries Science Center in Panama City, Florida for processing and ageing.

Fishery-Independent Monitoring

Spanish mackerel are frequently caught in the division's statewide Independent Gill Net Survey (Program 915) and Pamlico Sound Trawl Survey (Program 195) from which ageing structures are also collected. Ageing structures, otoliths, are collected from both independent sampling programs and sent to the Southeast Fisheries Science Center in Panama City, Florida for processing and ageing (Table 2). The average size of Spanish mackerel caught in the independent surveys (398 mm) is slightly smaller than the fish sampled from the fisheries (409 mm; Tables 1 and 3).

MANAGEMENT STRATEGY

In North Carolina, Spanish mackerel are included in the North Carolina Fishery Management Plan for Interjurisdictional Fisheries, which defers, to the SAFMC's Coastal Migratory Pelagics FMP and the ASMFC's FMP for Spanish Mackerel (NCDMF 2015; SAFMC 2015; ASMFC 2013).

Spanish mackerel is currently managed under recent Amendment 20A (SAFMC 2014a), Amendment 20B (SAFMC 2015) and Framework Amendment 1 (SAMFC 2014b) to the Coastal Migratory Pelagics Fishery Management Plan. Amendment 20A prohibits the sale of all bag-limit-caught Spanish mackerel, except those harvested during a state-permitted tournament. Amendment 20B establishes separate commercial quotas of Atlantic Spanish mackerel for a Northern Zone (north of North Carolina and South Carolina state line) and Southern Zone (south of North Carolina and South Carolina state line). Framework Amendment 1 modifies the annual catch limits for Spanish mackerel in the U.S. Atlantic and modifies the recreational annual catch target, based on the results of the most recent stock assessments for these stocks. North Carolina currently has a 12-inch fork length minimum size limit, a 15 fish per day bag limit for recreational anglers and a 3,500-pound commercial trip limit. The harvest season is open year-round, and is based on a fishing year of March 1 to the last day in February with commercial and recreational fisheries closing when the quota is reached.

The ASMFC's South Atlantic State-Federal Fisheries Management Board approved the Omnibus Amendment for Spot, Spotted Seatrout, and Spanish Mackerel in 2011 (ASMFC 2011). For Spanish mackerel, the Amendment includes commercial and recreational management measures, adaptive management measures, and a process for Board review and action in response to changes in the federal regulations. This allows for complementary management throughout the range of the species.

The Board approved Addendum I (ASMFC 2013) to establish a pilot program to allow states to reduce the Spanish mackerel minimum size limit for the commercial pound net fishery to 11.5 inches from July through September for the 2013 and 2014 fishing years. In August 2015, the Board evaluated the success of the pilot program and extended the provisions of Addendum I for the 2015, 2016, and 2017 fishing years. The program was created to reduce waste of these shorter fish, which are discarded dead in the summer months, by converting them to landed fish that will be counted against the quota. The addendum responded to reports about the increased incidence of Spanish mackerel one-quarter to one-half inch short of the 12-inch fork length

minimum size limit in pound nets during the summer months which die prior to being released, possibly due to a combination of temperature, stress, and crowding. While work has been done to experiment with wall or panel mesh sizes and escape panels, little success has been made in releasing undersized fish quickly enough to prevent dead discards during this time of year. North Carolina, the only state to implement the Addendum thus far, provides annual reports to the Board on Spanish mackerel catch in its pound net fishery. Current management strategies for Spanish mackerel in South Atlantic waters are summarized in Table 4.

RESEARCH NEEDS

From Omnibus Amendment (ASMFC 2011):

- Increase collection of fishery-dependent length, sex, age, and CPUE data to improve stock assessment accuracy. Simulations on CPUE trends should be explored and impacts on assessment results determined. Data collection is needed for all states, particularly those north of North Carolina.
- Develop fishery independent methods to monitor stock size.
- Develop methodology for predicting year class strength and determination of the relationship between juvenile abundance and subsequent year class strength.
- To ensure more accurate estimates of t^0 , increase efforts to collect age-0 specimens for use in estimating von Bertalanffy growth parameters.
- Provide better estimates of recruitment, natural mortality rates, fishing mortality rates, and standing stock. Specific information should include an estimate of total amount caught and distribution of catch by area, season, and type of gear.
- Commission and member states should support and provide the identified data and input needed to improve the SEDAR process.
- Conduct yield per recruit analyses relative to alternative selective fishing patterns.
- Investigate the discard mortality of Spanish mackerel in the commercial and recreational trolling fisheries and commercial gill net fishery.
- Need observer coverage for Spanish mackerel fisheries: gill nets, cast nets, handlines, pound nets, and shrimp trawl bycatch.
- Evaluate potential bias of the lack of appropriate stratification of the data used to generate age-length keys.
- Evaluate CPUE indices related to standardization methods and management history, with emphasis on greater temporal and spatial resolution in estimates of CPUE.
- Expand Trip Interview Program (TIP) sampling to better cover all statistical areas.
- Complete research on the application of assessment and management models relative to dynamic species such as Spanish mackerel.
- Establish a monitoring program to characterize the bycatch and discards of Spanish mackerel in the directed shrimp fishery in Atlantic Coastal waters.
- Obtain adequate data to determine gutted to whole weight relationships.
- Conduct inter-lab comparisons of age readings from test sets of otoliths in preparation for any future stock assessment.
- Address issue of fish retained for bait (undersized) or used for food by crew (how to capture these as landings).

- Investigate whether catchability varies as a function of fish density and/or environmental conditions.
- Investigate how temporal changes in migratory patterns may influence indices of abundance.
- Investigate the possibility of using models that allow catchability to follow a random walk, which can be useful in tracking longer-term trends in time-varying catchability and thus detect changes over time in CPUE (from SEDAR 2008).

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TABLES

Table 1. Mean, minimum and maximum fork lengths (mm) and total number sampled of Spanish mackerel from fishery dependent sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2008 | 376.7 | 75 | 668 | 2,489 |
| 2009 | 395.3 | 54 | 971 | 3,606 |
| 2010 | 411.6 | 172 | 677 | 4,785 |
| 2011 | 420.9 | 256 | 1080 | 5,523 |
| 2012 | 413.4 | 30 | 704 | 5,576 |
| 2013 | 417.9 | 31 | 723 | 4,009 |
| 2014 | 411.0 | 77 | 766 | 4,558 |
| 2015 | 404.0 | 52 | 701 | 5,935 |
| 2016 | 409.4 | 52 | 739 | 7,486 |
| 2017 | 431.9 | 276 | 688 | 2,180 |

Table 2. Mean, minimum and maximum fork lengths (mm) and total number sampled of Spanish mackerel aged through Comprehensive Life History (Program 930).

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2008 | 362.6 | 196 | 684 | 328 |
| 2009 | 387.9 | 235 | 638 | 317 |
| 2010 | 377.5 | 174 | 645 | 411 |
| 2011 | 383.3 | 155 | 712 | 430 |
| 2012 | 367.5 | 159 | 670 | 557 |
| 2013 | 385.1 | 188 | 699 | 370 |
| 2014 | 373.7 | 192 | 656 | 515 |
| 2015 | 375.5 | 183 | 701 | 412 |
| 2016 | 382.4 | 215 | 739 | 579 |
| 2017 | 473.1 | 177 | 715 | 451 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SPANISH MACKEREL

Table 3. Mean, minimum and maximum fork lengths (mm) and total number sampled of Spanish mackerel from fishery independent sampling programs.

| Year | Mean Length | Minimum Length | Maximum Length | Total Number Measured |
|------|-------------|----------------|----------------|-----------------------|
| 2008 | 328.7 | 80 | 680 | 371 |
| 2009 | 356.6 | 110 | 568 | 547 |
| 2010 | 344.6 | 75 | 550 | 378 |
| 2011 | 356.5 | 52 | 520 | 132 |
| 2012 | 340.9 | 38 | 580 | 122 |
| 2013 | 301.1 | 117 | 608 | 80 |
| 2014 | 266.0 | 42 | 483 | 45 |
| 2015 | 316.0 | 43 | 680 | 266 |
| 2016 | 398.7 | 175 | 568 | 42 |
| 2017 | 519.6 | 209 | 625 | 125 |

Table 4. Summary of management strategies by North Carolina for Spanish Mackerel

| Management Strategy | Implementation Status |
|---|-------------------------------|
| 12 inch minimum size limit | Rule 15A NCAC 03M .0301(a)(1) |
| 15 fish creel limit | Rule 15A NCAC 03M .0301(a)(2) |
| 15 fish creel limit outside three miles only with a NMFS Commercial Vessel Permit | Rule 15A NCAC 03M .0301(a)(3) |
| Charter vessels or head boats with NMFS Commercial Vessel Permit must comply with possession limits when fishing with more than three persons | Rule 15A NCAC 03M .0301(c) |
| Commercial trip limit of 3,500 pounds of Spanish mackerel, king mackerel or in aggregate | Rule 15A NCAC 03M .0301(d) |
| Prohibits purse gill nets when taking king or Spanish mackerel | Rule 15A NCAC 03M .0512 |
| Prohibits sale of Spanish Mackerel harvested from the EEZ in a commercial fishing operation without a valid Federal Commercial Spanish Mackerel Permit; Prohibits charter vessels or headboats with both a valid Federal Atlantic Charter/Headboat Coastal Migratory Pelagics Permit and a valid Federal Commercial Spanish Mackerel Permit to sell Spanish Mackerel from the EEZ when fishing with more than three persons; Prohibits purchase of Spanish Mackerel harvested from the Atlantic Ocean without a valid Federal Gulf and South Atlantic Dealer Permit; Prohibits purchase of Spanish Mackerel from the EEZ from a vessel that does not have a valid Federal Commercial Spanish Mackerel Permit. | Proclamation FF-21-2017 |
| 11 ½ inch fork length minimum size limit for Spanish mackerel for pound nets | Proclamation FF-25-2017 |

FIGURES

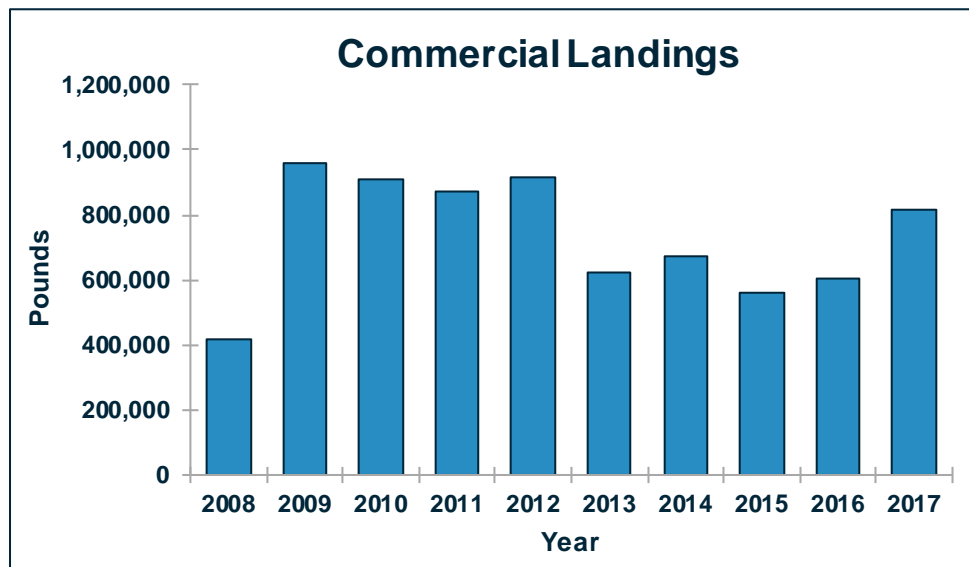


Figure 1. Commercial landings of Spanish mackerel in North Carolina from 2007-2016.

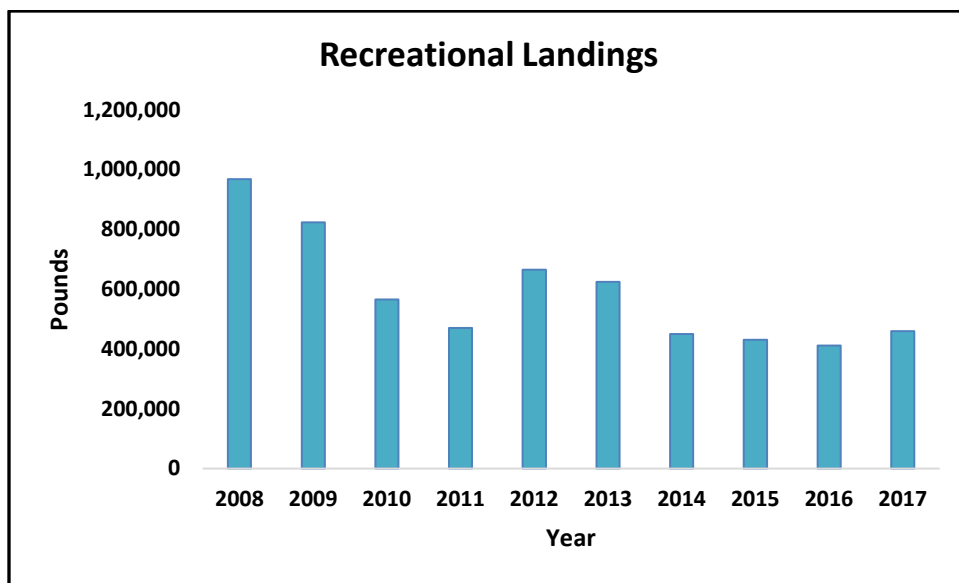


Figure 2. Estimated recreational harvest of Spanish mackerel in North Carolina from 2008-2017.

**FISHERY MANAGEMENT PLAN UPDATE
SPINY DOGFISH
AUGUST 2018**

STATUS OF THE FISHERY MANAGEMENT PLAN

Fishery Management Plan History

| | |
|---------------------------|--|
| MAFMC/NEFMC FMP Adoption: | January 2000 Framework 1 2006 Amendment 1 2007 Framework 2 2009 Amendment 2 2011 Amendment 3 2014 Amendment 4 2015 Framework 3 2018 |
| ASMFC FMP Adoption: | November 2002 Addendum I November 2005 Addendum II October 2008 Addendum III April 2011 Addendum IV August 2012 Addendum V October 2014 |
| Amendments: | None |
| Revisions: | None |
| Supplements: | None |
| Information Updates: | None |
| Schedule Changes: | None |
| Next Benchmark Review: | None |

Spiny dogfish sharks are interjurisdictionally managed by the Mid-Atlantic and New England Fishery Management Councils (MAFMC/NEFMC) in federal waters and the Atlantic States Marine Fisheries Commission (ASMFC) in state waters. A fisheries management plan (FMP) was created for the stock in 2000. The FMP includes an annual commercial quota allocated for each fishing year (May 1-April 30). This quota is subdivided into two semi-annual periods from May 1 through October 31 (57.9%), and November 1 through April 30 (42.1%).

The MAFMC/NEMFC spiny dogfish FMP has had four amendments since initiated in 2000. Amendment 1 requires a standardized method to report by-catch, Amendment 2 establishes

annual catch limits (ACLs) and Accountability Measures (AMs), Amendment 3 allows for updates to essential habitat definitions, establishes provisions to maintain existing management measures (including quotas) in the event of delayed rulemaking, and eliminates the seasonal allocation of the coast-wide commercial quota, and Amendment 4 implemented a standardized bycatch reporting methodology. All amendments were approved by the National Oceanic and Atmospheric Association (NOAA).

In state waters, the ASMFC 2002 Interstate FMP for spiny dogfish establishes the annual quota and possession limits. The Spiny Dogfish and Coastal Shark Management Board, Advisory Panel, Technical Committee, and Plan Review Team oversee the management of spiny dogfish in state waters. The management unit includes the U.S. Atlantic coast (Maine-Florida) distribution of spiny dogfish from the estuaries eastward to the inshore boundary of the exclusive economic zone.

There are no amendments to the ASMFC interstate FMP but there are five addenda. Addendum I allows the Spiny Dogfish Management Board to set multi-year specifications and Addendum II establishes regional allocation of the annual quota with 58 percent to states from Maine to Connecticut. Addendum III was added to create flexibility in quota shares for southern Atlantic States (New York to North Carolina). Addendum III allows for quota transfer between states, rollovers of up to five percent, state-specified possession limits, and includes a three-year reevaluation of the measures. North Carolina is allocated 14.036 percent of the southern quota. Addendum IV standardizes the definitions of overfishing between the three management agencies and adopts a fishing mortality threshold consistent with the federal FMP. Addendum V ensures consistency in spiny dogfish management with the Shark Conservation Act of 2010 by prohibiting processing at-sea, including the removal of fins.

To ensure compliance with interstate requirements, North Carolina (N.C.) also manages spiny dogfish 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).

Management Unit

For spiny dogfish, the entire U.S Atlantic Coast from the estuaries eastward to the inshore boundary of the exclusive economic zone is considered a single stock which is managed by the ASMFC, NEFMC, and MAFMC. North Carolina is allotted a state specific share of the coastwide quota and allowed to specify possession limits in state waters.

Goals and Objectives

The overall goal of the joint MAFMC/NEFMC FMP is to conserve spiny dogfish to achieve optimum yield from the resource. In support of this goal, the follow objectives were adopted:

1. Reduce fishing mortality to ensure that overfishing does not occur.
2. Promote compatible management regulations between state and council jurisdictions and the US and Canada.
3. Promote uniform and effective enforcement of regulations.
4. Minimize regulations while achieving the management objectives stated above.
5. Manage the spiny dogfish fishery to minimize the influences of the regulations on the prosecution of other fisheries, to the extent practicable.
6. Contribute to the protection of biodiversity and ecosystem structure and function.

The goal of the ASMFC FMP for spiny dogfish is to promote stock rebuilding and management of the spiny dogfish fishery in a manner that is biologically, economically, socially, and ecologically sound. In support of this goal, the following objectives are recommended:

1. Reduce fishing mortality and rebuild the female portion of the spawning stock biomass to prevent recruitment failure and support a more sustainable fishery.
2. Coordinate management activities between state, federal, and Canadian agencies to ensure complementary regulations throughout the species range.
3. Minimize the regulatory discards and bycatch of spiny dogfish within state waters.
4. Allocate the available resource in biologically sustainable manner that is equitable to all the fishers.
5. Obtain biological and fishery related data from state waters to improve the spiny dogfish stock assessment that currently depends upon data from the federal bottom trawl survey.

STATUS OF THE STOCK

Life History

Spiny dogfish (*Squalus acanthias*) are found across the Atlantic Ocean in temperate and subarctic waters. In the northwest Atlantic, they range from Labrador, Canada to Florida but are most abundant from Nova Scotia, Canada to Cape Hatteras, North Carolina (Nammack et al. 1985). As seasonal migrants, spiny dogfish tend to select areas where water temperatures range from 45 to 55 degrees Fahrenheit and migrate to coastal waters of North Carolina in the winter

and move north along the Atlantic Coast in the spring (Sulikowski et al. 2010). Spiny dogfish are a relatively long lived and slow growing species reaching a maximum size of approximately 4 feet (Campana et al. 2006). Males are mature at approximately 23.6-inches (6 years), while females mature at between 29.5 and 31.5-inches (12 years; Nammack et al. 1985). The maximum recorded age for males is 35 years and 40 years for females (Campana et al. 2006; Campana et al. 2009). The spiny dogfish gives birth to live young called pups. Spiny dogfish gestation is approximately 22 months with two to 15 pups produced (average of six) in each litter and offspring production (fecundity) increases with fish length (Ketchen 2011). Mating occurs offshore in the mid-Atlantic during the fall and winter and pups are born during the winter in the offshore wintering grounds (Campana et al. 2009).

Stock Status

The latest stock assessment indicates that spiny dogfish are not overfished and overfishing is not occurring (NEFSC 2015a, NEFSC 2015b).

Stock Assessment

The spiny dogfish stock was considered rebuilt in 2008 when female standing stock biomass (SSB) was determined to exceed the target level. The 2015 stock assessment also determined that female spiny dogfish SSB was above the established reference point from 2000-2015 (Figure 1). The 2015 assessment used a fishing mortality (F) target of $F_{40\%}$ spawning potential ratio (SPR) of 0.24 and determined that the observed F was below this target ($F=0.21$). However, potentially low reproductive success from 1997-2003 could affect future SSB and the stock should continue to be closely monitored. The next spiny dogfish stock assessment is scheduled for fall of 2018.

STATUS OF THE FISHERY

Current Regulations

Spiny dogfish are primarily harvested commercially with no recreational regulations in effect. Commercial harvest of spiny dogfish is quota managed with harvest periods and trip limits in federal waters and regional and state quota allocations in state waters. The ASMFC spiny dogfish board approved a 38,195,060-pound quota for the 2018 fishing season. The quota is subdivided into a northern region (Maine to Connecticut) share of 58% of the coastwide quota and the southern region having state-specific shares (New York to North Carolina) with North Carolina receiving 14.036% percent (5,361,166 pounds) of the annual quota. The North Carolina Division of Marine Fisheries (NCDMF) limits harvest with a trip limit and most recently set a trip limit of 20,000 pounds effective November 18, 2017.

Commercial Landings

In North Carolina, spiny dogfish landings steadily increased from 2008 to 2014 but have declined since (Figure 2). Most of the spiny dogfish are landed from the ocean gill net fishery,

but they also have been landed from estuarine gill nets, beach seines, ocean trawls, and hook and line gears (Figure 3).

Recreational Landings

Total annual North Carolina recreational landings, obtained from the NOAA Marine Recreational Information Program, have been diminutive for the past ten years (Table 2). As a source of total mortality, recreational fishing is considered negligible (Rago and Sosebee 2015).

MONITORING PROGRAM DATA

Fishery-Dependent Monitoring

Fishery-dependent monitoring programs for beach seine, estuarine gill net, ocean gill net, and ocean trawl sampled spiny dogfish from 2008 to 2017. Samples were taken at fish packing houses while the catches were offloaded. Fishing captain or crew members were interviewed to obtain information including area fished, gear specifications, and water depth. For each collected sample, length was taken (total and fork) to the nearest mm, aggregated weight was recorded (nearest kg), and sex was determined by the presence/absence of external claspers. Total catch weight for spiny dogfish was collected from the fish house dealer's trip ticket report. From 2008-2017 sampled spiny dogfish total length (TL) has averaged 864mm and ranged between 989-1080 mm TL (Table 3). Numbers of spiny dogfish measured have ranged from 76 in 2017 to 2,461 in 2012 (Table 3). Generally, female spiny dogfish are encountered more often during sampling events most likely due to their relatively higher abundance in offshore areas where fishing occurs (Figure 4). Like many elasmobranch species, spiny dogfish collected in fish house sampling exhibited sexual dimorphism with males (Table 4) generally having a smaller average body size than females (Table 5).

Fishery-Independent Monitoring

The NCDMF initiated a fisheries independent gill net survey of Pamlico Sound in 2001. The objective of this project is to provide annual, independent, relative-abundance indices for key estuarine species in the near shore Pamlico Sound. The survey employs a stratified random sampling design and utilizes multiple mesh gill nets (3.0-inch to 6.5-inch stretched mesh, by ½-inch increments). A total of 797 spiny dogfish were measured in the Pamlico Sound independent gill net study from 2001 to present. Total length ranged from 511 to 1,010 millimeters and averaged 841 millimeters during the total survey period (Table 6).

MANAGEMENT STRATEGY

To set the annual spiny dogfish quotas, an annual joint meeting between the ASMFC Technical Committee and MAFMC Monitoring Committee is held. The Technical and Monitoring committees make quota recommendations after considering discards, Canadian landings, and management uncertainty. To ensure effective management, quota recommendations are informed using fisheries data collected from the previous fishing season. These quota

recommendations are then communicated to the Spiny Dogfish and Coastal Shark Management Board and MAFMC for approval. Current management targets and thresholds are below:

- $F_{msy} = 0.244$; allows for the production of 1.5 female pups per female that will recruit to the spawning stock biomass (SSB).
- $SSB_{target} = 351$ million pounds (159,288 metric tons); level of biomass that would maximize recruitment to the population (100 percent SSB_{max}).
- $SSB_{threshold} = 175$ million pounds (79,644 metric tons); 50 percent of SSB_{target}

RESEARCH NEEDS

Continuing research priorities from the ASMFC FMP include:

- Determine area, season, and gear specific discard mortality estimates coast wide in the recreational, commercial, and non-directed (bycatch) fisheries.
- Monitor the level of effort and harvest in other fisheries as a result of no directed fishery for spiny dogfish.
- Characterize and quantify bycatch of spiny dogfish in other fisheries.
- Increase observer trips to document the level of incidental capture of spiny dogfish during the spawning stock rebuilding period.
- Conduct a coast wide tagging study to explore stock structure, migration, and mixing rates.
- Standardize age determination along the entire East Coast. Conduct an ageing workshop for spiny dogfish, encouraging participation by NEFSC, NCDMF, Canada Department of Fisheries and Oceans, other interested agencies, academia, and other international investigators with an interest in dogfish ageing.

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ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SPINY DOGFISH

TABLES

Table 1. Commercial spiny dogfish landings (lbs.) by gear 2008-2017 (Division Trip Ticket Program)

| Year | Ocean Gill Net | Beach Seine | Ocean Trawl | Ocean Hook-N-Line/Longline | Estuarine Gill Net | Other Estuarine Gears | Annual Total |
|------|----------------|-------------|-------------|----------------------------|--------------------|-----------------------|--------------|
| 2008 | 158,562 | | | | 165 | | 158,727 |
| 2009 | 1,405,549 | 10,486 | | | 327 | | 1,416,362 |
| 2010 | 1,695,878 | 11,170 | 1,273 | | 116 | | 1,708,437 |
| 2011 | 2,553,293 | | 4,500 | | 130 | | 2,557,923 |
| 2012 | 2,663,008 | 65,645 | | | 229 | | 2,728,882 |
| 2013 | 3,000,602 | | | | 10,356 | | 3,010,958 |
| 2014 | 5,643,146 | | 1,800 | | 5,339 | | 5,650,285 |
| 2015 | 4,223,979 | 4,090 | | 10,000 | 9,139 | 5 | 4,247,213 |
| 2016 | 2,225,279 | | 319 | 6,250 | 9,548 | | 2,241,396 |
| 2017 | 389,504 | | | | 3,581 | | 393,085 |

Table 2. North Carolina recreational spiny dogfish harvest and discards from Marine Recreational Information Program survey for 2008-2017 (NMFS 2018).

| Year | Harvest Number (A+B1) | PSE (Num) | Weight (lbs.), (A+B1) | PSE (lbs.) | Number Released | PSE |
|-----------------|-----------------------|-----------|-----------------------|------------|-----------------|------|
| 2008 | 0 | N/A | 0 | N/A | 10,139 | 58.4 |
| 2009 | 0 | N/A | 0 | N/A | 8,854 | 73.2 |
| 2010 | 1,070 | 64.7 | 5,399 | 69.7 | 31,644 | 37.7 |
| 2011 | 1,247 | 73.3 | 8,294 | 75.9 | 39,908 | 41.1 |
| 2012 | 140 | 71.2 | 712 | 71.2 | 25,515 | 36.9 |
| 2013 | 3,404 | 75.4 | 6,134 | 67.4 | 135,333 | 47.5 |
| 2014 | 853 | 72.1 | 4,296 | 79.4 | 80,131 | 37.1 |
| 2015 | 8,140 | 77.6 | 43,797 | 88.1 | 75,189 | 53.1 |
| 2016 | 1,708 | 72.6 | 11,770 | 70.4 | 5,413 | 44.0 |
| 2017 | 227 | 61.6 | 1,739 | 64.6 | 3,757 | 54.0 |
| 10 Year Average | 1,679 | | 8,214 | | 41,588 | |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SPINY DOGFISH

Table 3. Summary table of spiny dogfish trips sampled sample weight (kg) and length data collected from dependent sampling surveys from 2008-2017.

| Year | Number of Trips Sampled | Total Number Measured | Sample Weight (kg) | Mean Total Length (mm) | Minimum Total Length (mm) | Maximum Total Length (mm) |
|------|-------------------------|-----------------------|--------------------|------------------------|---------------------------|---------------------------|
| 2008 | 10 | 545 | 1,369 | 859 | 724 | 995 |
| 2009 | 28 | 1,048 | 2,650 | 864 | 704 | 1,080 |
| 2010 | 23 | 843 | 2,227 | 861 | 712 | 1,015 |
| 2011 | 24 | 686 | 1,893 | 847 | 661 | 1,005 |
| 2012 | 67 | 2,461 | 7,030 | 876 | 681 | 1,074 |
| 2013 | 66 | 2,373 | 6,765 | 877 | 668 | 1,035 |
| 2014 | 63 | 2,168 | 6,025 | 878 | 470 | 1,065 |
| 2015 | 41 | 1,365 | 3,731 | 873 | 634 | 1,021 |
| 2016 | 24 | 795 | 2,463 | 872 | 600 | 1,015 |
| 2017 | 3 | 67 | 179 | 836 | 693 | 989 |

Table 4. Length data collected from male spiny dogfish sampled across all commercial gears from 2008-2017.

| Year | Mean Total Length (mm) | Minimum Total Length (mm) | Maximum Total Length (mm) | Total Number Measured |
|------|------------------------|---------------------------|---------------------------|-----------------------|
| 2008 | 792 | 741 | 937 | 18 |
| 2009 | 786 | 721 | 940 | 54 |
| 2010 | 785 | 712 | 895 | 49 |
| 2011 | 765 | 700 | 829 | 34 |
| 2012 | 769 | 702 | 882 | 87 |
| 2013 | 779 | 670 | 896 | 88 |
| 2014 | 776 | 641 | 844 | 74 |
| 2015 | 795 | 640 | 968 | 84 |
| 2016 | 772 | 661 | 894 | 68 |
| 2017 | 764 | 693 | 820 | 14 |

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SPINY DOGFISH

Table 5. Length data collected from female spiny dogfish sampled across all commercial gears from 2008-2017.

| Year | Mean Total Length (mm) | Minimum Total Length (mm) | Maximum Total Length (mm) | Total Number Measured |
|------|------------------------|---------------------------|---------------------------|-----------------------|
| 2008 | 862 | 724 | 995 | 527 |
| 2009 | 868 | 704 | 1,080 | 994 |
| 2010 | 865 | 715 | 1,015 | 794 |
| 2011 | 852 | 661 | 1,005 | 647 |
| 2012 | 880 | 681 | 1,074 | 2,373 |
| 2013 | 881 | 668 | 1,035 | 2,285 |
| 2014 | 882 | 470 | 1,065 | 2,094 |
| 2015 | 878 | 634 | 1,021 | 1,281 |
| 2016 | 881 | 600 | 1,015 | 727 |
| 2017 | 855 | 730 | 989 | 53 |

Table 6. Length data of spiny dogfish collected from the Pamlico Sound independent gill net survey from 2001-2017.

| Program | Time Series | Mean Total Length (mm) | Minimum Total Length (mm) | Maximum Total Length (mm) | Total Number Measured |
|---|-------------|------------------------|---------------------------|---------------------------|-----------------------|
| Pamlico Sound Independent Gill Net Survey | 2001-2017 | 841 | 511 | 1,010 | 797 |

FIGURES

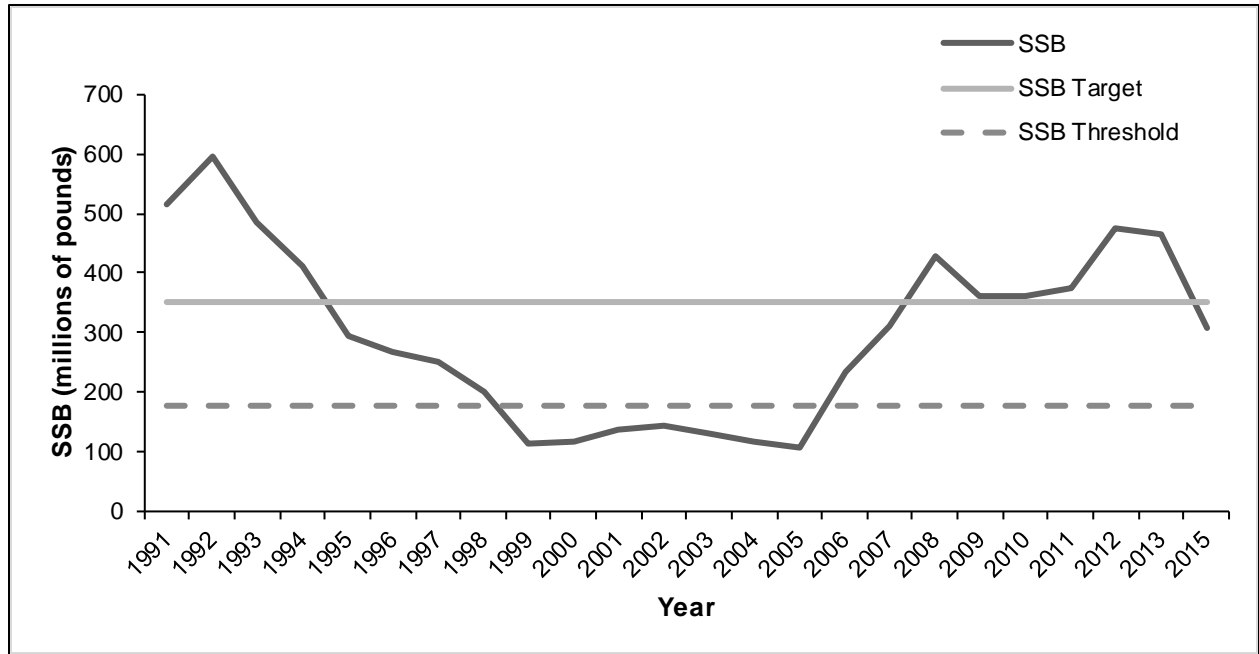


Figure 1. NEFSC spiny dogfish spawning stock biomass 1991-2015 (Note: 2014 was not included in the 2015 update due to a mechanical breakdown in the NEFSC trawl survey.)

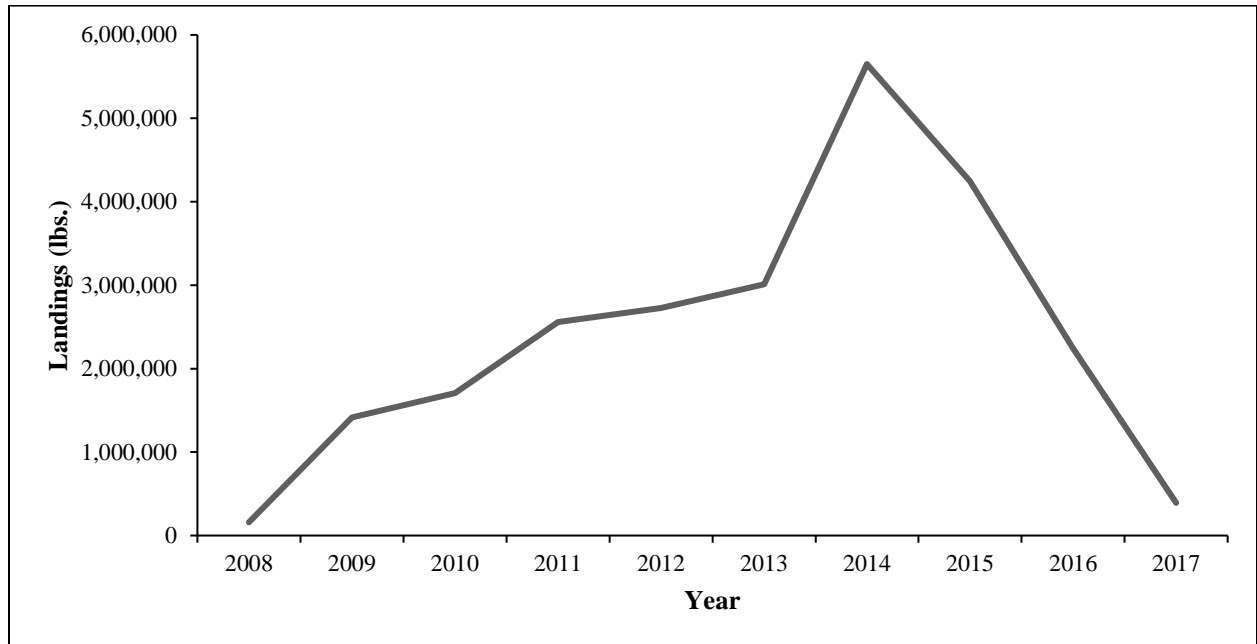


Figure 2. Annual total commercial spiny dogfish landings (lbs.) across all gear types from 2008-2017 (NCDMF Trip Ticket Program).

ASMFC AND FEDERALLY-MANAGED SPECIES WITHOUT N.C. INDICES – SPINY DOGFISH

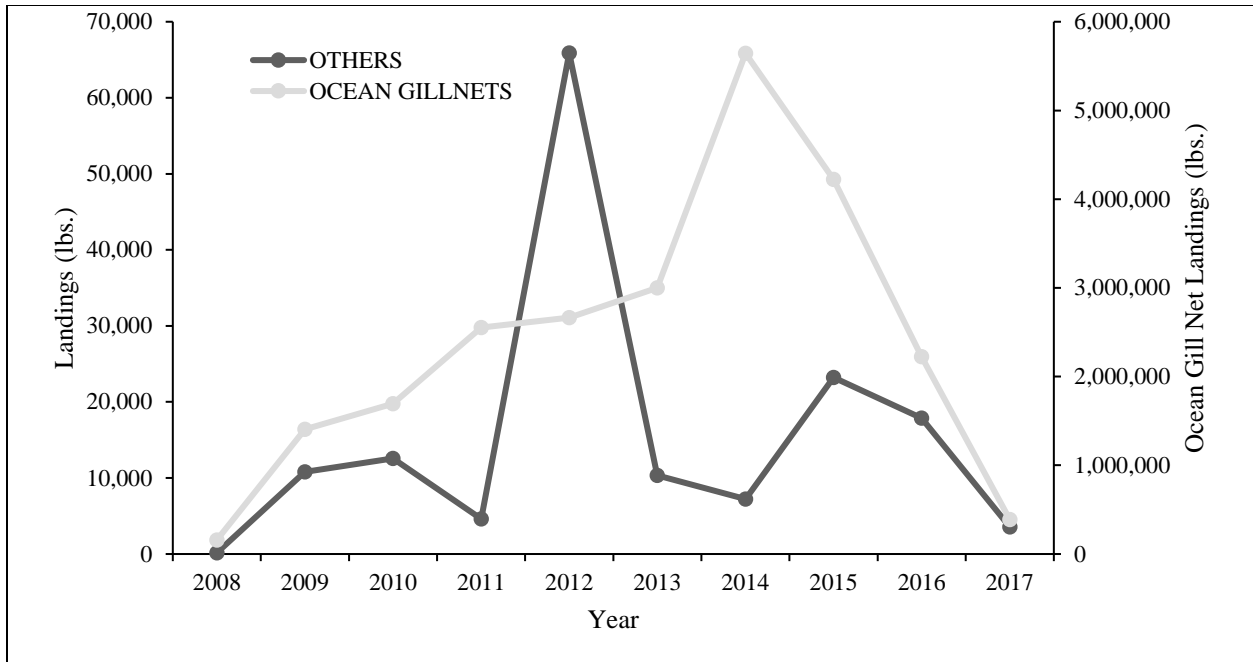


Figure 3. Annual total commercial spiny dogfish landings (lbs.) in the ocean gillnet fishery compared to all other ocean fisheries from 2008-2017 (NCDMF Trip Ticket Program).

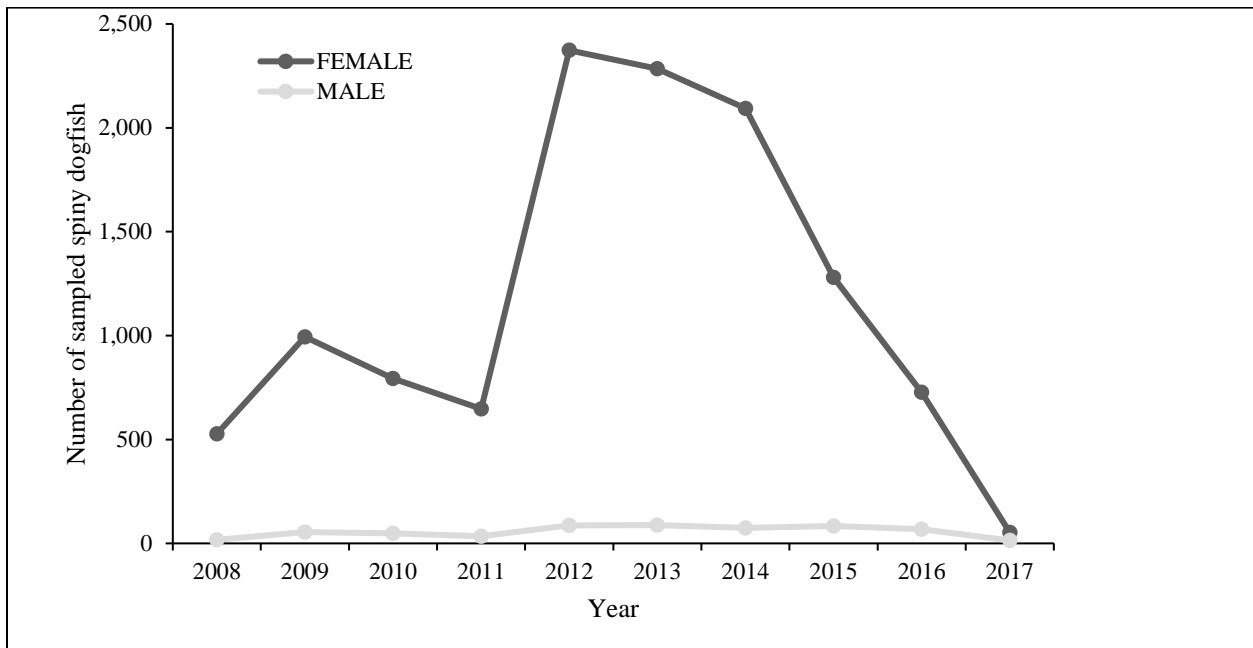


Figure 4. Number of spiny dogfish samples collected in all fishery-dependent surveys by sex.